4-13-2017

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Recommended Citation

G?mez-Mi?ambres, J., & Schniter, E. (2017). Emotional calibration of self-control. *Journal of Behavioral and Experimental Economics, 68*, 110–118. https://doi.org/10.1016/j.socec.2017.04.003

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PII: S2214-8043(17)30039-3
DOI: 10.1016/j.socec.2017.04.003
Reference: JBEE 271

To appear in: *Journal of Behavioral and Experimental Economics*

Received date: 24 August 2014
Revised date: 10 April 2017
Accepted date: 11 April 2017

Please cite this article as: Joaquín Gómez-Miñambres , Eric Schniter , Emotional Calibration of Self-Control, *Journal of Behavioral and Experimental Economics* (2017), doi: 10.1016/j.socec.2017.04.003

HIGHLIGHTS

- We study a dynamic self-control model affected by past decisions.
- Past decisions produce effort and regret emotions that affect self-control.
- We explain switching consumption patterns of indulgence and restraint (and vice versa)
- The amplitude of this pattern increases with foresight.
- Unavoidable temptations affect future preferences, and pre-commitment decisions.

Emotional Calibration of Self-Control

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This Draft: April, 2017

Abstract

We study a dynamic model of self-control where previous decisions have influence on subsequent decision making. In our model effort and guilt are negative emotions produced by previous decisions to either resist or yield to temptation, respectively. These emotions calibrate an individual's self-control, in turn affecting future decisions. Our model explains non-stationary consumption paths characterized by compensatory indulgence and restraint, why under some circumstances the amplitude of this switching pattern increases with foresight, and how unavoidable options that might show up on one's menu influence choices, consequent emotions, consumption paths, and preferences for commitment. We discuss the implications of self-control insights provided by our model for both consumers and marketers.

KEYWORDS: Self-control; emotion; dynamic choice; temptation; commitment.

JEL CODES: D11, D90, I12.

"The only way to get rid of a temptation is to yield to it. Resist it, and your soul grows sick with longing for the things it has forbidden to itself" (Oscar Wilde, The Picture of Dorian Gray, 1891)

"The dieter spots the German chocolate cake on the dessert trolley and is sorely tempted. His rational assessment urges restraint. The weight he will gain, it tells him, is too big a price to pay for the fleeting moment of gastronomic pleasure. Yet, despite this calculation, he often gives in. And when he does, he almost invariably expresses regret." (Robert H. Frank, Passions within Reasons, 1988, p. 86)

1. INTRODUCTION

The decision whether to indulge temptation or exert restraint is one of the most basic problems that people frequently struggle with. Feelings of indulgence guilt or restraint effort seem to influence consumers' subsequent decisions, and marketers seek to exploit this – yet the dynamic relationship between these feelings and decisions is poorly understood. Emotions like guilt and effort play no role in standard economic theories.

Standard economic theories assume that consumers always choose what they prefer given their well define preferences characterized by a single, time-invariant, utility function. In contrast to the standard approach, some economists have long pointed out that when self-control dilemmas are faced, despite stated intentions, people often demonstrate difficulty "committing" to pursuit of their declared preferences (Strotz, 1955). A popular approach to formalizing this kind of time-inconsistent behavior considers an individual as a "dual-self" whose choices are the products of two utility functions with conflicting interests. As Schelling (1978) described, sometimes a person "behaves like two people, one who wants clean lungs and long life and another who adores tobacco, or one who wants a lean body and another who wants dessert. The two are in a continual contest for control".

The internal conflict idea has also been considered and justified in disciplines outside of economics. Miller's (1960) classic research presented rats with a stimulus that created a dilemma: it provided both reward (i.e., food) and punishment (i.e., electrical shock) – causing alternation between approach and avoidance. More recent developments in *neuroscience* explain the cognitive basis for switching behaviors: when self-control problems are faced, two separate neural subsystems are activated (McClure et al., 2004; Hare et al., 2009) and regulated by distinct brain circuitry associated with emotion in animals and humans (e.g. see Gray, 1990; Hoebel et al., 1999; Davidson, 1990, 1992, 2000). Evolutionary psychologists (e.g. Tooby and Cosmides, 1990) propose that these internally conflicted systems, with emotions as their co-evolved "guidance systems", may have been selected for because they can provide efficient solutions to the dynamic problems of changing environments. Livnat and Pippenger's (2006) analysis of decision making systems supports this perspective, finding that under limited computational ability an optimal brain system may involve subsystems that are in conflict with each other. Overall, this evidence suggests that a "dual-self" model may provide a more appropriate description of decision making under dilemma conditions than the standard single preferences approach.

In economics, "dual-self" models are based on two utility functions with conflicting goals (e.g. see Fudenberg and Levine, 2006). When deciding among a set of available alternatives (a menu), an individual with dual utilities may not be able to maximize both simultaneously. Therefore, an important difference from a standard choice model is that decisions create unfulfilled preferences or "forgone utilities" –the difference between a maximum possible utility available and a realized utility. In this paper we use the idea of forgone utilities to formalize the negative emotions that consumers derive from previous self-control decisions. While this paper does not aim to provide discussion or analysis of the myriad ways that *expected* and *immediate* emotions can affect economic decisions (for this, see Rick and Loewenstein, 2008), our goal is to introduce the effects of menu-dependent negative emotions on future preferences and self-control decisions in a simple "dual-self" model.

Evolutionary psychologists (Tooby and Cosmides, 1990; Nesse, 1990) have proposed that emotions are functionally designed to orchestrate physiological and cognitive systems for the purpose of predisposing those who feel or remember them to act more or less in a certain way. The emotions we focus on appear to facilitate behavioral regulation via negative affective feedback (i.e. unpleasant feelings). Indulgence guilt (here forward *guilt*) has been identified as commonly experienced after indulgence (e.g., Lascu, 1991) and limits the tendency to further indulge upon future opportunity (Baumeister and Heatherton 1996). Restraint effort (here forward *effort*) has been identified as commonly experienced during and after restraint decisions that forgo more pleasurable alternatives (Kivetz and Keinan 2006, Kurzban et al., 2013). The recalibrational role of emotions on behavior has also been noted in the marketing literature on food consumption (Mukhopadhyay et al. 2008) and moral behaviors (Cornelissen et al. 2013).

To understand the intuition behind emotional calibration of self-control, consider the following example. A consumer with two conflicting preferences goes to lunch every day at the same restaurant where he decides whether to eat cake for dessert. According to his *restraint utility*, concerned with long-term health maintenance, he wants to eat a low calorie diet, avoiding desserts. However, according to his *temptation utility*, concerned with the immediate satiation of cravings, he wants to eat rich desserts. Thus, if the consumer eats the cake, he is making the best possible decision given his temptation preferences while making the worst possible decision given his restraint preferences. When the consumer eats cake, forgone restraint is maximal, producing guilt. On the other hand, when the consumer declines to eat cake, forgone temptation is maximal, producing effort. Note that these emotions are menu-dependent in the sense that, for instance, effort from not eating cake would be stronger if, along with the previously mentioned cake, there was also a more tempting higher-calorie chocolate cheesecake on the menu. In our "dual-self" model consumers' preferences are affected by previously generated emotions. We illustrate our notion of effort with justifications commonly invoked by consumers for their decisions to indulge. For example, "I deserve to eat cake today because I've behaved so well (having resisted the temptation to eat cake) these past days." Similarly, the notion of guilt is invoked by justifications for the restraint shown at decision junctures. For example, "I don't deserve to eat cake because I haven't been behaving well (having eaten cake these past days)."

This paper contributes to the existing literature by introducing how previous self-control decisions under specific menu conditions generate emotions that orchestrate future preferences and decisions. While previous self-control models have introduced the concept of forgone utilities (see review in Section 5), they have typically assumed consumers' preferences are fixed. In our setting, restraint and temptation preferences are affected by not only immediate choices but also forgone menu options (experienced as effort and guilt) in previous self-control decisions. Both emotions are negative in the sense that they impose costs that decrease the cardinal scale of targeted utilities. To facilitate the analysis and interpretation of our model we use a Hotelling specification, derived from Hotelling's (1929) location model, which has been previously introduced to formalize self-control problems (Gómez-Miñambres, 2015). In our model, mutually exclusive restraint and indulgence preferences are located at the extremes of a unit length segment. This "Hotelling line" provides an intuitive way to capture differences in restraint and temptation preferences as different "ideal points" in a characteristic space. We can generalize our introductory cake example by considering that different points on the Hotelling line would represent different kinds of cakes, situated according to their caloric value. Higher calorie cakes would be located closer to the temptation preference while lower calorie cakes would be located relatively closer to the restraint preference. A menu, representing the alternatives faced by an individual, contains a subset of all possible cakes included on the Hotelling line. Therefore, under this specification, forgone utilities are proportional to Euclidean distances between the point of actual consumption (i.e., the chosen cake) and the boundaries of the menu. If the individual has taken actions closer to the ideal point of restraint (e.g., by consuming low calorie "diet" cakes instead of available higher calorie cakes), the effort experienced from resisting temptation will be higher, in turn decreasing the relative weight of the restraint preference (and thus the appeal of the "diet" cake over the "real thing"). Thus, future attempts to resist available high calorie temptations, even with the aid of available diet cakes, will be more difficult. Similarly, if an individual has been taking actions closer to the ideal temptation point (i.e., by consuming high calorie cakes), the guilt experienced as a consequence of yielding to temptation will be higher, in turn decreasing the relative cardinal scale of temptation preference. Thus, future attempts to resist temptation will be easier.

We provide several results from our model explaining the menu-dependent non-stationary consumption described above. First, we consider a model with a given menu that is known by the consumer. We show that the optimal consumption path follows a switching pattern in line with previously described evidence (for a more detailed review see Lichtenstein and Slovic, 2006). In particular the agent tends to fast if he has previously feasted and vice versa. The amplitude of this switching depends on the given menu as well as on the agent's discount factor. Second, we consider a model where the consumer initially commits to a menu that he will face in subsequent consumption periods unless uncontrolled alternatives arise (which we examine the consequences of). Let us consider illustrations of this with our restaurant and cake example. A consumer who visits the same restaurant daily could be faced with a new "special" being offered: a new kind of chocolate cheesecake with even higher caloric value than the ones formerly available. The new alternative, even if not chosen, generates menu-dependent emotions that affect subsequent preferences and decisions. Thus, availability of a special extra-decadent chocolate cheesecake could trigger consumption of cakes that otherwise would not have been consumed. As we show, our model predicts that forward-looking consumers will demand commitment menus with some (but not full) flexibility. While small (full-commitment) menus minimize the emotions generated when no uncontrolled alternatives arise, with flexible menus, consumers are better able to adapt their consumption to the emotional effects produced by uncontrolled alternatives when they appear.

The paper proceeds as follows. Section 2 describes the setup of our model. In section 3 we present and discuss the main results. Section 4 considers an extension of the basic model that allows us to study the implications of menu uncertainty and preferences for commitment. In Section 5 we discuss how our model relates to existing dual-preference self-control models. Finally, Section 6 discusses future research and concludes.

2. MODEL SETUP

We consider a consumer making decisions over two periods indexed by $t = \{1,2\}$. Actions are represented as locations on a Hotelling line of unit length $[0,1]$. We denote by x_t the consumption choice in period t and define M as the time invariant compact set of available alternatives (or menu).[1] The menu is a closed interval that lies on the Hotelling line. Thus,

[1] In Section 4 we will also consider the case of a time-variant set of alternatives.

M≡$[\underline{m},\overline{m}]$⊆[0,1] with $\underline{m} \leq 1/2 \leq \overline{m}$. We assume that the consumer is perfectly informed about the alternatives on the menu.

Consistent with "dual-self" models we assume that consumer's preferences are characterized by two different utilities. We denote these utility functions by u and v. We assume that preferences are located at the extremes of the Hotelling line. Without loss of generality we consider that u's ideal point is located at zero while v 's ideal point is located at one. Therefore, utility functions are given by

$$u(x_t) = s - c(x_t, 0)$$

$$v(x_t) = s - c(x_t, 1)$$

where s∈$\mathbb{R}_+$ represents the maximum consumers' surplus, and c(·) is a continuous and twice differentiable "transportation cost" function, which represents the cost of making decisions different from the ideal points and which satisfies

(i) Symmetry: $c(x, y) = c(y, x)$;
(ii) Non-negativity: $c(x, y) \geq 0$;
(iii) Identity of indiscernibles: $c(x, y) = 0$ *iff* $x = y$
(iv) Increasing in Euclidean distance: $c(x, y) \geq c(x', y')$ *iff* $|x - y| \geq |x' - y'|$
(v) Convexity: $\frac{d^2c(x,y)}{d^2x} > 0$

The quadratic function, $c(x, y) = (x - y)^2$, is an example of a transportation cost function that satisfies all properties (i)-(v).

In our model, the Hotelling line represents a continuum of product ranked with respect to a particular dimension (e.g., caloric value), where the ideal products of the two conflicting utilities are located at the end points. For simplicity of exposition we call u the restraint utility and v the temptation utility. Though this nomenclature is arbitrary, it fits very well with our introductory cake example where M represents the caloric value of available cakes and x_t represents the cake consumed by the individual in period t. Under this interpretation, when the consumer exercises restraint (consuming a lower calorie cake), x_t would be closer to the u-preference's ideal point and vice versa.

In our dual-self model, because an agent cannot maximize both utilities simultaneously, forgone utilities are generated by his decisions. Consistent with the terminology used by others (e.g., Gul and Pesendorfer 2001, 2004, 2007; Kopilov 2012) we call the forgone u-utility generated by period 1 actions the *effort* emotion:

$$e(x_1, \overline{m}) = \max_{x \in M} v(x) - v(x_1) = v(\overline{m}) - v(x_1) \quad [1]$$

Similarly, we call the forgone v-utility generated by period 1 actions the *guilt* emotion:

$$g(x_1, \underline{m}) = \max_{x \in M} u(x) - u(x_1) = u(\underline{m}) - u(x_1) \qquad [2]$$

Therefore, resisting temptation in period 1 (i.e., x_1 close to $\underline{m}$) creates feelings of high effort but low guilt, while yielding to temptation (i.e., x_1 close to $\overline{m}$) generates high guilt but low effort.[2]

To formalize the role of emotions in consumption behavior we use the "extended utility" concept (Becker 1996), widely used in models of habit formation. This approach incorporates past experiences into preferences, so that utility functions depend not only on immediate consumption but also on previous consumption decisions. In our approach, period 2 utilities are calibrated with previously generated emotional experiences so that

$$U(x_1, x_2, \underline{m}) = u(x_2) - \rho g(x_1, \underline{m}) c(x_2, 0) = s - \left(1 + \rho g(x_1, \underline{m})\right) c(x_2, 0) \qquad [3]$$

$$V(x_1, x_2, \overline{m}) = v(x_2) - \rho e(x_1, \overline{m}) c(x_2, 1) = s - \left(1 + \rho e(x_1, \overline{m})\right) c(x_2, 1) \qquad [4]$$

where $\rho \in \mathbb{R}_+$ is a parameter measuring the impact of emotions on extended utilities.

Note that while the primitive utility functions, u and v, are constant, the extended utilities also depend on past choices as well as on forgone restraint and temptation opportunities $\underline{m}$ and $\overline{m}$, respectively. Our extended utilities capture the idea that guilt and effort are negative emotions since they decrease the cardinal scale of the primitive utilities by increasing the transportation cost of making decisions different from their ideal points. This assumption captures the intuitive behavior-regulating recalibrational effects of restraint effort and indulgence guilt that we report finding in neuroscience, psychology and marketing literatures (see Introduction). For instance, note that the marginal U-utility of consumption in period 2 $\frac{dU(x_1, x_2, \underline{m})}{dx_2} = -\left(1 + \rho g(x_1, \underline{m})\right) c'(x_2, 0) < 0$ decreases with $g(x_1, \underline{m})$. This indicates that indulgence guilt created in the past makes it more costly to yield to temptation again now. Similarly, note that the marginal V-utility of consumption in period 2 $\frac{dV(x_1, x_2, \overline{m})}{dx_2} = -\left(1 + \rho e(x_1, \overline{m})\right) c'(x_2, 1) > 0$ increases with $e(x_1, \overline{m})$, indicating that the restraint effort created in the past makes it more costly to apply that restraint again today.

[2] Note that in this model we are treating effort and guilt emotions symmetrically. This assumption is made for the sake of simplicity and exposition. Alternatively, we can consider that effort and guilt are not equally important emotions. The asymmetry of effort and guilt would include a new parameter and hence an extra degree of freedom in the model but the main qualitative results would remain unchanged.

Below we mainly focus on choices from stable menus and the implications for non-stationary behavior, though we also consider time-variant menu alternatives and the choice of menus in Section 4.

3. THE OPTIMAL CONSUMPTION PLAN

In this section, we compute the optimal consumption decisions in both periods. We relegate all the proofs and technical details of the results to the Appendix.

Note that, since extended utilities in period 2 depend on period 1 decisions, the optimal consumption in the second period is given by the solution to the problem

$$\max_{x_2 \in M} U\big(x_1, x_2, \underline{m}\big) + V(x_1, x_2, \overline{m}) \qquad [P_{t=2}]$$

Given assumption (v) of $c(\cdot)$ we know that $\frac{d^2 U(x_1,x_2,\underline{m}) + V(x_1,x_2,\overline{m})}{d^2 x_2} < 0$ so the solution of this problem, $x_2^*(x_1)$, is unique.

We can then define the value function $W^*(x_1)$ as

$$W^*(x_1) = \max_{x_2 \in M} U\big(x_1, x_2, \underline{m}\big) + V(x_1, x_2, \overline{m}) \qquad [5]$$

The consumer's objective in the first period is to maximize the discounted sum of utilities, i.e.,

$$\max_{x_1 \in M} u(x_1) + v(x_1) + \delta\, W^*(x_1) \qquad [P_{t=1}]$$

Once again, our assumptions guarantee that the objective function of this problem is concave so the optimal consumption plan (x_1^*, x_2^*) is unique.

In a standard model where emotions play no role ($\rho = 0$), once a preferred alternative is chosen, the menu does not affect the agent's utilities in period 2 so $U\big(x_1, x_2, \underline{m}\big) = u(x_2)$ and $V(x_1, x_2, \overline{m}) = v(x_2)$. In this case, the agent would simply choose the compromise between the two conflicting preferences in both periods, i.e., the point lying equidistantly between the two ideal points. We summarize this result in the lemma below.

Lemma 1 (Standard model benchmark) Assume $\rho = 0$ and let (x_1^*, x_2^*) be the optimal consumption plan. Then $x_1^* = x_2^* = \frac{1}{2}$.

Hereafter we will focus on a model with $\rho > 0$ where past consumption decisions and foregone menu options affect the cardinal scale of utilities. As usual, we solve our model by backward induction – first characterizing the agent's decisions in period 2: $x_2^*(x_1) = \text{argmax}_{x_2} W^*(x_1)$. Our first proposition shows how previous choices affect current consumption.

Proposition 1 (Switching consumption pattern) Let $x_2^*(x_1) = \text{argmax}_{x_2} W^*(x_1)$ be the optimal consumption in period 2 given x_1. Then $\frac{dx_2^*(x_1)}{dx_1} < 0$

This results states that consumption in both periods are substitutes. Note that this is exactly the opposite of what is found in addiction literature where past consumption reinforces present consumption. This is because in our model the negative effort and guilt emotions impose costs that prevent reinforcement. In particular, succumbing to temptation in period 1 (higher x_1) generates more guilt than effort, motivating the agent to exercise more restraint in period 2.

The switching consumption pattern captures the intuition that individuals want to "launder" their minds of negative emotions by compensating an action with its opposite in the next period. This is in line with previous findings in psychology and marketing. For instance, Mukhopadhyay et al. (2008) found evidence of individuals who recalled resisting or yielding to the temptation of eating tasty but unhealthy food demonstrated a switching consumption pattern: they experienced greater activation of their unfulfilled preferences when faced with temptations similar to those faced in the recent past. Thus, as our model shows, recently indulgent consumers who recall their behaviors tend to show restraint when facing temptations again and recently restrained consumers tend to yield to temptation when recalling their restraint. Similar patterns, like those seen with alternating feasting and fasting behaviors, are often observed among everyday activities such as shopping, exercising, and working.

The next corollary shows how the effort and guilt emotions generated as a result of first period actions affect second period consumptions.

Corollary 1 (Emotional effects) Let $x_2^*(x_1) = \text{argmax}_{x_2} W^*(x_1)$ be the optimal consumption in period 2 given x_1. Then $x_2^*(x_1) \geq \frac{1}{2} \;\; iff \;\; e(x_1, \overline{m}) \geq g(x_1, \underline{m})$

Thus, if the agent generates more effort than guilt as a result of his first period consumption, his second period consumption will be closer to temptation preferences. Similarly, if guilt is greater than effort consumption will be closer to restraint preferences.

Effort and guilt emotions depend on first period choices so, even though useful for understanding our model's intuition, Proposition 1 and Corollary 1 do not provide the solution to the agent's problem. We now proceed to characterize the optimal consumption plan (x_1^*, x_2^*). Since the emotions produced by first period consumption will affect choices in the second period, a forward looking individual will anticipate these effects and consume accordingly in the first period. In the next proposition we prove how an individual's optimal consumption path and the emotions produced depend on the menu.

Proposition 2 (Menu Effects) Let (x_1^*, x_2^*) be an optimal consumption plan. Then

(i) $If\ \ \mu = 0\ \ then\ \ x_1^* = \frac{1}{2} = x_2^*$

(ii) $If\ \ \mu > 0\ \ then\ \ x_1^* \leq \frac{1}{2} < x_2^*$

(iii) $If\ \ \mu < 0\ \ then\ \ x_1^* > \frac{1}{2} \geq x_2^*$

where $\mu = c(\underline{m}, 0) - c(\overline{m}, 1)$

The first part of the proposition states that given a symmetric menu ($\mu = 0$) the consumer would make the same choice as if there were no emotions, i.e., the compromise between restraint and temptation utilities. If the consumer faces a menu with more options closer to temptation preferences ($\mu > 0$), the effort felt as a consequence of first period choices would be higher than the guilt. As proven in Lemma 2, this implies that consumption in the second period will be closer to temptation preferences. However, this action imposes a higher cost on the restraint utility since consumption is further away from its ideal point. The way of minimizing this cost consists of making a consumption decision that more closely fulfills restraint preferences in period 1, which would keep guilt low and result in less costly indulgence in period 2 (higher x_2), since the marginal U-utility decreases with guilt. Similarly, if the agent faces a menu that limits temptations and favors restraint ($\mu < 0$), guilt would dominate effort which, again according to Lemma 2, implies that he prefers consumption closer to restraint preferences. In this case, anticipating that he will do the opposite in period 2, the agent would consume closer to temptation preferences in period 1 in order to keep effort low, which makes resisting temptation (lower x_2) less costly in the second period since the marginal V-utility decreases with effort.

Results in Proposition 2 are important for at least two reasons. First, the results show how consumption adapts to the menu. If the menu has more options closer to temptation preferences, effort will dominate, bringing consumption closer to the ideal temptation preference in period 2. Similarly, if the menu has more options closer to restraint preferences, guilt will dominate, bringing consumption closer to the ideal restraint preference in period 2. Revisiting the cake example presented earlier, menu-dependent emotions incentivize low consumption when the available cakes are smaller and high consumption when the cakes are larger. This result is consistent with concerns raised by nutritionists that expanding portion sizes have contributed to the rise of obesity in United States. In line with our model, Rolls et al. (2002) found evidence that availability of large portions of food—ceteris paribus—contributes to excess consumption.[3] Second, a forward looking consumer takes into account how emotions created by their decisions will affect future preferences. Coming back to the cake example, where the Hotelling line represents the caloric value, when given a set of alternatives that includes very high-calorie cakes, the consumer knows that he will end up choosing a higher calorie cake than if he would have faced a less "tempting" menu. However, the consumer finds it optimal to exercise restraint now and hence keep the consequent guilt low so that later consumption of a high-calorie cake will be less emotionally costly. In the next corollary we prove that if the consumer cares more about the future he will be more willing to engage in this behavior in order to minimize second period emotional costs.

Corollary 2 (Comparative statics) Let (x_1^*, x_2^*) be an optimal consumption plan. Then

(i) $\frac{d|x_2^* - x_1^*|}{d\overline{m}} > 0$ *and* $\frac{d|x_2^* - x_1^*|}{d\underline{m}} > 0$

(ii) $\frac{d|x_2^* - x_1^*|}{d\delta} > 0$ and $\frac{d|x_2^* - x_1^*|}{d\rho} > 0$

Thus, the amplitude of the consumer's switching behavior depends on the boundaries of the menu (i) as well as on the discount factor and the impact of emotions on extended utilities (ii).

The model presented above helps us understand how emotions affect the dynamics of consumers' behavior when facing self-control problems. Guilt and effort emotions calibrate consumers' preferences so as to form consumption patterns that depend on available menu options. In the next section, we focus on how an agent with these types of preferences chooses his menus and responds to uncontrolled alternatives.

4. MENU UNCERTAINTY AND COMMITMENT

In this section we relax the assumptions that the agent has perfect information and no control over the alternatives on the menu. Instead we consider that, before consumption takes place, the agent must decide on his menu for the consumption periods. In particular, we consider a three period, $t = \{0,1,2\}$, version of the model presented in Section 2, where in the first period ($t = 0$) the agent decides the set of alternatives that he will choose from during the consumption periods. We refer to the set of alternatives that the individual chooses in $t = 0$ as the *commitment menu* and, as in our basic model, it consists of a closed interval $M^C \equiv [\underline{m}^C, \overline{m}^C] \subseteq (0,1)$ with $\underline{m}^C \leq 1/2 \leq \overline{m}^C$. To relax the assumption that consumers always

[3] Rolls et al. (2002) use a between subjects experiment where participants face different portions of macaroni and cheese. Even the smallest portion of macaroni and cheese was selected to be significantly larger than the typical intake. Participants with the smallest portion (500g) consumed on average 335g, while participants with a large portion (1000g) consumed 434g. These results are consistent with our model's premise that the menu that a consumers faces may affect his preferences.

face the same set of alternatives, we also consider that at the beginning of the first consumption period ($t = 1$) a set of *uncontrolled alternatives* (Z) may arise. We assume that Z and M^C are disjoint sets ($M^C \cap Z = \emptyset$) so uncontrolled alternatives are not part of the agent commitment menu and hence, even though considered, they will not be chosen during the consumption periods. To illustrate this in a simple way, we assume that there are three states of nature $j \in \{T, R, \emptyset\}$. In state T the uncontrolled alternative coincides with the ideal temptation preference point, $Z = \{1\}$. In state R the new alternative is the restraint preference point, $Z = \{0\}$. In the state where $Z = \{\emptyset\}$, no new alternatives arise. Thus

$$Z = \begin{cases} 1 & \text{with probability } p_T, \\ 0 & \text{with probability } p_R, \\ \emptyset & \text{with probability } p_\emptyset = 1 - p_T - p_R. \end{cases}$$

where $p_j \geq 0$ is the probability that new uncontrolled alternatives are created in state *j*.

It could be useful to interpret M^C as the food available in the consumer's pantry representing his committed meals; and Z as temptation that the consumer may or may not encounter in uncontrolled display (e.g., TV commercials advertising alternative meals). Uncontrolled displays might offer the consumer "unhealthy" meals more in line with temptation preferences ($Z = \{1\}$) or "healthy" meals more in line with restraint preferences ($Z = \{0\}$). Our theory emphasizes that, even if not consumed, these uncontrolled alternatives generate guilt and effort emotions that, in turn, provide a psychological impulse affecting subsequent consumption.

Technically, the total set of alternatives faced by the consumer ($M_j = M^C \cup Z \subseteq [0,1]$) is the union of a proper interval (M^C), representing the agent's commitment menu, and a possibly degenerate interval (Z), that represent the uncontrolled alternatives. If $Z = \{\emptyset\}$, no new alternatives will be faced, so guilt and effort emotions generated from a consumption decision $x_1 \in M^C$ are $e(x_1, \overline{m}^C)$ and $g(x_1, \underline{m}^C)$ respectively. However, if $Z = \{1\}$ the option that maximizes temptation preferences is $1 > \overline{m}^C$ so a consumption decision generates a higher effort emotion, $e(x_1, 1) > e(x_1, \overline{m}^C)$. Similarly if $Z = \{0\}$ the consumer will suffer a higher guilt emotion, $g(x_1, 0) < g(x_1, \underline{m}^C)$. In other words, when uncontrolled alternatives are present guilt or effort emotions will be higher because more extreme options are encountered.

Given M^C and Z we can characterize optimal consumption paths as we did in the previous section. For notational convenience we denote by $x_{t,j}^* \in M^C$ the optimal consumption path in period $t \in \{1,2\}$ and state $j \in \{T, R, \emptyset\}$. We can then re-define the value function [5] as

$$W^*(x_{1,j}) = \max_{x_{2,j} \in M^C} U(x_{1,j}, x_{2,j}, \underline{m}_j) + V(x_{1,j}, x_{2,j}, \overline{m}_j)$$

where

$$\overline{m}_j = \begin{cases} 1 & \text{if } j{=}T \\ \overline{m}^C & \text{otherwise} \end{cases} \quad \text{and} \quad \underline{m}_j = \begin{cases} 0 & \text{if } j{=}R \\ \underline{m}^C & \text{otherwise} \end{cases}$$

are the upper and lower bounds of the set of alternatives faced by the consumer which now depend on the particular realization of Z.

Therefore, the consumer problem in period 1 can also be re-written as

$$\max_{x_{1,j} \in M^C} u(x_{1,j}) + v(x_{1,j}) + \delta W^*(x_{1,j})$$

Given the optimal consumption plans $\{x^*_{t,j}, x^*_{2,j}\}$ for every $j \in \{T, R, \emptyset\}$, the optimal commitment menu is given by

$$M^{C*} = \underset{M^C \subseteq (0,1)}{\operatorname{argmax}}\, p_T \Psi_T + p_R \Psi_R + p_\emptyset \Psi_\emptyset$$

with $\Psi_j = u(x^*_{1,j}) + v(x^*_{1,j}) + \delta[U(x^*_{1,j}, x^*_{2,j}, \underline{m}_j) + V(x^*_{1,j}, x^*_{2,j}, \overline{m}_j)]$

A central component of our framework is that emotions created by previous self-control decisions affect subsequent preferences. It is only logical that a forward looking agent who is choosing a commitment menu tries to minimize these negative emotions. One possibility is to commit to a menu that only includes the compromise between temptation and restraint ideal points, thus $M^C = \left\{\frac{1}{2}\right\}$. This singleton menu would certainly be optimal if there were no uncontrolled alternatives since, in this case, the agent is prevented from suffering emotions given that there are no other options to forgo on the menu. However, note that the uncontrolled alternatives that arise with probability $(p_T + p_R)$ will create negative effort (when $Z = \{1\}$) and guilt (when $Z = \{0\}$) emotions for any consumption decisions, so the optimal menu may be different. In the next lemma we show the optimal menu decisions in each possible state of nature.

Lemma 2 Let $M^{C*} \equiv [\underline{m}^{C*}, \overline{m}^{C*}]$ be an optimal commitment menu. Then,

(i) $x^*_1(M^{C*}) = x^*_2(M^{C*}) = \frac{1}{2}$ if $p_\emptyset = 1$
(ii) $x^*_1(M^{C*}) = \underline{m}^{C*} < x^*_2(M^{C*})$ if $p_T = 1$
(iii) $x^*_1(M^{C*}) = \overline{\mathrm{m}}^{C*} > x^*_2(M^{C*})$ if $p_R = 1$

By Proposition 1, we know that if $p_T = 1$ effort will dominate guilt and if $p_R = 1$ guilt will dominate effort in the second period; and the optimal switching consumption pattern implies that x_1 should be closer to the lower bound of the menu in the former and closer to the upper bound in the latter case (Lemma 2). If, as we consider in this section, the agent can decide on a commitment menu, he will choose $\underline{m}^C = x_1$ when $p_T = 1$ so that $g(x_1, \underline{m}^C) = 0$, and $\overline{m}^C = x_1$ when $p_R = 1$ so that $e(x_1, \overline{m}^C) = 0$. By choosing the commitment menu in this way, the agent assures that, in period 2, there will be no guilt when he yields to temptation and no effort when he exercises restraint, minimizing the emotional costs of his choices.

To better understand this result we consider a simple example which allows us to provide parametric solutions to the model. Let us assume that $c(x, y) = (x - y)^2$ and $\rho = \delta = 1$. In this case, given $x_{1,j}$ the solution of the consumer's problem in the second period, $P_{t=2}$, in state j is given by

$$x^*_{2,j}(x_{1,j}) = \frac{1+e(x_{1,j},\overline{m}_j)}{2+e(x_{1,j},\overline{m}_j)+g(x_{1,j},\underline{m}_j)} \qquad [6]$$

where $e(x_{1,j}, \overline{m}_j) = (1 - x_{1,j})^2 - (1 - \overline{m}_j)^2$ and $g(x_{1,j}, \underline{m}_j) = {x_{1,j}}^2 - {\underline{m}_j}^2$

Therefore, we can easily check that if $p_T = 1$ and $\underline{m}^{C*} = x^*_1$ then $x^*_1 = \frac{1}{2}$ and using equation [6] we get $x^*_2 = \frac{5}{9} > x^*_1$. Similarly, if $p_R = 1$ and $\overline{\mathrm{m}}^{C*} = x^*_1$ then $x^*_1 = \frac{1}{2} > \frac{4}{9} = x^*_2$. Note that in these cases the optimal commitment menu is not unique. For instance, if $p_T = 1$ an optimal menu is given by $M^{C*} = \left[\frac{1}{2}, \overline{m}^{C*}\right]$ for any $\overline{m}^{C*} \geq \frac{5}{9}$. This is because when $Z = \{1\}$ the effort emotion $e(x_1, 1)$ is independent of $\overline{m}^C$ so there is no cost for the consumer of increasing $\overline{m}^C$ above the optimal second period decision $x^*_2 = \frac{5}{9}$. However, if there is positive probability of being in a different sate, any $\overline{m}^C > \frac{5}{9}$ may generate unwanted effort emotions and hence the optimal menu would be unique. Formally, if $p_T = 1 - \varepsilon$ with $\varepsilon \to 0$ then M^{C*} converges to $\left[\frac{1}{2}, \frac{5}{9}\right]$. Similarly, if $p_R = 1 - \varepsilon$ with $\varepsilon \to 0$ then M^{C*} converges to $\left[\frac{4}{9}, \frac{1}{2}\right]$.

Note that Lemma 2 would be the solution of a model where there is no uncertainty about the future state of nature. However, in our model, the agent does not know the particular realization of Z. It is clear from the previous result that, if the probability of not facing new alternatives ($p_\emptyset$) is sufficiently high, the agent would be willing to commit to the singleton menu, which creates no emotions, with probability $p_\emptyset$ and just suffer the negative emotions when the uncontrolled alternatives arise with probability $1 - p_\emptyset$.

Corollary 3 If $p_\emptyset \geq p(\delta, \rho)$ then $M^{C*} \equiv \left\{\frac{1}{2}\right\}$, where $\frac{\partial p(\delta,\rho)}{\partial \delta} > 0$ and $\frac{\partial p(\delta,\rho)}{\partial \rho} > 0$

Therefore, the greater the consumer's discount factor and the impact of emotions on behavior, the less we should expect choice of a singleton menu. This is not surprising given that, as proved in Corollary 2, the switching consumption pattern for a given menu increases in intensity with these parameters, such that the agent would demand a menu with more flexibility so he can accommodate his consumption path to emotions created by the uncontrolled alternatives. In the next proposition we solve the model for the agent who does not want to commit to a singleton menu.

Proposition 3. If $p_{\emptyset} < p(\delta, \rho)$ then $M^{C*} \equiv \left[\underline{m}^{C*}, \overline{m}^{C*}\right]$, where $\overline{m}^{C*} > \underline{m}^{C*}$ and:

(i) $1 > \underline{m}^{C*} + \overline{m}^{C*}$ if $p_R > p_T$
(ii) $1 < \underline{m}^{C*} + \overline{m}^{C*}$ if $p_R < p_T$
(iii) $1 = \underline{m}^{C*} + \overline{m}^{C*}$ if $p_R = p_T$

The intuition of this result is the following. By Lemma 2 we know that when $Z = \{0\}$ second period consumption would decrease so the optimal commitment menu must be more shifted towards the restraint preferences when $p_R > p_T$ (Proposition 3.i). Similarly, when $Z = \{1\}$ second period consumption would increase so the optimal commitment menu must be more shifted towards the temptation preferences when $p_R < p_T$ (Proposition 3.ii). Finally, if $p_R = p_T$ the optimal menu would be symmetrically balanced, i.e., lying equidistantly between temptation and restraint preferences.

It is important to emphasize that Proposition 3 shows that an individual affected by negative guilt and effort emotions will want to commit to a menu with some (but not necessarily full) flexibility if the probability of facing menu extensions is sufficiently large. In our model, the uncontrolled novelties contribute to the production of effort and guilt emotions that, in turn, will change the relative weights of conflicted preferences. In this case, the agent faces the following trade-off. A larger commitment menu will allow him the ability to adapt by following the switching consumption pattern described in the last section. However, by choosing greater flexibility, the agent creates menu options that could be more emotionally costly to forgo, so complete flexibility would not be optimal.

Let us now consider the example of a diet-conscious consumer who plans to cope with temptations at home: he has to decide about the cake he will purchase and keep in his refrigerator. If he knows that he will not face any other uncontrolled menu alternatives in the future he could decide not to stock a cake in his refrigerator. However, if the consumer knows that there is a high probability that he will watch tempting commercials for large German chocolate cakes on TV, he could decide to stock a small cake in the refrigerator. By consuming a small cake, the consumer can better moderate the restraint-reducing sense of effort created when shown the alternative of tempting large German chocolate cake.

5. DISCUSSION OF RELATED LITERATURE

Gul and Pesendorfer (2001) provide a popular representation of temptation that uses a dual-utility model to capture the idea that self-control can be costly and incomplete. In their model the forgone temptation utility derived from a decision is a linear self-control cost that favors the choice of small menus (*preference for commitment*). Following our terminology, Gul and Pesendorfer's self-control costs are effort emotions. In order to compare this framework with our model, let us consider Kopylov's (2012) extension of Gul and Pesendorfer's (2001) representation that includes forgone restraint utility (i.e., guilt):

$$W^K(M) = \max_{x \in M}[u(x)+v(x)] - \max_{x \in M} v(x) - k \max_{x \in M} u(x)$$

where $k \in (0,1)$.[4]

Note that $x_t = \operatorname{argmax}_{x \in M} u(x)+v(x) = \frac{1}{2}$ for any M that includes the alternative $1/2$ (the compromise between the individual's conflicting preferences). Therefore, consumption choices made from menus are unaffected by forgone utilities (which only affect choices of menus) so their model cannot explain the non-stationary consumption pattern that we have explained here.

There are other self-control models based on the dual-self idea. Dekel et al. (2009) provide a contrasting view to the assumption that only the most tempting offer in a menu determines self-control costs. In the Dekel et al. (2009) representation, self-control costs can be affected by several menu options. Fudenberg and Levine (2006, 2012) consider a version of the Gul and Pesendorfer (2001) representation where the self-control cost is not necessarily linear. In these models numerous temptations are more difficult to resist with each additional temptation.

A few papers have introduced a dynamic self-control model. Gul and Pesendorfer (2004) provide a recursive self-control model where, each period, an individual makes a consumption decision and chooses a menu for the next period. Using this recursive self-control idea, Gul and Pesendorfer (2007) introduce addiction by considering that previous consumption affects the marginal temptation utility in the next period while the restraint utility is left unaffected. Like our model, Gul and Pesendorfer (2007) may generate a switching consumption pattern (a

[4] Kopylov (2012) axiomatizes these preferences for $k \in (-1,1)$. In our model we only consider the case of costly forgone utilities (where k is positive) that is consistent with our notion of guilt. The representation also covers cases where consumption opportunities are forgone (where k is negative) and thus the restraint utility valued by the consumer is maximized. This model offers explanations for perfectionist strivings (Stoeber and Otto, 2006) and seemingly irrational behaviors that people exhibit when, for example, they pay for gym memberships or other products which they subsequently do not make use of (DellaVigna and Malmendier, 2006).

"cycle of addiction"), although the mechanisms differ. In their model, as drug consumption increases, the relative power of the tempted utility decreases until the restraint utility has relatively dominant power: leading a drug addict to go "cold-turkey" for one period before starting addictive consumption once again. In contrast, we consider a dual-self utility model where decisions depend not only on previous consumption but also on forgone menu alternatives. The switching consumption pattern arises as the result of the individual trying to minimize the impact of these forgone utilities (interpreted as guilt and effort emotions) on subsequent decisions. Therefore, in contrast to a model à la Gul and Pesendorfer, consumption choices are menu-dependent in our setting. For example, if menu options are closer to temptation preferences, the agent resists temptation now keeping guilt low so that his yield to temptation tomorrow is less costly.

Finally, another novel contribution of our model derives from its ability to consider appearance of uncontrolled options on menus that might have disruptive effects on self-control. We showed that a forward looking individual commits to menus with some flexibility, allowing their consumption to adapt to changes in emotional states created by uncontrolled options that arise. This result differs from previous self-control models where individuals always prefer smaller menus (*preferences for commitment*).[5] To see this, consider once again the version of Gul and Pesendorfer preferences discussed above. Since $k > 0$, any additional alternative $y \neq 1/2$ creates negative consequences for the individual. If $y > 1/2$, max $v(x) > v(1/2)$ while if $y < 1/2$, $\max_{x \in M} u(x) > u\left(\frac{1}{2}\right)$, so the consumer's overall utility $W^K(M)$ would decrease. In other words, by committing to a singleton menu which only includes the compromise between conflicting preferences ($M = \{1/2\}$), the individual minimizes the negative consequences of the menu extensions and maximizes overall utility. Obviously, this result remains unchanged even if we allow for uncontrolled alternatives as we did in Section 4. The consumer would be worse off with menu extensions but the preference for commitment prevails, such that uncontrolled alternatives play no role in consumption decisions.

6. CONCLUSION

We have developed a dynamic self-control model with negative emotions. In our model, effort and guilt are emotions produced by forgone temptation and forgone restraint utilities, respectively. We have proved several results in line with empirical evidence that normal non-pathological humans demonstrate non-stationary consumption paths characterized by

[5] Kopylov's (2012) representation also predicts a menu with some flexibility. However, the driving force is very different. In Kopylov's model menu flexibility is a consequence of self-deception and individuals never choose additional options since the consumption path is stationary (menu-independent). In our model, acknowledgement of non-stationarity in preferences implies a demand for a broader menu that allows one to resist or yield to temptation when uncontrolled menu extensions arise.

compensatory indulgence and restraint (or vice versa). We have also explained why the amplitude of this switching pattern increases with an individual's foresight and how it is affected by the menu. Finally, we have shown that uncertainty about the alternatives on the menu can influence both an individual's consumption path and preferences for commitment.

There are several promising extensions of our basic model. First, our model only considers negative emotions, i.e., previous forgone utilities that impose a cost on the consumer's utility. However, we can easily imagine that the consumer may also experience positive emotions. For instance, when an individual resists temptation he typically feels effort (a negative emotion), but also feels pride (a positive emotion) as a consequence of his decision. The introduction of positive emotions will generate more complicated extended utilities that will complicate the analysis, but the main results of our paper–the influence of menus on consumers' preferences and decisions—should remain unchanged.

Second, our model proposes a new way to capture context and framing effects that can be tested in the laboratory. For example, consider decisions faced by individuals with self-control problems such as dieting vs. eating indulgently, engaging in work vs. leisure, exercising vs. relaxing, abstaining from vs. having sex, and saving vs. spending money. By manipulating the menu of available options faced by the individual (e.g. by exogenously introducing novel options whose appearance the decision maker has no control over) we can observe whether switching patterns of indulgence and restraint emerge and whether the amplitude of these patterns depends on the menu as our model predicts.

Finally, our model also has important implications for the study of pricing and marketing strategies. Some papers studying selling and pricing strategies employed by firms have introduced temptation and self-control preferences (e.g., Eliaz and Spiegler, 2006; Esteban et al., 2007; Gómez-Miñambres, 2015). These papers model consumers as having self-control representations (e.g. Gul and Pesendorfer, 2001) that do not consider the menu dependence we studied here. As such, consumers' willpower is fixed and these models fail to explain puzzling consumer behaviors, such as the indulgence-restraint cycles documented for "normal" dietary behavior (Casper and Beaton, 1992; Mukhopadhyay et al., 2008), and the sporadic shopping spree behaviors described for typical consumers (Dhar et al.. 2007; Mukhopadhyay and Johar, 2009). Our model with menu-dependent emotions provides a rationale for these behavioral phenomena: by resisting temptation the consumer experiences effort. Memories of greater effort associate with restraint make it more difficult to resist temptation in the future. Similarly, by yielding to temptation the consumer experiences guilt. Memories of greater guilt associated with indulgence make it easier to resist temptation in the future.

Marketers as well as consumers can benefit from knowing that menu options offered by firms today will affect consumers' future demands. By producing emotional experiences in consumers and offering attractive choices (e.g., commitment plans, healthy or money-saving options, extravagances, indulgences and “treats”) in the wake of these experiences, marketers can capitalize on the dynamic properties of emotionally calibrated consumers. Consumers struggling with self-control problems may be able to improve their willpower by avoiding marketing traps and learning to better anticipate emotional consequences of their decisions. Advances in the arms race between marketers and informed consumers will have important implications for the strategies employed by firms (e.g. prices, sales and promotions, calorie and content disclosures, product locations) that deserve to be considered in future research.

7. **REFERENCES**

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APPENDIX

Proof of Lemma 1

If $\rho = 0$, period 1 actions do not affect period 2 utilities. Thus,

$$x_t^* = \underset{x \in M}{\operatorname{argmax}}\, u(x) + v(x) = \underset{x \in M}{\operatorname{argmax}} 2s - c(x,0) - c(x,1)$$

By properties (iv) and (v) of $c(\cdot)$ this problem is well define and concave. From the first order condition of the problem

$$c'(x,0) = -c'(x,1)$$

We know the only solution is $x^* = \frac{1}{2}$; and by the second order condition

$$-c''(x,0) - c''(x,1) < 0$$

we know is a maximum

□

Proof of Proposition 1

The first order and second order conditions of [$P_{t=2}$] are given by

$$-\Big(1 + \rho g\big(x_1, \underline{m}\big)\Big)\, c'(x_2^*, 0) - \big(1 + \rho e(x_1, \overline{m})\big) c'(x_2^*, 1) = 0 \qquad [FOC_{t=2}]$$

$$-\Big(1 + \rho g\big(x_1, \underline{m}\big)\Big)\, c''(x_2^*, 0) - \big(1 + \rho e(x_1, \overline{m})\big) c''(x_2^*, 1) < 0 \qquad [SOC_{t=2}]$$

where $c'(\cdot)$ is the derivative and $c''(\cdot)$ the second derivative of $c(\cdot)$. Note that the second order condition for a maximum is satisfied since $c''(x_2, 0)$ and $c''(x_2, 1)$ are both positive because of convexity, property (v).

When making a consumption decision in period 2, the consumer takes as given the effort and guilt generated in period 1. Thus, $e = e(x_1, \overline{m})$ and $g = g\big(x_1, \underline{m}\big)$. By deriving $FOC_{t=1}$ with respect to $e = e(x_1, \overline{m})$ we get

$$(1 + \rho g) c''(x_2^*, 0) \frac{dx_2^*}{de} + \rho c'(x_2^*, 1) + (1 + \rho e) c'(x_2^*, 1) \frac{dx_2^*}{de} = 0$$

Thus,

$$\frac{dx_2^*}{de} = \frac{-\rho c'(x_2^*, 1)}{(1+\rho g) c''(x_2^*, 0) + (1+\rho e) c''(x_2^*, 1)} > 0 \qquad [A1]$$

The numerator of this expression is positive since $c'(x_2^*, 1) < 0$ by property (iv) of $c(\cdot)$, while the denominator is also positive by property (v) and the fact that e and g are both positive.

Similarly, by deriving FOC$_{t=2}$ with respect to g we get

$$\rho c'(x_2^*, 0) + (1 + \rho g)c''(x_2^*, 0)\frac{dx_2^*}{dg} + (1 + \rho e)c'(x_2^*, 1)\frac{dx_2^*}{dg} = 0$$

Thus,

$$\frac{dx_2^*}{dg} = \frac{-\rho c'(x_2^*, 0)}{(1+\rho g)c''(x_2^*, 0) + (1+\rho e)c''(x_2^*, 1)} < 0 \qquad \text{[A2]}$$

The numerator of this expression is negative since $c'(x_2^*, 1) < 0$ by property (iv) of $c(\cdot)$, while the denominator is also positive by property (v) and the fact that e and g are both positive.

The optimal decision in period 2 can be written as a function of period 1 decision, $x_2^*(x_1)$. By applying the chain rule we get that

$$\frac{dx_2^*(x_1)}{dx_1} = \frac{dx_2^*}{de}\frac{de}{dx_1} + \frac{dx_2^*}{de}\frac{dg}{dx_1}$$

Thus, given [A1] and [A2] and the fact that $\frac{de}{dx_1} < 0$ and $\frac{dg}{dx_1} > 0$ we get $\frac{dx_2^*(x_1)}{dx_1} < 0$

□

Proof of Corollary 1

We start by rewriting the first order condition of the agent's problem in period 2 (FOC$_{t=2}$) given x_1 that we use in the proof of Proposition 1 as

$$\frac{1 + \rho g(x_1, \underline{m})}{1 + \rho e(x_1, \overline{m})} = -\frac{c'(x_2^*(x_1), 1)}{c'(x_2^*(x_1), 0)}$$

From this expression it is immediate that if $e(x_1, \overline{m}) > g(x_1, \underline{m})$ then $-\frac{c'(x_2^*(x_1),1)}{c'(x_2^*(x_1),0)} < 1$ so by property (iv) of $c(\cdot)$ we get $x_2^*(x_1) > \frac{1}{2}$. Similarly, if $e(x_1, \overline{m}) < g(x_1, \underline{m})$ then $-\frac{c'(x_2^*(x_1),1)}{c'(x_2^*(x_1),0)} > 1$ so $x_2^*(x_1) < \frac{1}{2}$.

□

Lemma A1 $\frac{dx_2^*(x_1)}{d\bar{m}} > 0$ and $\frac{dx_2^*(x_1)}{d\underline{m}} > 0$

Proof

Note that from the definition of *e* and g and property (iv) of $c(\cdot)$ we know that, given first period consumption, $\frac{de(x_1^*,\bar{m})}{d\bar{m}} = -\frac{dc(\bar{m},1)}{d\bar{m}} > 0$ and $\frac{dg(x_1^*,\underline{m})}{d\underline{m}} = -\frac{dc(\underline{m},0)}{d\underline{m}} < 0$. Therefore, applying the chain rule and using [A1] and [A2] we get

$$\frac{dx_2^*(x_1)}{d\bar{m}} = \frac{dx_2^*}{de}\frac{de}{d\bar{m}} > 0 \text{ and } \frac{dx_2^*(x_1)}{d\underline{m}} = \frac{dx_2^*}{dg}\frac{dg}{d\underline{m}} > 0$$

□

Proof of Proposition 2

Note that a symmetric menu, $c(\bar{m}, 1) = c(\underline{m}, 0)$, can be defined as $M = [m, 1 - m]$ with $m\epsilon(0,1/2)$. Let's also define $c_m = c\left(m, \frac{1}{2}\right)$. Finally, let E^* be the sum of effort and guilt when $x_1 = x_2 = 1/2$

$$E^* = c\left(\frac{1}{2}, 1\right) + c\left(\frac{1}{2}, 0\right) - 2c_m$$

And let $\hat{E}$ be the sum of effort and guilt when $x_1 \neq x_2 \neq 1/2$.

$$\hat{E} = c(x_1, 1) + c(x_1, 0) - 2c_m$$

To prove that $x_1(m) = x_2(m) = 1/2$ it is sufficient to prove that $E^* < \hat{E}$, which is true because of properties (iv) and (v) as we show in the proof of Lemma 1.

The second and third parts of the proposition can be proved by looking at shifts from this symmetric menu and applying our previous results. Let's consider a menu, M^T, containing more options closer to temptation preferences than the symmetric menu, where $\bar{m} > 1 - m$ or $\underline{m} > m$ or both. By Lemma A1 we know that $x_2(M^T) > x_2(M) = \frac{1}{2}$, and hence by Proposition 1 it must be the case that $x_1(M^T) < x_1(M) = \frac{1}{2}$. Similarly, if we consider a meny, M^R, containing more options closer to restraint preferences than the symmetric menu, where $\bar{m} < 1 - m$ or $\underline{m} < m$ or both. By Lemma A1 we know that $x_2(M^R) < x_2(M) = \frac{1}{2}$, and hence by Proposition 1 it must be the case that $x_1(M^R) > x_1(M) = \frac{1}{2}$.

□

Proof of Corollary 2

The first part of this corollary follows directly from Proposition 1 and Lemma A1. To prove the second part let's remember condition $FOC_{t=1}$ that we derived in the proof of Corollary 1.

$$\frac{1+\delta\rho c(x_2^*,1)}{1+\delta\rho c(x_2^*,0)} = -\frac{c'(x_1^*,1)}{c'(x_1^*,0)}$$

The derivative of the left-hand side of this equation with respect to either δ or ρ is positive if and only if $c(x_2^*,1) > c(x_2^*,0)$. Which implies that first period consumption increases with both δ, $\frac{dx_1^*}{d\delta} > 0$, and ρ, $\frac{dx_1^*}{d\rho} > 0$, if and only if $x_2^* > \frac{1}{2}$. Given the switching pattern that we proved in Proposition 1, this result proves the corollary.

□

Proof of Lemma 2

If there are no new alternatives ($p_\emptyset = 1$), the agent can perfectly commit to consider only M^C during the consumption periods. In this case the agent would choose a singleton menu so that $e(x_1, \overline{m}^C) = g(x_1, \underline{m}^C) = 0$. The only option in this commitment menu would be $\frac{1}{2} = \mathrm{argmax}_{x\in[0,1]}\, u(x) + v(x)$.

If $p_T = 1$ the agent will surely have to consider the uncontrolled alternative {1} during the consumption periods. In this case, according to Proposition 2, for any given menu the agent wants to consume closer to restraint in order to minimize guilt in the first period. When the agent can control the commitment menu he can completely eliminate guilt by choosing the lower bound of M^C to coincide with the first period consumption. Thus, $g(x_1, \underline{m}^C) = 0$ iff $x_1^*(M^{C*}) = \underline{m}^C$. And, applying Proposition 2, in this case we get $x_2^*(M^{C*}) > x_1^*(M^{C*})$

Similarly, if $p_R = 1$ the agent will surely face the alternative $\{0\}$, and according to Proposition 2, for any given menu the agent wants to consume closer to temptation preferences in $t = 1$ so as to minimize effort. By choosing the upper bound of M^C to coincide with first period consumption his decision will generate no effort emotion. Thus, $e(x_1, \overline{m}^C)$ iff $x_2^*(M^{C*}) = \overline{m}^C$. And, applying Proposition 2, in this case we get $x_2^*(M^{C*}) > x_1^*(M^{C*})$.

□

Proof of Corollary 3

From Lemma 2 it is immediate that if $Z = \{\emptyset\}$ is likely enough the agent will choose a singleton menu which allows to have no negative emotions with probability $p_{\emptyset}$.

Moreover, by Lemma 2 and Proposition 2 we know that the agent would follow a switching consumption pattern when $Z = \{1\}$ or $Z = \{0\}$. In Corollary 1 we showed that the amplitude of this switching consumption increases with δ and ρ. Therefore, the cost of choosing the singleton menu $\left\{\frac{1}{2}\right\}$ increases with δ and ρ, and the result follows.

□

Proof of Proposition 3

This result follows directly from Lemma 2.