Hedonic Aspiration Control*

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Abstract

Faced with tradeoffs between hedonic pleasure from ordinary consumption and an effective technology that reduces the amount of consumption required to avoid discontentment, our model shows how utility maximizing consumers allocate wealth between hedonic consumption and aspiration control. Aspiration control turns out to be an inferior good over a large subset of parameter space. Demand for hedonic aspiration control is discontinuous and non-monotonic with respect to price (i.e., sometimes Giffen). Our simple, one-shot allocation problem therefore reveals a surprising anything-goes result for ordinary demand. Counterintuitive consumer responses to subsidies and supply shocks in markets for aspiration control are likely.

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1 Introduction

"Excessive" borrowing, housing purchases, and risk taking (of virtually all kinds) feature prominently in debates over consumer protection regulation and uptake of privately produced products designed to help consumers better control their spending.[1] The model presented in this paper describes an agent who, after thinking through different ways of maximizing utility, faces a trade-off when allocating resources between ordinary hedonic consumption and expenditures on a costly preference-change technology that shifts the experienced utility associated with any fixed quantity of ordinary hedonic consumption higher (or, equivalently, enabling the consumer to feel just as well off—hedonically—while consuming less).

The consumer in our model allocates expenditure by asking: Is it better to increase (expected) levels of ordinary consumption conditional on what one wants, or control what one wants conditional on what one has?[2] Following standard competitive price theory, our model assumes that the consumer takes the price of preference-change technology as given (relative to ordinary consumption, which serves as the numeraire). The model then provides an optimal choice rule for consumers who simultaneously consider trade-offs between allocating resources (i.e., an income or wealth endowment) to raising expected quantities of ordinary consumption versus costly preference-change technology that increases the likelihood that one will be satisfied with the quantity of ordinary consumption received ex post. Our model therefore addresses the questions: (i) How to optimally allocate a fungible resource between aspiration control and ordinary hedonic consumption in an otherwise orthodox model of consumer choice?; and (ii) How do consumers with access to an aspiration-control technology respond to exogenous changes in price and income?

Policies, programs and products aimed at cultivating aspiration control are interpreted as interventions that lower the price of aspiration control. Our model provides an answer to the question of how consumers might respond to new incentives to take up aspiration control. Re-allocating a dollar from ordinary consumption into the desire-moderating technology (i.e., aspiration control) pays off only if the aspiration-control technology succeeds at shifting a contentment threshold sufficiently downward so that the consumer experiences greater utility from the reduced quantity of ordinary consumption (affordable after re-allocating from hedonic consumption into aspiration-control technology). In the stochastic version of the model, aspiration control directly raises utility by transforming preferences such that every fixed level of ordinary consumption yields greater experienced satisfaction because, ex ante, it provides a reduced risk of falling short of one's goal. This mechanism captures

[1] The yoga and diet industries, with estimated annual sales of 6 and 60 billion US dollars, respectively (Kendall, 2011; LaRosa, 2011), are examples of private suppliers of products designed to moderate desire and shift aspirations. Counseling programs for compulsive behaviors of many kinds, including compulsive borrowing and compulsive consumption, are provided by multiple industries, nonprofits and, in some cases, governments.

[2] Differing views about how humans achieve happiness are found in various philosophical traditions, as discussed in detail by Bruni and Porta (2007), who emphasize the importance of social ties and the need to apply techniques that moderate desire for hedonic consumption. Although the topics of aspiration control and moderation of desire are sometimes described in esoteric terms, this paper focuses on aspiration control in the context of ongoing financial market crises and numerous proposals in public policy debates aimed at helping consumers manage their borrowing, consumption, and use of financial services with high borrowing costs.

a simple motive for aspiration control, revealing surprising non-monotonicities relevant to uptake rates and consumer responses to the provision or cultivation of aspiration control.

Among the surprising results that emerge from this simple model are the following. First, aspiration control may be an inferior good (i.e., demand decreases as a function of exogenously given money or wealth). Second, because of the joint interaction of ordinary consumption and the contentment threshold (which are the two choice variables under the decision maker's control), demand for aspiration control exhibits unusually strong income effects, resulting in upward-sloping segments of the consumer's demand curve on a dense subset of the model's parameter space. Thus, the model provides one explanation for consumers who prefer high-priced aspiration-control technologies.

Finally, because demand for aspiration control is non-monotonic in price (in the stochastic version of the model), and because the globally maximizing level of aspiration control switches discontinuously from interior to corner solutions as a function of price, the model cautions us to expect highly unstable demand responses to changes in the relative price of aspiration control. Small changes in price (over large regions of the model's parameter space) can produce dramatic shifts in demand for aspiration control, equivalent to different social norms regarding what constitutes adequate personal savings, or what constitutes adequate investment in human capital, and the emergence of religious revolutions that focus on asceticism and moderation of desire for material or worldly consumption. Therefore, attempts (by policy makers, nonprofits, banks, and other firms selling aspiration control services) to influence consumers to take up aspiration control by introducing financial incentives (e.g., reductions in the price of aspiration control) may have no effect at all, disappointingly small effects, or—in the case where the decision-making environment is situated on an upward-sloping portion of the demand schedule for aspiration control—large effects in the opposite direction from what was intended. Given a sufficiently precise description of all parameters required to pin down exogenous factors in the decision-making environment, the consumer's demand function as derived below does provide (mostly) unambiguous predictions about consumer responses to incentives aimed at inducing greater aspiration control. Any imprecision in those parameter estimates, however, would lead to indeterminate signs on the predicted demand responses of aspiration control and a high likelihood of unintended consequences for those attempting to encourage its uptake by lowering its price.

It is somewhat puzzling that deliberative choice over varying quantities of costly preference change is not more widely discussed in behavioral economics and decision sciences more generally. Purposeful preference change and the deliberative processes that underlie it would appear to be a regularity in observed real-world consumer behavior. Consumers purchase (and industries supply) products intended to moderate desire. In addition to private and government supply of aspiration control technology, a number of social groups and religious schools of thought attract substantial communities of practitioners seeking to self-manage their hedonic desires as a fundamental of wellbeing. Prime examples of teachings that recommend deliberate consideration of aspiration control can be found in quotes (attributed to Stoic philosopher Epictetus) such as: "Freedom is secured not by the fulfilling of men's desires, but by the removal of desire;" and "He is a wise man who does not grieve for the things which he has not, but rejoices for those which he has."[3] Controling desire and

[3]Samuelson, in his famous principles textbook, introduces the "ancient formula, Happiness = material

limiting psychological attachment to material consumption is well recognized in Buddhist, Hindu and other Eastern traditions and rose to prominence in segments of Western society as well (e.g., Cynic philosophers' concept of Eudaimonia, which required asceticism, making do with the bare necessities of survival, and indifference to money and conventional metrics of value; Stoic philosophers' emphasis on avoiding suffering by controling hedonic desire; and the ascetic teachings of Christian monastics). In contrast, Calvinists, Puritans and other Protestant groups with their own strands of ascetic teachings nevertheless placed positive value on the goal of accumulating material wealth (while limiting the ways in which it should be enjoyed).

Both deliberative and automatic components of desire appear in the first two definitions for the noun *desire* in the *Merriam-Webster Dictionary*: (1) "conscious impulse toward something that promises enjoyment or satisfaction in its attainment," and (2) "longing, craving, sexual urge or appetite." Our model attempts to capture both of these components of desire with a utility function that depends on a contentment threshold under the decision maker's control (i.e., the deliberative aspect) and on ordinary consumption (i.e., the automatic mechanism mapping ordinary consumption into hedonic satisfaction).

Reducing one's desired level of ordinary consumption reduces the chance of disappointment or discontentment in the event that hedonic consumption fails to meet the desired level.[4] This asymmetry with respect to a reference point is consistent with similar asymmetries in experienced utility from losses and gains that are widely studied in behavioral economics. What is novel in our model is the surprising non-monotonicity of income and price responses. The optimal quantity of aspiration control turns out to be discontinuous and non-monotonic in price and income, giving rise to a new theoretical possibility rationalizing the Giffen phenomenon (i.e., upward-sloping segments on the consumer demand curve). Introducing rational choice over quantities of a technology for controling hedonic aspiration leads to an anything-goes result for consumer demand.

One immediate implication of this theoretical indeterminacy and our model's endogenously derived demand discontinuities (by which a small price change leads to discontinuous jumps toward, or away from, a corner solution) is that firms and governments trying to encourage uptake of aspiration control by reducing its price (i.e., subsidizing it) are likely to face disappointingly counterintuitive behavioral responses that violate standard predictions based on textbook price theory. Without introducing consumer irrationality, time inconsistency, or powerful income effects in general equilibrium, our simple approach demonstrates that the only modeling element required to drive non-monotonicity and discontinuity of demand is inclusion of hedonic aspiration control as a choice variable in an otherwise standard resource allocation problem.

consumption / desire" (Samuelson, 1955, p. 707). Samuelson goes on to dismiss attempts to increase happiness by reducing desire as old fashioned: "Thoreau's counsel to hold down the denominator now gives way to insistence on increasing the numerator of material real income." In later editions of Samuelson's textbook, he again disparages "decreased desire to consume" in connection with the so-called paradox of thrift.

[4]Our specification of the consumer problem as a one-shot allocation decision (with a known quantity of aspiration-control technology and an uncertain quantity of hedonic consumption) obviously does not account for all mechanisms of aspiration control (e.g., adaptive aspiration mechanisms in multi-period dynamic models in which time inconsistency may arise). The stark simplicity of our model makes the finding of unstable and non-monotonic demand curves even more surprising.

The paper proceeds as follows. Section 2 discusses related literature providing motivation and context for our model. Section 3 introduces a deterministic model of aspiration control and solves for optimizing quantities of ordinary consumption and aspiration control. Section 4 specifies the stochastic version of the decision problem and expresses demand for aspiration control as a function of: the price of aspiration control, income, risk, and the parameters specifying both production and aspiration control technologies. Section 5 reports comparative statics showing that aspiration control technology in the standard consumer problem is an inferior good. Section 6 graphically depicts non-monotonic and discontinuous demand curves for aspiration control. Section 7 concludes with a discussion of the model's applications to consumer finance, markets for aspiration control technology and institutional design.

2 Motivation

The literature on reference-point-dependent preferences can be classified into two broad streams. The first consists of habit formation or status-quo effects. In such models, the reference point is determined by an aggregator function that maps acts of consumption from the past into a reference point that is assumed to be relevant in the present (e.g., the arithmetic mean of past consumption). Ryder and Heal (1973), Sundaresan (1989), Abel (1990), Constantinides (1990) and Campbell and Cochrane (1999) provide further detail regarding the habit formation approach. Smith's (2004) endogenous preference model of food choice uses an original approach to modeling habit formation and provides analysis of yet another aspect of consumer behavior that our deliberative model of aspiration control is intended to complement. The second broad stream of research on reference-point-dependent preferences allows current reference points to depend on future expectations, by mapping perceived future payoff distributions into the reference point (as determined by some specification of forward-looking expectations). Kőszegi and Rabin (2006, 2007, 2009) and Crawford and Meng (2011) are examples of this approach. Therefore, in sequential choice models, the reference point can be viewed: (i) as an aggregator function that maps past consumption acts into a present reference point, which is interpreted as a habit; or (ii) as a functional operator mapping future random utility distributions into a present aspiration.

Our simple and stylized model demonstrates that, without taking a stand on which of these temporal mechanisms drives the determination of reference points, we can still say something about the deliberative component of aspiration control. That preferences are, to a partial extent, a choice variable in our model draws motivation from George's (2001) meta-preferences theory and from the observation that people regularly attempt to transform their preferences by means of various techniques for moderating desire.

After introspecting on one's goals and various means of reaching them, the decision maker in our model wishes to modify his or her objective in a way that makes the desired level of hedonic consumption more achievable (i.e., less prone to the discontentment). There is abundant evidence suggesting that higher hedonic aspirations can reduce individual happiness (e.g., Stutzer, 2004). If a person's hedonic aspiration is too high, then the gap between aspiration level and realized levels of hedonic consumption generates substantial psychological costs according to many behavioral theories and in empirical studies (e.g., Iga's (1986)

The Thorn In The Chrysanthemum: Suicide and Economic Success in Modern Japan). Many authors explain this phenomenon by arguing that what really matters for happiness is not income *per se* but the gap between income and material aspirations (e.g., Easterlin, 1995, 2001; Frey and Stutzer, 2002). With awareness of the potential psychic costs of excessively high hedonic aspirations, we note that consumers can, and sometimes do, choose to substitute out of ordinary consumption into expenditures allocated to preference-change technology with the goal of moderating desire for hedonic consumption.

Acquisition of costly desire-changing technology is referred to in this paper as *demand for aspiration control* to distinguish from demand for expenditures on everything other than aspiration control, which we refer to as *ordinary consumption* (i.e., goods and services that monotonically increase utility, holding hedonic preferences fixed). Our model provides comparative statics of the consumer's demand for aspiration control, describing how consumers optimally respond to new regulatory institutions, educational campaigns, and supply shocks that expand the available quantity, and/or relative price, of services aimed at helping consumers improve hedonic aspiration control. Rather than uptake of aspiration control always responding inversely to exogenous changes in its price, our model shows that small differences in income and price generate optimal consumer responses of generally indeterminate sign.

In *More Die of Heartbreak,* novelist Saul Bellow (1987) wrote: "the deficiencies of the undeveloped countries in the East lie in shortage of matter, while the maladies of developed countries in the West consist in expansion of desires." We acknowledge the risk of over-interpreting the influence of ascetic teachings on individual behavior across developing regions in Asia and Middle East in the context of economic development, where multiple causal factors not included in our model would play obviously important roles. Many have nevertheless argued for the view that religiously inspired asceticism was at least partly responsible for relatively low levels of economic development and material consumption, because ascetic teachings helped establish and reinforce social norms that encouraged deliberate lowering of hedonic aspirations. In contrast, developed countries have, according to critics of excessive consumerism, actively intensified hedonic desire by encouraging extraordinary aspirations (by historical standards) for increasing consumption levels despite already enjoying high levels of material comfort.

The exogenous preference model of neoclassical economics focuses on maximization of a utility function that depends on ordinary consumption while holding preferences and an exogenously given resource constraint (determined jointly by prices and income or wealth) fixed. The alternative goal-seeking model that we focus on, which fits within the standard neoclassical framework (yet, is rarely addressed in this literature), solves the following problem instead: Given prices and the resource constraint, the consumer maximizes satisfaction derived from his or her wealth by allocating it (in some continuously valued combination) to ordinary consumption and to purposeful preference change with the aid of an aspiration-control (or hedonic-desire-changing) technology.

Goal seeking is modeled and tested empirically by Güth (2010), Berninghaus, Güth, Levati and Qiu (2011), and Güth, Levati and Ploner (2009). Fisher and Montalto (2010) use a reference-point-dependent model similar in spirit to ours, combined with empirical analysis of a large survey data set, to argue for the empirical relevance of reference points, goal setting, and the importance for policy makers to consider multiple consumer goals. Jain

(2009) presents a related model of goal seeking but without the contentment threshold in our specification of utility. Consistent with our paper, Samwick (2006) documents heterogeneous goals among savers; Zhang, Huang and Broniarczyk (2010) demonstrate additional dimensions of the consumer's multiple goals; and a number of experimental studies lend support to goal setting as a primary behavioral mechanism that can, when mishandled or taken to excess, result in discontentment (Lee and Ariely, 2006; Trudel, Cotte and Murray, 2008; Drolet, Luce and Simonson, 2009).

Preference transformation technologies put forward in the aspiration control literature include Wertenbroch (1998); Thaler and Benartzi (2004); Dey and Mumy (2005); Kumru and Thanopoulos (2008); do Vale, Pieters, and Zeelenberg (2008); Barr and Dokko (2008); Kerr and Dunn (2008); Sprenger and Stavins (2008); and Bertaut, Haliassos and Reiter (2009). The mechanism by which the quantity demanded of aspiration control (denoted in the next section as s) moderates desire is assumed to take the form of a controlable threshold-level of ordinary consumption that determines when the event of contentment (or its set complement, discontentment) occurs. Contentment and discontentment are psychological states defined in terms of this threshold parameter (motivated by the threshold-dependent approaches of Simon, 1956; Gigerenzer and Selten, 2002; and Güth, 2010), which appears as an explicit choice variable in our model. Jain (2009) studies goal attainment, with the interesting finding that it is sometimes better for consumers not to have any goals. Our model is not a satisficing model because it wholly adopts the assumption of utility maximization and its implication of exhaustive search through the choice set rather than limited search (as in the satisficing model), although the threshold mechanism that defines discontentment in our model functionally resembles satisficing.

3 The Deterministic Model

3.1 Reference-Point-Dependent Utility Function

Let x ($x \geq 0$) represent the quantity of ordinary hedonic consumption the decision maker chooses. As distinct from ordinary consumption x, we now introduce notation for the other quantity variable in the allocation problem that the consumer faces, s, representing a quantity of hedonic aspiration control ($s \geq 0$) directed at one's self, purchased at a known cost, and known by the consumer to increase the utility associated with any fixed quantity of ordinary consumption. The consumer is assumed to understand—and deliberate about—how different quantities of s affect the shape of the utility function. The following paragraph describes how our model represents this deliberative reasoning about allocation of scarce resources to the preference-transforming quantity s.

Aspiration control affects utility by reducing the likelihood that the consumer's ordinary consumption falls short of his or her aspiration (for ordinary consumption), all else equal.[5]

[5]The desire-changing technology referred to as aspiration control enables one to feel content with less. Discontentment and contentment refer to a psychological component of the utility function that is distinct from its hedonic component which depends only on x, as defined subsequently when the full specification of utility for the respective cases of deterministic and stochastic ordinary consumption is introduced. Examples of allocating wealth to the purpose of moderating demand for ordinary consumption observed in the real world would include taking part in (and possibly paying for) counseling programs for compulsive consumption

All else is *not* equal, however, whenever the decision maker adjusts s, because increasing s raises the experienced utility of any value of x. When the consumer raises s (to a higher level of aspiration control), doing so incurs a real cost. Therefore, at the cost of wealth that would otherwise go toward ordinary consumption, the decision maker in our model can choose instead to spend on lowering the threshold that defines contentment and thereby actively transform his own preferences.

The threshold level of ordinary consumption that defines contentment is denoted $t = t(s)$, which depends on aspiration control s. If $x < t(s)$, then the event of discontentment occurs, which reduces utility by an amount representing the psychic cost of failing to achieve one's goal in terms of ordinary consumption. When $x \geq t(s)$, the discontentment term is zero.[6]

The assumption that s can only contribute positively to utility by reducing the threshold that separates the range of ordinary consumption levels into discontented and contented outcomes implies that greater allocations of wealth into s are required to reduce the threshold t: $\frac{dt(s)}{ds} < 0$ (assuming differentiability of the aspiration control technology as a function of s). This inequality is a natural assumption about the preference-transformation technology for moderating desire. Aspiration control reduces the level of ordinary consumption needed to avoid the psychological state of discontentment. If the linear technology $t(s) = t_0 - s$ is assumed, then $t'(s) = -1$. Here, t_0 can be interpreted as an exogenously given initial goal (or shared social norm) for ordinary consumption that would obtain when no aspiration control is applied ($s = 0$).

The magnitude by which ordinary consumption falls short of the threshold t is $\max\{t - x, 0\}$. Utility is then increasing in x and decreasing in $\max\{t - x, 0\}$. Let $y = -\max\{t(s) - x, 0\} = \min\{x - t(s), 0\}$. Then, utility is specified as the function $U(x, y)$, which is increasing in both arguments. The key trade-off in the model concerns the effects on utility of reducing ordinary consumption (x) and re-allocating that amount into acquisition of aspiration control (s), which reduces the contentment threshold (t) or, equivalently, increases y.

3.2 Resource Constraint

The exogenously given unit price of aspiration control is denoted as p and the consumer's money income as M.[7] Then, the budget constraint can be expressed as:

$$x + ps \leq M, \tag{1}$$

where ordinary consumption serves as the numeraire with price equal to 1.

as well as market transactions for books, services, and experiences that can be regarded as aspiration control technology and therefore not considered ordinary consumption. Ordinary consumption, then, is a residual consumption category, including all goods and services not used for aspiration control.

[6] DeJong and Ripoll's (2007) alternative approach adds a temptation cost to the objective function that is proportional at each period to the utility that would have been derived from spending one's entire lifetime wealth on present consumption.

[7] In a one-period model, M can be interpreted equivalently as income or wealth.

3.3 The Consumer's Decision Problem

The consumer's decision problem can now be specified in detail. The decision maker chooses x and s to maximize utility subject to the budget constraint and the aspiration control technology constraint:

$$\max_{(x,s)\in\Re^2_+} U(x,y), \text{ such that } x+ps \leq M, y=\min\{x-t(s),0\}. \tag{2}$$

Denote any solution to the problem above (assuming that at least one exists) as x^* and s^*. The following lemma shows that, at any optimal choice (x^*,s^*), the consumer never chooses $x^* > t(s^*)$. The intuition is clear. If the constraint were not satisfied, then the consumer could have maintained the same level of discontentment remediation y by slightly reducing s, which could then be re-allocated to increasing x, thereby achieving greater utility.

Lemma 1. *Given that $\frac{\partial U(x,y)}{\partial x}$ exists and $\frac{\partial U(x,y)}{\partial x} > 0$ for all x, then $x^* \leq t(s^*)$.*

Proof. Suppose not, so that $x^* > t(s^*)$. Take $x' = x^* + p\epsilon$ and $s' = s^* - \epsilon$, where $\epsilon > 0$ is chosen small enough that $x' > t(s')$. The pair (x',s') still satisfies the budget constraint, and $\min\{x'-t(s'),0\} = \min\{x^*-t(s^*),0\} = y$, implying that y takes on the same value at (x^*,s^*) and (x',s'). Because utility is strictly increasing in x, then $U(x',y) > U(x^*,y)$, which contradicts the definition of (x^*,s^*) as a utility-maximizing choice.

This lemma states that aspiration control will never be wasted at an optimal choice of (x,s). At an optimal choice, either discontentment occurs rationally (because aspiration control is not worth paying for) or else the constraint $x^* \leq t(s)$ is binding (i.e., ordinary consumption is set just equal to the contentment threshold). By this lemma, we can replace $y=\min\{x-t(s),0\}$ with $y=x-t(s)$ and rewrite the consumer problem more simply:

$$\max_{(x,s)\in\Re^2_+} U(x,y), \quad \text{such that} \;\; x+ps \leq M, y=x-t(s), y\leq 0. \tag{3}$$

Assuming an interior solution, the first-order conditions give rise to:

$$\Big(\frac{\partial U(x,y)}{\partial x} + \frac{\partial U(x,y)}{\partial y}\Big)/\Big(-\frac{dt(s)}{ds}\frac{\partial U(x,y)}{\partial y}\Big) = \frac{1}{p}. \tag{4}$$

The usual interpretation is applicable. The left-hand side of equation (4) is the marginal rate of substitution between x and y, while the right-hand side is the price ratio.

To investigate comparative statics, we assume: $\frac{\partial^2 U(x,y)}{\partial x^2} < 0$, $\frac{\partial^2 U(x,y)}{\partial y^2} < 0$, and $\frac{\partial^2 U(x,y)}{\partial x \partial y} < 0$. The first two inequalities simply require diminishing marginal returns in each good.[8] The

[8] Diminishing marginal returns is a standard assumption. One might question this assumption when applied to aspiration control in light of the potential for increasing marginal utility in s. It may be, for example, that aspiration control is difficult when applied in small amounts (i.e., does not produce sizable returns per unit of aspiration control) yet produces greater returns per unit when applied in large amounts across many contexts. This would violate the assumption that $\frac{\partial^2 U(x,y)}{\partial y^2} < 0$, which should be regarded as a technical assumption open to further investigation, a point that we return to in the stochastic version of the model.

third inequality requires that the two goods are substitutes. Together, the three inequalities guarantee that the following propositions hold. Proofs are provided in the appendix.

Proposition 1. *If $p > 1$, then demand for aspiration control is a decreasing function of price (i.e., not Giffen): $ds^*/dp < 0$.*

This proposition says that if $p > 1$ (i.e., the price of aspiration control is higher than the price of ordinary goods), then demand for aspiration control decreases as its price rises, resulting in downward sloping demand for aspiration control. Proposition 1 does not, however, imply that aspiration control is never Giffen. If p is sufficiently small, $p < 1$, then the possibility of upward-sloping demand for aspiration control cannot be ruled out.

Proposition 2. *There exists $\overline{p}$ such that aspiration control is a normal good for any $p > \overline{p}$ and an inferior good for any $p < \overline{p}$.*

This proposition says that if p is sufficiently large (small), then aspiration control is normal (inferior).

Despite the apparent triviality of the two propositions, they have potentially interesting implications for price- and income-sensitivity of Marshallian demand for aspiration control. Imagine a situation in which a high degree of aspiration control is required, for example, in the event of an energy shortage, currency crisis, natural disaster leading to shortages of ordinary consumption, or environmental catastrophe.[9] Propositions 1 and 2 imply that aspiration control will not necessarily increase if the government attempts to lower the price of aspiration control, for example, by subsidizing aspiration control technology. And aspiration control will not necessarily increase as income grows. When the price of aspiration control is low, aspiration control becomes inferior and this negative income effect (depending on other parameters in the model) may become sufficiently large that demand slopes upward (i.e., aspiration control may be a Giffen good).

4 The Stochastic Model

This section introduces probabilistic uncertainty into the deterministic model. Let X represent the random quantity of ordinary consumption whose realized value the decision maker will receive ex post. The realized quantity of ordinary consumption is distributed with cumulative distribution function $F(x)$, density function $f(x)$, and expected value $\mathrm{E}[X] = \mu$ ($\mu \geq 0$).

The budget constraint is given (as before) by equation (1). Taking expectations on both sides of equation (1), the budget constraint in the stochastic model is:

$$\mu + ps = M. \tag{5}$$

[9] Spash and Hanley (1995) provide empirical data on problems that arise when eliciting valuations for environmental goods from consumers who have strong commitments to reducing ordinary consumption. Spash (2010) analyzes failures of emissions trading schemes to accomplish their stated goal of reducing aggregate emissions based on standard assumptions about income and price sensitivity, which implies new challenges for societies attempting to limit particular forms of ordinary consumption. And Earl and Wakeley (2009) propose mechanisms to help consumers who want to reduce their desire to consume goods with large carbon footprints or greenhouse gas emissions.

The expected value of ordinary consumption, μ, is now a choice variable. This variable represents expected hedonic value from ordinary consumption (or, more generally, from choices such as career, entrepreneurial behavior, investments in forms of human capital that raise expected levels of ordinary consumption).

We make three further simplifying assumptions. The specification below assumes that U is additively separable in ordinary consumption and discontentment. Second, the specification assumes, apart from the discontentment term, that preferences over distributions of X are risk neutral. Third, the specification ignores the magnitude by which ordinary consumption falls below the threshold t and represents discontentment as a binary indicator variable. Binary discontentment represents a psychological process in which failing to meet one's goal imposes a fixed psychic cost. A long-lasting malaise after failing to be admitted to a high-earning profession would be one example. Discontentment in this model can be interpreted as a change in mood (or psychological depression) triggered by the event of failing to reach one's goal. The model represents the decision process of agents who foresee that ex post failure to achieve their ex ante aspirations for ordinary consumption will reduce experienced utility (i.e., psychic value generated) from hedonic consumption by a fixed amount.

The resulting utility specification is:

$$U(X, \max\{t - X, 0\}) = X - \beta \mathbf{1}(X < t), \tag{6}$$

where $\beta > 0$ is the model's only preference parameter,[10] measuring the extent to which the decision maker places weight on the possibility of falling below the contentment threshold when weighing different choices of s and μ and the associated distributions of U. It is easy to see that Lemma 1 does not hold in the stochastic model, since X is a random quantity of hedonic consumption that can only be imperfectly controled by choice of its mean, μ.

Substituting $\mu = M - ps$ from the budget constraint (5) simplifies the constrained optimization problem in μ and s to an unconstrained optimization problem in s, with the following value function representing the consumer's aspiration control objective:

$$V(s) = M - ps - \beta F(t_0 - s). \tag{7}$$

Under the expectations operator, X is mapped into μ, which is then substituted as a function of s, and the indicator function that depends on X is mapped into its expectation: $\mathrm{E}[\mathbf{1}(X < t)] = F(t) = F(t_0 - s)$.

The objective function $V(s)$ explicitly shows the trade-off of primary interest. Aspiration control as measured by the decision maker's choice of s provides the benefit of reduced risk of discontentment (i.e., reducing t from its initial value of t_0 to the more moderate or restrained goal, $t_0 - s$), but comes at the cost of a reduced level of expected ordinary consumption (i.e.,

[10] As long as the binary indicator function is assumed, the constant discontentment cost is an innocuous assumption, because alternative assumptions allowing for arbitrary psychic cost-of-discontentment functions only to change the level of the cost associated with the binary event of discontentment. Generalizing to psychic cost functions that depend on the magnitude of the ex post shortfall in ordinary consumption will, in general, preserve the anything-goes results that follow. Within a broad class of psychic cost functions and probability distributions of ordinary consumption X, there exist dense subsets of the parameter space on which demand for aspiration control is alternatively increasing or decreasing (and sometimes non-monotonic) in both income and the price of aspiration control.

reducing its expected value from M to $M - ps$). If the consumer chooses zero aspiration control ($s = 0$, implying that all of the consumer's money is allocated to acquisitiveness), then the objective function simplifies to $V(0) = M - \beta F(t_0)$. The only way that aspiration control can provide improvements in utility is by reducing the β-weighted risk of discontentment by more than the re-allocation into aspiration control costs.

It would be a mistake to compute the first-order condition for an interior maximizer based on differentiation of (7) with respect to s using the notation in that expression, because it does not show explicitly that the shape of $F(x)$ depends on s. As s changes, so too does the distribution function $F(x)$. (Changing s forces μ to change because of the budget constraint. This dependence of $F(x)$ on s therefore holds at every fixed value of x, because changes in s shift the entire distribution function $F(x)$.) The indirect dependence of F on μ that is not explicit in the notation of equation (7) results from the fact that s affects μ through the budget constraint ($\mu = M - ps$). Accounting for the two channels through which s affects the value function in equation (7), we observe that s affects the probability of discontentment $F(t_0 - s)$ through two distinct channels—the argument of F (holding its shape constant), and the shape or position of F (holding its argument constant), which leads to the following formula for differentiating $F(t_0 - s)$ with respect to s:

$$\frac{dF(t_0 - s)}{ds} = F'(t_0 - s)\frac{\partial(t_0 - s)}{\partial s} + \frac{\partial F(t_0 - s)}{\partial \mu}\frac{\partial \mu}{\partial s} = f(t_0 - s)(-1) + \frac{\partial F(t_0 - s)}{\partial \mu}(-p). \quad (8)$$

By specifying $F(x)$ such that μ is strictly a position parameter shifting the distribution function to the right or left (e.g., if X is normally distributed), then the dependence of F on μ can be expressed directly in the argument of F and $\frac{\partial F}{\partial \mu}$ can be computed easily.

We now assume that X is normally distributed with exogenously given $\mathrm{Var}(X) = \sigma^2$, which allows the cdf to be rewritten in terms of the standard normal cdf $\Phi(z)$, and pdf $\phi(z)$, both of which are independent of μ and σ:

$$F(t) = F(t_0 - s) = \Phi\Big(\frac{t_0 - s - \mu}{\sigma}\Big) = \Phi\Big(\frac{t_0 - (1-p)s - M}{\sigma}\Big), \quad (9)$$

where the last equality follows from substitution of $M - ps$ for μ from the budget constraint. After substituting away all channels of dependence on μ so that the objective function is solely a function of s, $V(s)$ can be rewritten as:

$$V(s) = M - ps - \beta\Phi\Big(\frac{t_0 - (1-p)s - M}{\sigma}\Big). \quad (10)$$

For simplicity, the exogenous parameters can be stacked in the vector $\theta \equiv [p, t_0, M, \beta, \sigma]$ and the global maximizer of (10) denoted s^*, or $s^*(\theta)$ to make its dependence on the exogenous parameters explicit. It turns out that corner solutions to the problem of maximizing $V(s)$ (as specified with the standard normal cdf in equation (10)) with respect to s occur frequently. Therefore, the analysis of responses in s^* to changes in θ must state the relevant ranges in which these demand responses are non-zero, which occur inside the boundaries at which zero aspiration control, $s^* = 0$, and maximum aspiration control, $s^* = M/p$, are global maximizers. First, we focus on characterizing $\frac{ds^*}{d\theta}$ at an interior maximizer s^*, $0 < s^* < M/p$, for which the first-order condition (for a maximizer of (10)) is:

$$-p + \beta\phi\Big(\frac{t_0 - (1-p)s^* - M}{\sigma}\Big)\frac{1-p}{\sigma} = 0. \tag{11}$$

The second-order condition for an interior maximizer is:

$$-\beta\phi'\Big(\frac{t_0 - (1-p)s^* - M}{\sigma}\Big)\Big(\frac{1-p}{\sigma}\Big)^2 < 0, \tag{12}$$

which requires the pdf of X to be strictly increasing at $t_0 - s^*$ or, equivalently, that the argument of $\phi(\cdot)$ is negative:

$$t_0 - (1-p)s^* - M < 0. \tag{13}$$

This second-order condition, or the equivalent condition that $t_0 - s^* < \mu$, is the opposite of Lemma 1, which applies only to the case of deterministic (i.e., non-stochastic) X. In contrast to the deterministic case where t is always set weakly less than X to avoid discontentment (with certainty), the second-order condition in the stochastic case shows that (at an interior optimizer) the consumer chooses the discontentment threshold to be strictly greater than expected ordinary consumption to reduce the risk of discontentment.

To solve (11) explicitly for s^* requires taking the inverse of the image value of the standard normal pdf, denoted $w = \phi(z) = \frac{1}{(2\pi)^{1/2}}e^{-\frac{1}{2}z^2}$. The range of values of w that the standard normal pdf projects onto is the half-open, half-closed segment $(0, \frac{1}{(2\pi)^{1/2}}]$. The inverse relation mapping this interval back to the real line can be expressed as $z = \pm[-2\log((2\pi)^{1/2}w)]^{1/2}$. By virtue of the second-order condition, however, only the negative term above is needed, which we use to re-express the first-order condition (11) as follows:

$$\phi\Big(\frac{t_0 - (1-p)s^* - M}{\sigma}\Big) = \frac{p}{1-p}\frac{\sigma}{\beta}. \tag{14}$$

This representation of the first-order condition can be interpreted as choosing aspiration control to equate marginal benefit (measured as a reduction in the probability of discontentment on the left-hand side) to the risk-benefit-weighted marginal cost of aspiration control (right-hand side).

The inverse of ϕ is, in general, not a function but a set-valued relation. However, the inverse $\phi^{-1}(\cdot)$ can be functionally identified with the negative element from among the pair of elements in its image. Doing so enables us to apply the inverse function $\phi^{-1}(\cdot)$ to both sides of (14):

$$\frac{t_0 - (1-p)s^* - M}{\sigma} = -\Big[-2\log\Big((2\pi)^{1/2}\frac{p}{1-p}\frac{\sigma}{\beta}\Big)\Big]^{1/2}. \tag{15}$$

In applying the inverse of $\phi(\cdot)$, it is crucial that the exogenous parameters lie in the admissible range (guaranteeing that the argument of the log function on the right-hand side of (15) is negative, so that the expression in brackets raised to the power 1/2 is positive and the entire expression on the right-hand side is negative to satisfy the second-order condition): $0 < \frac{p}{1-p}\frac{\sigma}{\beta} < \frac{1}{(2\pi)^{1/2}}$. This inequality gives the boundary values of θ that partition its space into regions corresponding to interior and corner solution values of s^*. If $p = 0$, then the first inequality describing where interior solutions occur is violated because aspiration control is free and everyone can therefore avoid discontentment with probability one by choosing $s = \infty$. If the parameters are outside the admissible range in the other direction, that is, if $\frac{1}{(2\pi)^{1/2}} \leq \frac{p}{1-p}\frac{\sigma}{\beta}$, then aspiration control is too expensive relative to the (β/σ) benefit/risk-weighted reduction in the probability of discontentment, and the decision maker rationally chooses zero aspiration control, $s = 0$. The admissibility conditions for an interior value s^* an be further simplified as:

$$p < \frac{1}{\frac{\sigma}{\beta}(2\pi)^{1/2} + 1}, \tag{16}$$

which implies that $p < 1$ must hold. Otherwise, if $p \geq 1$, it would cost more than one unit of expected ordinary consumption to reduce the contentment threshold by one unit, which would provide no positive net benefit: if expenditures on s cause μ to fall by a magnitude greater than s, then the probability of discontentment goes up, not down.

We now use (15) to solve explicitly for s^* when θ satisfies admissibility conditions for an interior solution:

$$s^*(\theta) = \frac{1}{1-p}\left(t_0 - M + \sigma\left[-2\log\left((2\pi)^{1/2}\frac{p}{1-p}\frac{\sigma}{\beta}\right)\right]^{1/2}\right). \tag{17}$$

Demand for aspiration control as given by $s^*(\theta)$ turns out to be non-monotonic in p, and discontinuous in p on some subsets of the border region of the admissible parameter set. As illustrated in the next section, small changes in price can cause erratic jumps in demand for aspiration control, from zero to strictly positive levels, without continuously increasing through intermediate values of s as a function of p. The non-monotonic and sometimes highly unstable statics of aspiration control with respect to the exogenous variables θ are analyzed next and depicted graphically as Marshallian demand curves and income expansion paths relating p and M, respectively, to s^*.

5 Consumer Response to Changes in the Decision-Making Environment: Statics of $s^*(\theta)$

When regulations, programs and products targeting consumer aspiration control are introduced, a basic question concerns how consumers will likely respond to incentives encouraging uptake and participation. Financial incentives to take up such offerings would, in our model, amount to reductions in p. Thus, the response of s^* to p is the primary relationship we undertake to characterize. Before presenting graphs showing s^* as a function of p, inequalities characterizing behavioral responses can be stated in the language of calculus (revealing both insights from and limitations of this approach). One challenge in characterizing $s^*(\theta)$ as a function of p is discontinuity. In some regions of the parameter space, $s^*(\theta)$ does not respond at all to changes in p. In other regions, however, very small changes in p cause demand for aspiration control to discontinuously alternate between corner and interior quantities of aspiration control. At such points of discontinuity, of course $\frac{\partial s^*(\theta)}{\partial p}$ does not exist. The questions of where corner solutions prevail and what happens along the boundary between interior and corner values of s^* are primary points of interest. The results reported in this section apply only to parameter values of θ at which $s^*(\theta)$ is interior.

According to formula (17), the exogenous component of the contentment threshold t_0 (representing an individual's goal, or that of a group with a shared norm for ordinary consumption, before any aspiration control technology has been applied) exerts a strictly positive effect on s^* (holding M and all other exogenous variables constant):

$$\frac{\partial s^*(\theta)}{\partial t_0} = \frac{1}{1-p} > 0. \tag{18}$$

When t_0 rises without any increase in the resources available to finance consumption, then consumers face an increased risk of discontentment. Consumers respond by re-allocating resources away from ordinary consumption into aspiration control.

One scenario that matches this prediction would be the observable increases in religiosity in poor subpopulations experiencing virtually no income growth during the last three decades when hedonic consumption norms in non-poor subpopulations increased dramatically. Increasing information (e.g., via internet) about rapidly growing norms of hedonic consumption among relatively well-to-do subpopulations might plausibly exert upward pressure on t_0 even among those whose incomes remained flat. The model implies that a rational response to such a scenario may not involve redoubling efforts to catch up in terms of income growth but rather a re-allocation of resources away from ordinary consumption toward aspiration control. Religions—especially those with ascetic teaching or advocacy that adherents put less weight on standard metrics of value linked to ordinary consumption—can be interpreted in this model as providing technology (among other services) for finding fulfillment without increasing consumption. In feudal economies under which organized Christianity developed or in earlier societies across Asia in which Buddhist thought gained wide influence, the model would predict increased numbers of people and hours spent (per person) practicing techniques for moderating desire. Such expansions in the application of aspiration control technology would seem to coincide with the increasing availability of information available to poor people regarding the high levels of ordinary consumption enjoyed by others (interpreted as an increase in t_0).

The effect on s^* of greater wealth (e.g., advances in labor-saving technology that increase the value of one's resource endowment) exerts an unambiguously negative effect on the demand for moderation of desire:

$$\frac{\partial s^*(\theta)}{\partial M} = -\frac{1}{1-p} < 0. \tag{19}$$

Therefore, in this model, aspiration control is unambiguously an inferior good. As M increases, so too does μ, which reduces the discontentment probability. The reduced probability of discontentment enables the consumer to reduce s. This result that aspiration control is an inferior good begins to reveal the strong and negative income effects that we will see below can produce upward-sloping demand curves.

If t_0 (the exogenous component of the contentment threshold) and M (the real value of the consumer's endowment of resources) grow by equal amounts, then the two resulting effects on s^* perfectly offset one another with no net effect. Shifts in the contentment threshold t_0 have an effect on aspiration control when t_0 changes by more than M. And shifts in M are similarly important only if they do not track with changes in t_0. In other words, changes in contentment thresholds and wealth only have effects on optimal aspiration control net of changes in the other among this pair of factors: $\frac{\partial s^*(\theta)}{\partial t_0} + \frac{\partial s^*(\theta)}{\partial M} = \frac{1}{1-p} - \frac{1}{1-p} = 0$.

It is useful to denote the bracketed term in (17) as the function $h(f) \equiv [-2\log((2\pi)^{1/2} f)]^{1/2} = z$ (with f evaluated at $\frac{p}{1-p}\frac{\sigma}{\beta}$), which maps outputs of the standard normal pdf (f) back into normalized z values. Because $h(f)$ is a positively valued and strictly decreasing function, we can take advantage of the inequality $h'(f) < 0$, from which it is straightforward to verify the intuitively obvious result that an increase in β (reflecting stronger subjective weight on the possibility of discontentment) causes demand for aspiration control to increase:

$$\frac{\partial s^*(\theta)}{\partial \beta} = -h'\Big(\frac{p}{1-p}\frac{\sigma}{\beta}\Big) p \Big(\frac{1}{1-p}\frac{\sigma}{\beta}\Big)^2 > 0. \tag{20}$$

The parameter σ represents the volatility or riskiness of ordinary consumption (or the hedonic value derived from a known quantity of ordinary consumption). Yet another interpretation of σ would be as a proxy for wealth inequality that is orthogonal to aspiration control: the distribution of material standards of living are more spread out in environments with large σ, even if everyone were to choose the same level of x and s. To characterize the sign of $\frac{\partial s^*(\theta)}{\partial \sigma}$, it is useful to notice that $h'(f) = -\frac{1}{f h(f)}$ and apply this result to simplify the following expression:

$$\frac{\partial s^*(\theta)}{\partial \sigma} = \frac{1}{1-p}\left[h\Big(\frac{p}{1-p}\frac{\sigma}{\beta}\Big) + \sigma h'\Big(\frac{p}{1-p}\frac{\sigma}{\beta}\Big)\frac{p}{1-p}\frac{1}{\beta}\right] = \frac{1}{1-p}\left[h\Big(\frac{p}{1-p}\frac{\sigma}{\beta}\Big) - \Big[h\Big(\frac{p}{1-p}\frac{\sigma}{\beta}\Big)\Big]^{-1}\right]. \tag{21}$$

The sign of $\frac{\partial s^*(\theta)}{\partial \sigma}$ depends on whether $h(\frac{p}{1-p}\frac{\sigma}{\beta})$ is greater or less than 1. By definition, $h(\phi(z)) = z$ for positive z. Therefore, the sign of $\frac{\partial s^*(\theta)}{\partial \sigma}$ depends on whether $\frac{p}{1-p}\frac{\sigma}{\beta}$ is greater or less than $\phi(1) \approx 0.2420$. Keeping in mind that h is decreasing, we therefore have: $h(\frac{p}{1-p}\frac{\sigma}{\beta}) < 1$ if $\frac{p}{1-p}\frac{\sigma}{\beta} > \phi(1)$, and $h(\frac{p}{1-p}\frac{\sigma}{\beta}) > 1$ if $\frac{p}{1-p}\frac{\sigma}{\beta} < \phi(1)$. The sign of the desired risk response of optimal aspiration control can be characterized as:

$$\frac{\partial s^*(\theta)}{\partial \sigma} > 0 \text{ if } \frac{p}{1-p}\frac{\sigma}{\beta} < \phi(1), \text{ and } \frac{\partial s^*(\theta)}{\partial \sigma} < 0 \text{ if } \frac{p}{1-p}\frac{\sigma}{\beta} > \phi(1). \tag{22}$$

Thus, the effect of σ on $s^*(\theta)$ is in general indeterminate. For moderate levels of σ and p, the effect is positive, implying increased demand for aspiration control when risk or inequality rises. In low-risk or low-inequality environments, a small increase in σ increases the risk of discontentment (on the relatively steep range of the pdf ϕ), implying that increases in s have proportionally large effects. In contrast, when beginning from a relatively flat range of the pdf farther than one standard deviation from the mean, the consumer achieves much weaker effects in terms of reducing the risk of discontentment when making adjustments to s.

Finally, the effect of p on $s^*(\theta)$ is non-monotonic as the figures in the next section show.

We record the analytic expression here:

$$\frac{\partial s^*(\theta)}{\partial p} = \frac{1}{(1-p)^2}\left[t_0 - M + \sigma h\Big(\frac{p}{1-p}\frac{\sigma}{\beta}\Big) + \frac{1}{1-p}\frac{\sigma^2}{\beta}h'\Big(\frac{p}{1-p}\frac{\sigma}{\beta}\Big)\right]. \qquad (23)$$

This can be developed, once again, using $h'(f) = \frac{1}{fh(f)}$. It is unclear, however, whether this leads to any new insights about which regions of parameter space correspond to upward- versus downward-sloping demand for aspiration control.

6 Demand for Aspiration Control

Figure 1 presents nine demand curves for aspiration control, plotting s^* as a function of price for particular values of the other parameters. Following convention in plotting Marshallian demand curves, the x-axis is quantity demanded s^*, measuring the distance (in units of ordinary consumption) by which the individual chooses to shift the contentment threshold t downward from its default t_0. The y-axis is the full range of prices from zero to the upper bound given in (16). The resource endowment M is normalized to 1 for all graphs. In Figure 1, t_0 is normalized to 1. In later figures, demand curves comparing higher and lower values of t_0 (by two standard deviations relative to the mean of X) are plotted. Figure 1 varies σ (moving from the top to bottom subfigures) and β (moving left to right). The three rows of subfigures in Figure 1 correspond to parameterizations in which the random component of ordinary consumption X is increasing (from top to bottom subfigures), as indicated by the values of σ = 0.1, 1.0 and 10.0. The x-axes are re-scaled (held fixed for subfigures across each row) to see the detail of the curves. Moving column-wise among subfigures left to right, the values of β are 0.5, 1, and 2, reflecting increasing subjective weight on the risk of discontentment.

Non-monotonicity of $s^*(\theta)$ as a function of p is evident in the upward-sloping (i.e., backward bending) regions of the upper-center and upper-right subfigures of Figure 1. The upper-right demand curve in Figure 1 also shows extreme sensitivity of demand for aspiration control to price near $p = 0.9$. In this range, quantity demanded shifts from 0 to the maximum amount possible in response to very small changes in price, suggestive of cultural or religious revolutions whose philosophies depend heavily on critique of excessive ordinary consumption or strong advocacy for the practice of strict aspiration control. We leave it to future research to pursue the question of whether these large price effects in opposite directions along the same demand curve (as in the upper-right subfigure of Figure 1) might provide an explanation for the emergence of religious and spiritual movements observed in the historical record. Their cautionary implication for the introduction of new programs and products aiming to improve aspiration control should be clear from the difficult-to-predict responses to changes in price. Unstable price effects on demand for aspiration control are further elaborated upon below.

The response of consumption risk on aspiration control, $\frac{\partial s^*(\theta)}{\partial \sigma}$, can also be seen to be non-monotonic in Figure 1, by reading off the quantity demanded corresponding to a price of 0.02 on the three subfigures along the left. In the topmost left subfigure corresponding to $\sigma = 0.1$ and $\beta = 0.5$, a price of 0.02 corresponds to a value of s^* of slightly more than

0.3. Moving down the left column to the middle-left subfigure corresponding to $\sigma = 1$ and $\beta = 0.5$, a price of 0.02 would correspond to a value of s^* that is slightly less than 3. In the bottom left subfigure corresponding to $\sigma = 10$ and $\beta = 0.5$, however, a price of 0.02 would correspond to a value of s^* of exactly 0. These three point evaluations for successively increasing values of σ show (for the parameter values considered) that $s^*(\theta)$ is an increasing function of σ when evaluated at some neighborhood to the right of $\sigma = 0.1$ but decreasing when evaluated to the right of $\sigma = 1$. This non-monotonicity is not an artefact of scaling.

Moving from left to right in Figure 1, the weight on discontentment in the objective function is increasing, and the demand curves consequently shift out to the right, just as one would expect. The combination of low σ and large β produces demand curves with an upward-sloping portion as mentioned above, reflecting large income effects on the demand for aspiration control.

Figure 2 illustrates an analogous set of demand curves, this time with a default contentment threshold that is very easy to reach: $t_0 = M - 2\sigma$. This corresponds to an environment in which discontentment is avoided at $s = 0$ with a probability of more than 97 percent. Although the possibility of discontentment is remote, positive quantities of aspiration control are nevertheless demanded if its price is low enough, reducing the chance of discontentment further. No unusual features of the demand curve are seen when t_0 is already very easy to reach, with aspiration control increasing monotonically as its price declines.

Figure 3 illustrates another set of environments, this time with a default contentment threshold that is very difficult to reach: $t_0 = M + 2\sigma$. In this case, if aspiration control is set to $s = 0$, then the risk of discontentment would be more than 97 percent. Figure 3 shows that environments with low σ and high t_0, in which discontentment is virtually certain, produce demand curves with large upward-sloping regions. Strongly negative income effects are intuitive in this case, because of the high likelihood of discontentment on the convex portion of the pdf, which results in a cost-benefit structure that looks mathematically equivalent to increasing returns to aspiration control. The more aspiration control the consumer applies, the more productive aspiration control becomes at reducing the probability of discontentment.

Figure 4 presents expenditure-price curves to visualize what fraction of total income is allocated to aspiration control over the price range. Recalling that the budget constraint $\mu + ps = M$, with M normalized to 1, the quantity $100ps$ gives the percentage of wealth allocated to aspiration control. Figure 4 presents nine expenditure-price curves with the same parameter values as in Figure 1. These show that non-monotonic expenditures on aspiration control—increasing and then decreasing expenditures on aspiration control as prices increases from zero—is the rule rather than the exception. When price is very low, a large quantity of aspiration control can be purchased for a small expenditure, moving the contentment threshold to the concave portion of the pdf of X. When price is very large, the sacrifice in terms of μ is so great that only a small portion of the endowment is allocated to aspiration control. In the middle of the price range, however, where larger shares of wealth are allocated to aspiration control as price increases, the expenditure-price behavior reflects the shift that occurs when moving from the convex (increasing-returns) part of the pdf to the concave part, at which point total expenditures on aspiration control as a share of wealth begins to decline again.

Finally, we document price discontinuities in the demand for aspiration control that occur for some parameterizations. Discontinuity occurs when quantities demanded jump from a substantial share of wealth to zero, as a response to only a small increase in price. Such a discontinuity is illustrated in the three Panels of Figure 5, which plot the consumer's objective function as a function of s at three nearby price levels. Figure 5 shows the univariate objective function $V(s)$ from equation (10) at $p = 0.70$ (Panel A), 0.72, (Panel B) and 0.74 (Panel C). The values of all other parameters are as in Figure 1, except for $t_0 = 0.5$, which makes the objective function easier to visualize because it corresponds to a scenario of moderate but not extreme risk of discontentment. In this parameterization, discontentment is defined by levels of ordinary consumption that are more than half a standard deviation below the un-controled default mean of X, $\mu = 0$. This moderate-risk-of-discontentment scenario ensures that the two competing motives in the consumer's allocation problem—to spend money on increasing hedonic consumption or on aspiration control—are clearly reflected in the objective function. The objective function itself is continuous in p, as seen in the modest vertical shifts in $V(s)$ across the three Panels in Figure 5. The discontinuity in s^* becomes visible, however, by comparing the position of the global maximizers in those three Panels. In Panels A and B of Figure 5, s^* is interior in both cases. Comparing the position of s^* in Panels B and C, however, one sees that the global maximizer of $V(s)$ jumps discontinuously, with an abrupt shift to the left-most corner, $s^* = 0$, in Panel C.

7 Summary and Discussion

Different interpretations of recent economic events of the Great Recession and financial crises of 2007-2008 (in financial, housing and labor markets) place varying degrees of emphasis on the role that flawed consumer decision making has played. Diagnoses of root causes focus, alternatively, on consumers' excessive borrowing (Financial Crisis Inquiry Commission, 2011; Holzer, 2009), regulatory failure (Bernanke, 2010; Brown and Finkelstein, 2007), insufficient fiscal stimulus (Krugman, 2009), and other institutional failures that may have encouraged accounting fraud (Black, 2005; Akerlof and Romer, 1993). Rather than address controversies surrounding these different interpretations, this paper takes for granted as a maintained hypothesis throughout the analysis that consumers are capable of excess, in the sense of wasting an opportunity to achieve a higher level of utility by re-allocating expenditures out of hedonic consumption and into controlling desire. Our model assumes, however, that consumers reflect on this possibility and attempt to change preferences in a purposeful and effortful manner by using available technology to reduce the threshold levels that define minimum requirements for ordinary consumption to avoid discontentment. The model of rational aspiration control provides price and income responses to programs and products designed to help control desire.

When the cost of aspiration control is sufficiently large, demand for aspiration control is zero and the consumer chooses to pursue happiness exclusively through the channel of ordinary consumption. When the price of aspiration control falls below this critical threshold (which our model shows to be dependent on preference parameter β and the shape of the probability distribution of X), demand for aspiration control responds systematically although not always monotonically or continuously.

Our model does reveal three globally monotonic effects on the demand for aspiration control. First, aspiration control is sometimes an inferior good in the deterministic model (whenever the price of aspiration control is sufficiently small) and always an inferior good when hedonic consumption is risky. Aspiration control always decreases as income rises in the case where X is stochastic, because higher incomes reduce the chance of discontentment (holding all other parameters that determine both the exogenous components of hedonic aspirations and the shape of the consumption risk distribution constant). Second, more intense desire for ordinary consumption (i.e., raising the exogenous component of the contentment threshold t_0 while holding all else equal) increases demand for aspiration control. Third, the preference parameter β, which measures the weight placed on the risk of falling short of the contentment threshold, causes aspiration control to increase monotonically.

In the deterministic model, income effects become negative when aspiration control is relatively cheap and can cause the market for aspiration control to exhibit the Giffen phenomenon. In the stochastic model, aspiration control is monotonically decreasing in its own price (i.e., is downward-sloping) only in sufficiently risky environments, where the volatility of hedonic consumption is large enough to prevent the increasing returns (i.e., increasing marginal benefit) of aspiration control. Although income effects are always negative in the stochastic model, they become strong enough to generate backward-bending demand for aspiration control (i.e., with an upward-sloping segment) when the discontentment probability is high (i.e., the exogenously component of the contentment threshold is very difficult to reach) and volatility of hedonic consumption is relatively low. The effect of uncertainty on demand for aspiration control is non-monotonic (holding the price of aspiration control constant), because of increasing and decreasing returns to aspiration control that the utility function inherits from convex and concave portions of the density function for discontentment risk.[11]

The non-monotonicity and inferior-good status of aspiration control have interesting implications for market efficiency. As technological breakthroughs enable production of greater quantities of aspiration-control technology at lower cost—or as governments and firms offer discounts (reducing p in the model) to incentivize consumers to use greater quantities of aspiration control—one may be tempted to apply standard market analysis using textbook demand theory predicting that lower prices will induce greater utilization of aspiration control. Our model shows why that intuition is likely to be wrong. Insofar as the nonstandard price responses of optimal aspiration control and anything-goes implication of our model are descriptively valid for real-world behavioral responses to incentives concerning moderation of desire, then the market for aspiration control could easily fail.

There could be multiple equilibria. Or it could be that no equilibrium exists. Therefore, the development of markets for aspiration control faces the problem that market entry and anything exerting downward price pressure may cause quantities demanded to fall (over some range of the demand curve) or otherwise fluctuate erratically, generating confusing signals that suppliers will have trouble interpreting.

In our model, consumers respond rationally by choosing optimal allocations of expenditures into ordinary hedonic consumption and aspiration control, and this rational behavior leads to negative income effects and non-monotonic demand for aspiration control as a func-

[11] This non-monotonicity would disappear if a triangle-shaped pdf on a finite support were used instead, or any density function without convex and concave regions on its domain.

tion of price. Technological breakthroughs that suppliers to lower prices or offer greater quantities may therefore fail to induce consumers to buy more aspiration control. If lower prices do not induce consumers to shift away from ordinary consumption and re-allocate expenditures into aspiration control (trying to generate greater utility using an input mix with smaller quantities of ordinary consumption and greater quantities of aspiration control), then missing, chaotic, and/or inefficient markets are to be expected. Our model shows that market failure—in the sense of failing to achieve Pareto optimality—is an especially acute possibility in markets for services designed to facilitate aspiration control.

Whether incentives inducing consumers to engage in more aspiration control will be effective or not depends on where in the model's parameter space the decision-making environment's descriptive parameters are drawn from. If the price of aspiration control is far above the critical threshold where $s^*(\theta)$ cuts off to zero, then the model implies that price will have no effect on behavior. In other environments, $\frac{\partial s^*(\theta)}{\partial p}$ may be large or small, and of varying sign.

If the decision-making environment happens to be on an upward sloping portion of the demand curve for aspiration control, then regulation, programs and products that offer price-based incentives can have the unintended effect of decreasing quantities demanded for aspiration control. In such environments, high-priced aspiration control induces greater uptake than low-priced aspiration control does (similar to some findings from the sociology and economics literatures on harsh norms, e.g., Berg and Kim, 2014, forthcoming).[12]

The case most conducive for modest policy interventions to succeed at encouraging aspiration control are the highly price-elastic (i.e., nearly flat) and decreasing portions of the demand curves in Figures 1-4. Figures 1, 3, 4 and 5 show a number of environments in which, starting from a parameter value θ at which $s^*(\theta) = 0$, a small reduction in p induces large shifts into aspiration control. A discontinuous jump is seen, for example, by comparing the zero expenditures on aspiration control in Panel C of Figure 5 (at $p = 0.74$) versus large expenditures on aspiration control in Panel B of Figure 5 (at $p = 0.72$).

Our model features the possibility of rationally choosing to abandon aspiration control, which challenges a basic definition of bounded rationality (often defined as bounds on willpower, computational capacity and/or self-interest). In our model, agents rationally choose to abandon aspiration control if its benefits do not outweigh its costs. Abandonment of aspiration control is therefore a rational and predictable function of the opportunities and costs in the environment, just as costly attempts at controling aspirations are chosen rationally without any normative assumptions that people require aspiration control because they are otherwise irrational. If one views cultural variation in attitudes toward hedonic consumption through the lens of our model, then one prediction (for appropriate values of θ) is that some people (and more broadly, some cultures) will choose to devote themselves wholly to ordinary consumption, while others will emphasize allocating resources (which include time and effort) to aspiration control in a way that moderates desire for hedonic consumption. Factors that could explain such real-world differences in aspiration control behavior that correspond to the parameters (θ) in our model would include: different lev-

[12]The popular teacher of breathing exercises and founder of the Art of Living Foundation, Sri Sri Ravi Shankar, says that it is important to charge a positive price for the service he offers, even though he is willing to give it away for free, because consumers value it more when its price is positive (Shankar, 2010).

els and forms of wealth (M); consumption norms that exogenously influence individuals' hedonic aspirations (t_0); upside and downside hedonic opportunity risk (σ); demand-side differences in sensitivity to the risk of discontentment (β); and supply-side differences that generate different real prices for those considering re-allocating wealth out of hedonic consumption and into aspiration control. This mix of factors describes the conditions (in the context of our model) under which individuals or cultures are predicted to rationally move from the corner solution of zero to strictly positive quantities demanded, or rationally move in the reverse direction—from positive quantities back to zero (i.e., total abandonment of aspiration control).

Although the model is behavioral in that it presumes aspiration control is costly and that preferences can be changed, the optimal resource allocation approach and price theory can be viewed as a methodological extension of classical marginalist demand theory. We use a parsimonious and highly stylized rational choice approach to the behavioral problem of choosing how much aspiration control to acquire when making consumption decisions. The model is essentially the two-good, one-period consumer choice problem from undergraduate microeconomic textbooks, augmented with a term in the utility function that depends on the difference between the level of ordinary consumption chosen and a reference-point level of ordinary consumption needed to hit one's psychological target or, equivalently, avoid discontentment. Although it draws inspiration from the satisficing and goal setting literatures, the model is not a satisficing model because it wholly adopts the assumption of expected utility maximization and its implication of exhaustive search through the choice set rather than limited search, as in the satisficing model.

The instability of demand for aspiration control in our simple allocation model reveals a cautionary finding for policy makers and other organizations attempting to predict rates of uptake for new programs, enforce regulations encouraging consumers to limit quantities consumed, or forecast demand for services designed to increase aspiration control. This descriptive concern over indeterminacy of demand responses only adds to the challenges of normative analysis and philosophical problems of paternalism concerning notions of "excessive" consumption. The model assumes that the individual, after introspectively consulting his or her own experiences and temptations, considers it possible for hedonic consumption to be either excessive or insufficient. Taking seriously this process of reflection on personal hedonic aspirations and the different allocative mechanisms available for avoiding discontentment, the model describes how consumers would rationally choose optimal quantities of aspiration control, trading off reduced quantities of hedonic consumption for reduced risks of discontentment.[13]

The point we want to make is that technologies aimed at aiding consumer aspiration control, because of the strong income effects they produce, can lead to counterintuitive consumer responses to interventions intended to encourage aspiration control. Without conclusive evidence to the contrary, aspiration control should perhaps be assumed to be

[13]This rationalization of partial or total lack of aspiration control draws inspiration from the work of Caplan (2001), whose model predicts that irrationality rationally accumulates where it is least costly while responding systematically to incentives in the environment. The rational irrationality framework is expanded on by Beaulier and Caplan (2007). Issues raised here regarding normative behavioral economics were first raised by Berg (2003) and elaborated on in the context of behavioral economics and paternalism in Berg and Gigerenzer's (2007) model of social welfare maximization for a society of satisficers.

non-monotonic in price and therefore inherently unstable. The possibilities of discontinuous and upward-sloping demand for aspiration control are not merely technical problems; they also point to real-world problems for policy interventions that our model predicts would very likely result in unanticipated and/or disappointingly small behavioral responses.[14]

In his essay, "Economic Possibilities for Our Grandchildren," Keynes (1930) writes: "I see us free, therefore, to return to some of the most sure and certain principles of religion and traditional virtue—that avarice is a vice, that the exaction of usury is a misdemeanour, and the love of money detestable, that those walk most truly in the paths of virtue and sane wisdom who take least thought for the morrow. We shall once more value ends above means and prefer the good to the useful. We shall honour those who can teach us how to pick the hour virtuously and well, the delightful people who are capable of taking direct enjoyment in things, the lilies of the field who toil not, neither do they spin."

Later in the same essay, Keynes argues that, although a shift in desire away from material consumption might eventually transpire and be socially beneficial, the normative priority on increasing hedonic consumption should remain, perhaps as an intermediate and enabling phase of economic development: "But beware! The time for all this is not yet. For at least another hundred years we must pretend to ourselves and to everyone that fair is foul and foul is fair; for foul is useful and fair is not. Avarice and usury and precaution must remain our gods for a little longer still. For only they can lead us out of the tunnel of economic necessity into daylight."

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[14]Our model's anything-goes finding, with vertical (i.e., perfectly inelastic) segments at quantity zero over large ranges in price and upward-sloping segments (in addition to discontinuities in price) is consistent with empirical accounts of interventions aimed at improving aspiration control that resulted in empirical demand responses in the opposite direction as was anticipated. For example, Pence (2001) documents how interventions to induce households to spend less have elicited essentially zero response, consistent with a decision-making environment in which comparative statics are uniformly zero. Many have expressed more general skepticism about the wisdom of consumer protections founded on the premise that consumer behavior is pathologically biased. In some financial market models (e.g., Berg and Lein, 2005; Jerzmanowski and Nabar, 2008), biased beliefs and financial decision making can lead to positive welfare effects. In such environments, interventions seeking to "de-bias" individual behavior could reduce efficiency and, with it, social welfare (Berg and Hoffrage, 2008; Berg and Gigerenzer, 2010).

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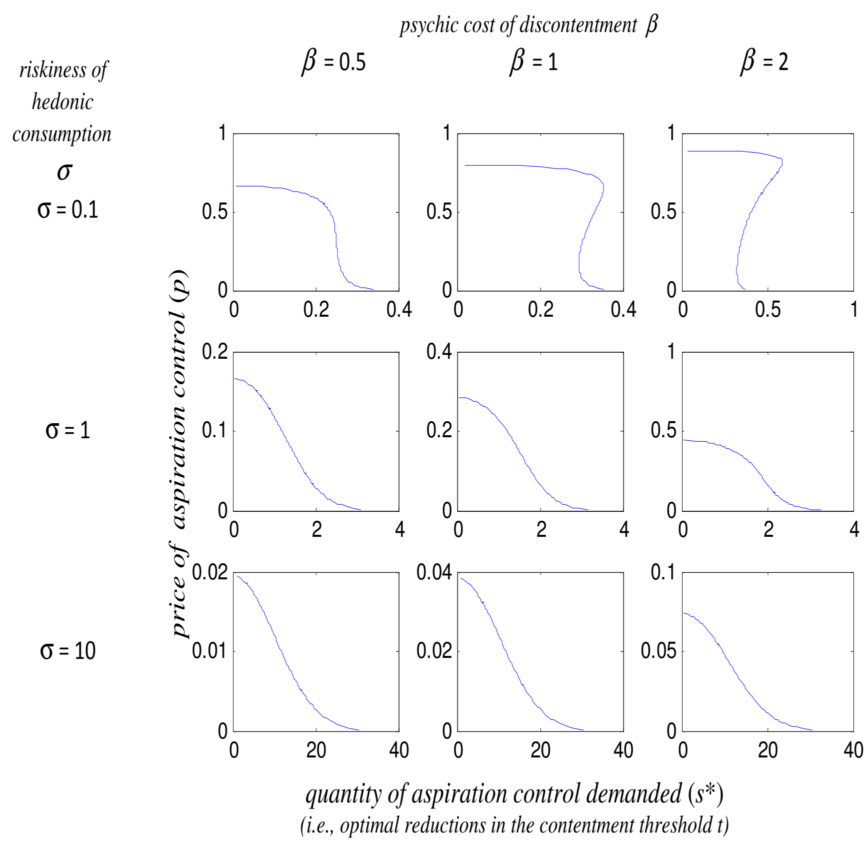
Figure 1: Demand for aspiration control (s^*) as a function of price (p) at nine different combinations of σ and β



Note: Demand curves in this figure plot expected-utility-maximizing values of s^* over prices ranging from zero to the upper bound in equation (16), $p < \frac{1}{\frac{\sigma}{\beta}(2\pi)^{1/2}+1}$, with $t_0 = 1$ and $M = 1$.

Figure 2: Demand for aspiration control with easy-to-reach default contentment threshold ($t_0 = M - 2\sigma$)

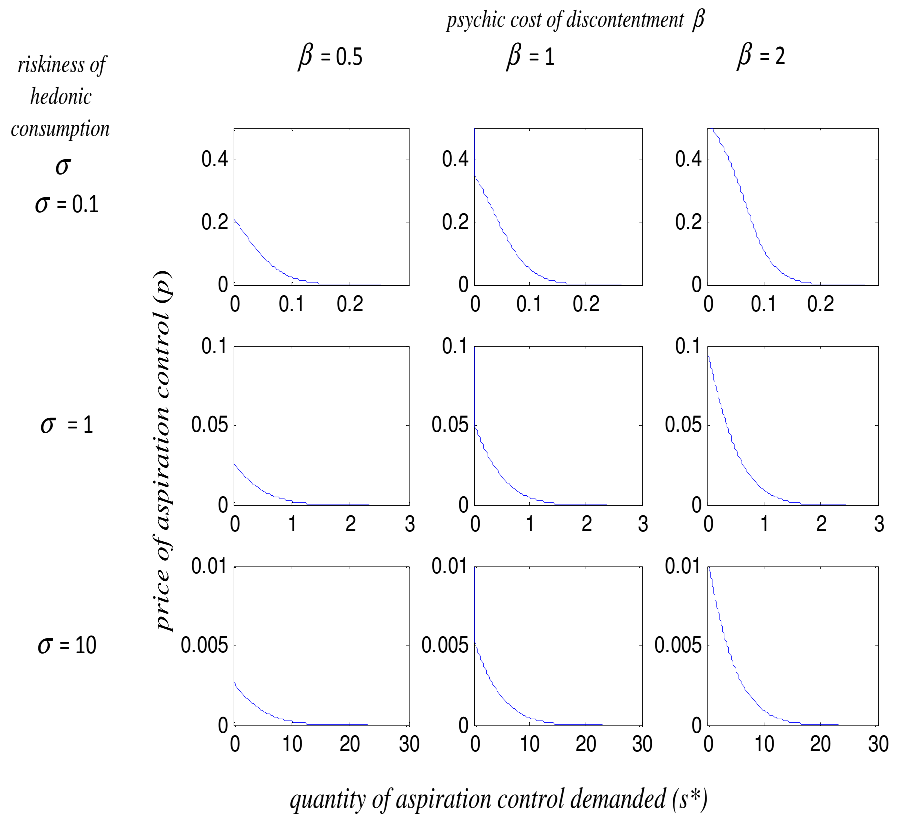


Figure 3: Demand for aspiration control with a hard-to-reach default contentment threshold ($t_0 = M + 2\sigma$)

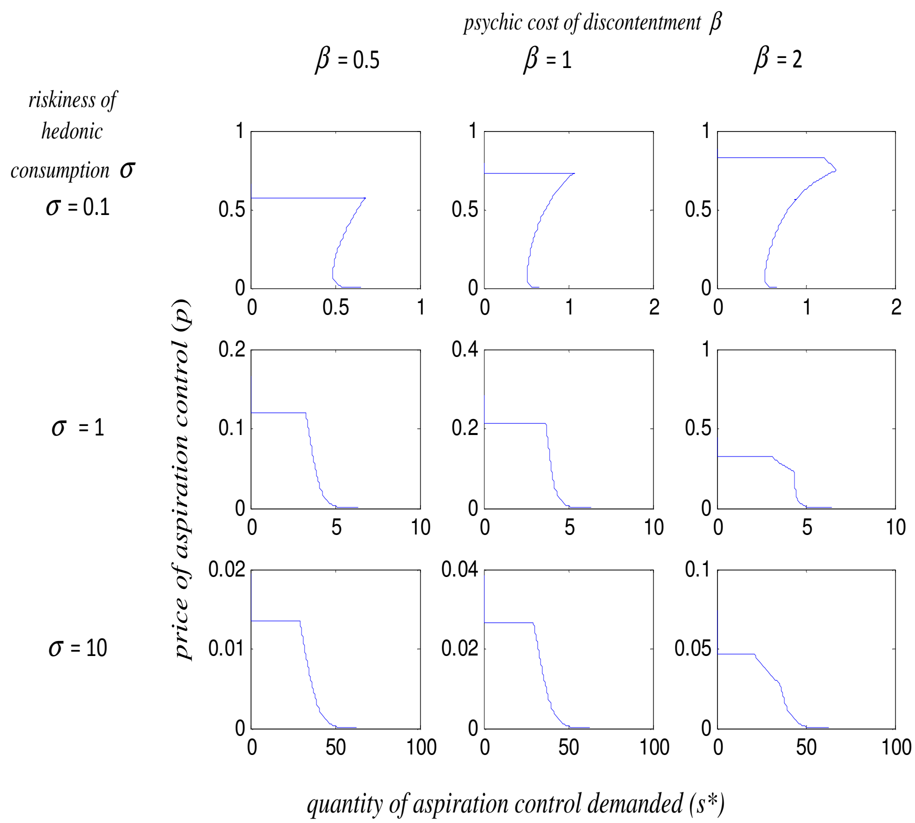


Figure 4: Percentage of M expended on aspiration control as a function of price

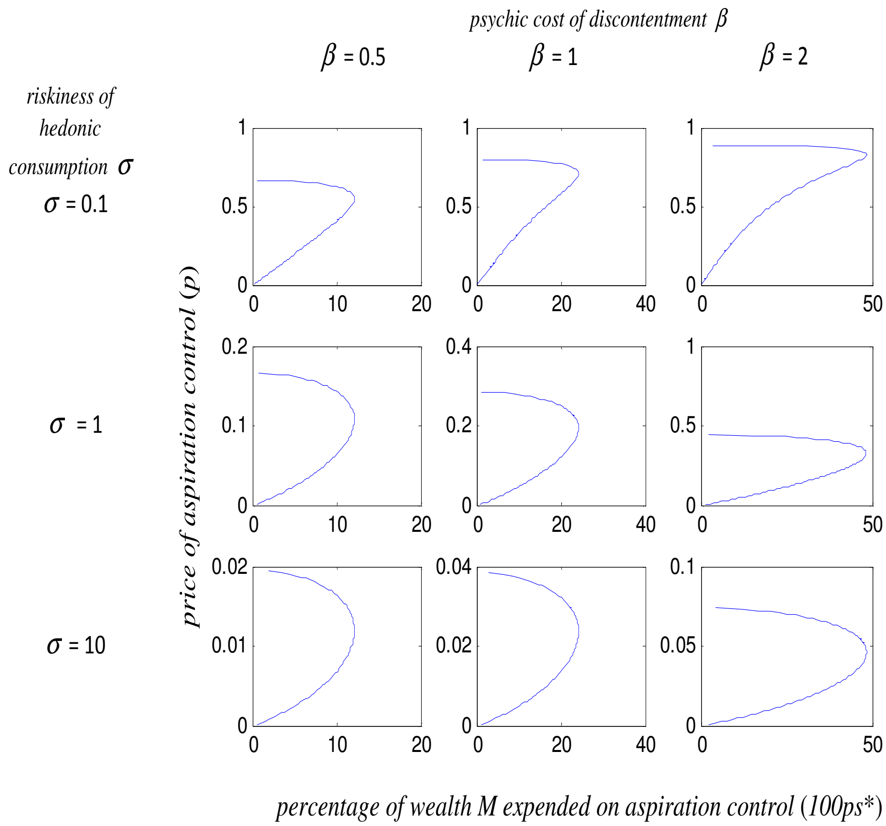
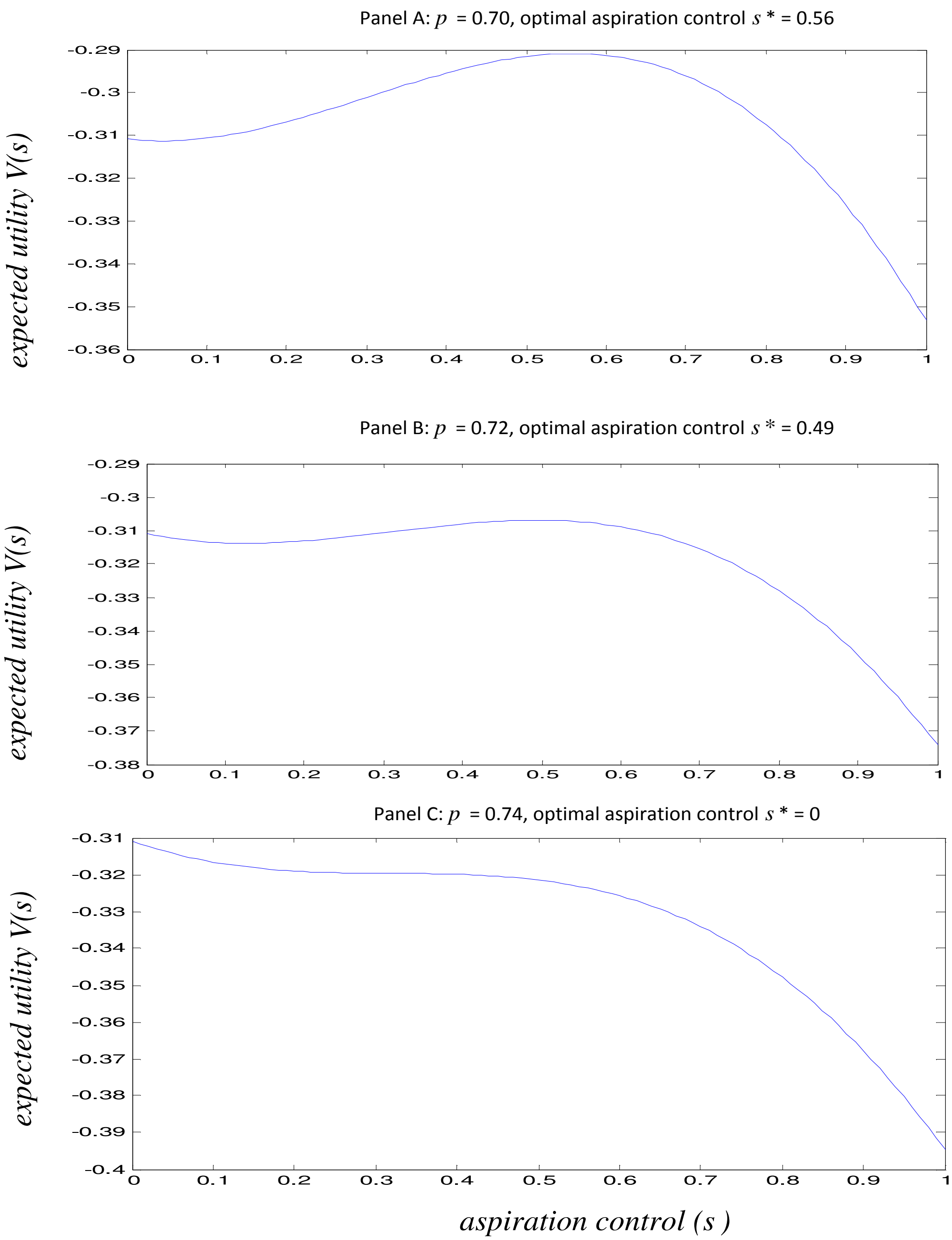


Figure 5: Discontinuity of s^*



Note: From Panel B to Panel C, there is a large and discontinuous change in the global maximizer of $V(s)$ in response to a small change in price.

Appendix A

Proof of Proposition 1: The Lagrangian for the utility maximization problem can be constructed as

$$L(x, s, \lambda) = U(x, x - t(s)) + \lambda(M - x - ps). \tag{A.1}$$

The first-order conditions imply:

$$\frac{\partial L}{\partial x} = U_1 + U_2 - \lambda = 0, \tag{A.2}$$

$$\frac{\partial L}{\partial s} = U_2 - \lambda p = 0, \tag{A.3}$$

$$\frac{\partial L}{\partial \lambda} = M - x - ps = 0. \tag{A.4}$$

The expression above results from applying the substitution $t'(s) = 1$. Total differentiation of the expressions in (A.2), (A.3) and (A.4) yields:

$$\begin{bmatrix} U_{11} + 2U_{12} + U_{22} & U_{12} + U_{22} & -1 \\ U_{21} + U_{22} & U_{22} & -p \\ -1 & -p & 0 \end{bmatrix} \begin{bmatrix} dx \\ ds \\ d\lambda \end{bmatrix} = \begin{bmatrix} 0 \\ \lambda \\ s \end{bmatrix} dp. \tag{A.5}$$

Applying Cramer's rule, we obtain an expression for $\frac{\partial s^*}{\partial p}$ as a ratio of determinants of two matrices as defined below:

$$\frac{\partial s^*}{\partial p} = \frac{\Delta_2}{\Delta}, \tag{A.6}$$

where $\Delta_2 = \begin{vmatrix} U_{11} + 2U_{12} + U_{22} & 0 & -1 \\ U_{21} + U_{22} & \lambda & -p \\ -1 & s & 0 \end{vmatrix}$ and $\Delta = \begin{vmatrix} U_{11} + 2U_{12} + U_{22} & U_{12} + U_{22} & -1 \\ U_{21} + U_{22} & U_{22} & -p \\ -1 & -p & 0 \end{vmatrix}$.

Straightforward calculations yield the inequality:

$$\Delta_2 = [p(U_{11} + U_{12}) + (p - 1)(U_{21} + U_{22})]s - \lambda < 0, \text{ if } p > 1.$$

Then, it follows directly that $\frac{ds^*}{dp} < 0$ whenever $p > 1$, because $\Delta > 0$ by the second-order condition.

Proof of Proposition 2: Similarly calculating $\frac{\partial s^*}{\partial p}$ by applying Cramer's Rule, we have:

$$\frac{\partial s^*}{\partial p} = \frac{\tilde{\Delta}_2}{\Delta}, \tag{A.7}$$

where $\tilde{\Delta}_2 = \begin{vmatrix} U_{11} + 2U_{12} + U_{22} & 0 & -1 \\ U_{21} + U_{22} & 0 & -p \\ -1 & -1 & 0 \end{vmatrix}$.

Again, a simple determinant calculation yields:

$$\tilde{\Delta}_2 = -p(U_{11} + U_{12}) + (1 - p)(U_{21} + U_{22}).$$

We note that $\tilde{\Delta}_2(p)$ is continuous in p; $\tilde{\Delta}_2(0) < 0$; and $\tilde{\Delta}_2(1) > 0$. Therefore, there exists $\overline{p}$ such that $\tilde{\Delta}_2(\overline{p}) = 0$. This completes the proof.