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A Triple Test for Behavioral Economics Models and Public Health Policy

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JEL classification codes
B41, D04, I18
Keywords
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1. Introduction

Behavioral economics has been seen as holding great promise in a range of policy applications, including that of improving health outcomes (Frank, 2004; Zimmerman, 2009; Loewenstein et al., 2007, 2012; Barberis, 2013). This promise has been recognized by policy makers across a range of countries, including France (Oullier and Sauneron, 2010), the United States (Lott, 2013) and the United Kingdom (Dolan et al., 2010). It has broadly matched the rise of the behavioral 'nudge' agenda: the possibility of obtaining quick wins in terms of policy outcomes by altering the decision environment of the individual in a way that does not forbid any option or change any economic incentive (see Thaler and Sunstein, 2008). The original classic example by Thaler and Sunstein concerned the case of a cafeteria where, by changing the placement of healthy and unhealthy food, it would be possible to affect the extent to which agents chose each. The alleged policy advantages, particularly to policy makers in an age of economic recession, were clear: the potential of better health outcomes without restricting the choice set of the rational consumer and, significantly, at little or no cost for the policy maker.

That said, a disconnection between the excitement of the promise of behavioral economics and the evidence base has been noted (Marteau et al., 2011). Early proposers of behavioral economics have put this in terms of policy getting ahead of science (Loewenstein et al., 2012), and of hard shoves (in terms of regulation) being needed as much as soft nudges. A recent report of the U.K. House of Lords has reached qualified conclusions on the potential of using only behavioral interventions in affecting outcomes (House of Lords, 2011). A recent scoping review of choice architecture interventions has reached the conclusion that the jury is still out on effect sizes for such interventions, both singly and in combination (Hollands et al., 2013).

The key question we ask in this paper is the degree to which behavioral economics is *actually* adding to the public health policy debate. One preliminary and entirely superficial way of asking this question is by wondering the extent to which behavioral economists are actually involved in policy discussions related to health outcomes. The House of Lords (2011) report considered 21 sources of oral evidence and 164 written submissions: out of 185 sources considered, only three appeared to include individuals who are, primarily, behavioral economists.[1] This may however reflect to some

[1] These included one out of five researchers in the context of one source of oral evidence and two jointly authored written submissions. For the purpose of this count, we define a behavioral economist as a researcher with an economics training working in behavioral economics. Of course, there is a grey area, most notably as there are the exceptions of

extent the U.K. environment (in contrast, for example, to the French report by Oullier et al., 2010, which has two behavioral economists as co-authors). To the extent that non behavioral economists may appropriately apply behavioral economics models, it could anyway be to no prejudice to the extent to which behavioral economics could be brought to bear on policy.

Behavioral economics was not born out of the blue. Rather, it mostly encapsulates and incorporates concepts and findings from psychology or cognate disciplines, which are combined with economic modeling to produce reasonably *new insights* hopefully of interest outside economics, including to policy makers (for examples, see Camerer et al., 2004; Skořepa, 2011; Cartwright, 2011). In order for behavioral economics to be relevant for public health policy, a *triple test* then needs to apply:

Test 1: it has to provide reasonably new insights;
Test 2: these have to be appropriately applied to policy settings;
Test 3: they have to be appropriately corroborated by empirical evidence.

This paper considers example behavioral economics models and shows how these tests can be usefully employed. We consider three areas where one can, with some legitimacy, claim that the first test is passed: social interactions; self-control devices; and prospect theory. We find that, with the partial possible exception of the area of self-control, in all three areas there has been a disconnection between insights from behavioral economics models, policy application and corroboration. This creates serious question marks for how references to behavioral economics – either in its promise of success or apparent failure – have been largely used within health economics and policy. More constructively, we suggest that the proposed triple test can be employed to verify the policy relevance of behavioral economics insights. We use the illustration of prospect theory to see how one can work towards a more successful triangulation between models, predictions and evidence. Section 2 provides the conceptual background to our triple test. Sections 3, 4 and 5 consider our three areas of application. Section 6 concludes.

2. A Conceptual Background

Figure 1 helps clarify key points underpinning the triple test being proposed here. As shown by any psychology textbook, there is of course a long tradition of psychological research having policy implications (link 1 in Figure 1); there is also a sizeable amount of empirical evidence in connection

psychologists who have made significant theoretical contributions to behavioral economics (most notably, Daniel Kahneman and Amos Tversky), but we are not aware of any among the remaining 182 sources.

to psychological concepts, including economic experiments that connect to them (link 2). While this needs not always be the case, behavioral economics often employs economic modeling to formalize concepts and findings from psychology (link 3); for example, the notion of social comparison and relative utility which we shall consider in section 3 draws its parentage both on social psychology (e.g., the social exchange theory of Adams, 1963) and on the cognitive psychology of relative evaluations (e.g., Kahneman and Varey, 1991, for references). Behavioral economics models can have implications for policy (link 4). *Test 1* is about whether something is gained conceptually in moving from psychology to policy through links 3 and 4 rather than directly via link 1. In other words, does behavioral economics provide any reasonably original insight that one would not be able to glean by employing plain vanilla psychological concepts? Note that we are not stating that behavioral economics must not relate to or be inspired by psychological models. Clearly, this will typically be the case. Nevertheless, the answer to the question on whether original insights are provided will not always be positive, for two reasons.

First, some of behavioral economics has been about formalizing psychological concepts in rational choice models that do not add any particular insight relative to such concepts, at least in relevant policy domains. For example, Akerlof and Kranton (2000) add a utility function but little more to the kind of insights that can be drawn from the social psychological research on group identity and intergroup relations (e.g., Hogg and Abrams, 2001, for a review). While this exercise is deemed valuable by economists insofar as utility maximization is considered as the methodological golden rule by most economists, non-economists and policy makers may not learn anything more than they would by referring directly to the appropriate psychological concepts.[2]

Second, sometimes the terminology 'behavioral economics' is used to refer to concepts taken straight from traditional behavioral psychology; for example, Murphy et al. (2007) speak of behavioral economic approaches to reduce college student drinking, but actually simply speak in terms of relative reinforcement and in terms of traditional economics (law of demand), neither of which require any behavioral economics; there is nothing in Murphy et al. (2007) that modern behavioral psychological treatments such as those in Fantino and Logan (1979) or Rachlin (1989) would not be able to explain.

[2] For a similar point, see Sugden (2010).

Test 2 is also connected to link 4, and is about whether the appropriate policy implications are drawn from a behavioral economics model; as section 5 on prospect theory will illustrate, this is not always straightforward.

Evidence-based policy requires however that, in order for an insight from behavioral economics to be relevant, it not only has to be accurately drawn from a behavioral economic model, but it also has to be supported by evidence (whether from economic experiments or otherwise). *Test 3* is connected to links 5 and 6 and requires evidence of corroboration of a given behavioral economics model. Note that, in considering evidence, there is no reason to be restricted to evidence from economics (let alone behavioral and experimental evidence). Therefore while modeling-wise we focus on behavioral economic models, for the sake of Test 3 we shall consider any relevant evidence – whether or not it comes from economics.

One source of confusion with empirical evidence is that sometimes empirical studies are motivated by policy (link 6) rather than by theory. As such, they are not tailored to test specific behavioral economic models, and as a result they provide only weak evidence in the context of Test 3. Consider for example Charness and Gneezy (2009), who show that short term financial incentives can lead to long term increases in gym attendance in a field experiment with college students. Obviously there is a direct policy motivation of this study: better gym attendance is seen as a positive health outcome. There is not however a single behavioral economic theory or set of theories that can explain why habit formation takes place; indeed, simple reinforcement theories from traditional behavioral psychology would again do the trick (Fantino and Logan, 1979; Rachlin, 1989).[3]

3. Applying Social Interactions Models to Health Behavior

3.1 Social Interactions Models and Test 1

Our first illustration arises from research in behavioral economics on how peers' behavior influences one's behavior, which can be labeled as *peer effects* for short. We consider three possible channels through which peer effects have been modeled to affect health behavior: i) social learning; ii) social comparison; iii) self-esteem or moral concerns. We discuss these in turn.

[3] So would, among others, modern psychological habit system theories (see Solway and Botwinick, 2012, for references) as well as the theories of rational addiction (Becker and Murphy, 1988) and, at least during the policy intervention period, behavioral economic models of self-control (e.g. Loewenstein and O'Donoghue, 2005, and section 4 below) mentioned by Charness and Gneezy (2009).

Social learning refers to the idea that what others do has information that is relevant for one's choices (Bikhchandani et al., 1992).[4] The inspiration for this comes from social learning theory in psychology, which has a long tradition (e.g., Bandura and Ross, 1961; Bandura, 1977). In a health context, Harris and Lopez-Valcarcel (2008) present a model in which a person decides whether to smoke by observing siblings' smoking behavior. It is assumed that the person is uncertain about the health consequences of smoking and whether smoking is socially accepted, but he or she makes inferences about these factors by observing others, and in this sense social learning takes place.

Social comparison models reflect the idea that preferences are shaped by comparisons of oneself with others leading to conformism. Blanchflower et al. (2009) consider the relationship between one's body weight and others' actual weight. The average weight in the society provides a reference point, and deviating from the reference weight decreases one's utility. Therefore being overweight can be more acceptable in a society with higher average weight (see Burke and Heiland, 2007 and Bednarek et al., 2008 for similar models). A slightly different way to look at the social comparison motive is that conformity may construct peer ties, which itself can be desired (i.e. social capital). For example, smoking among adolescents may just be one of several means to satisfy the demand for peer acceptance (DeCicca et al., 2000). Moreover, sharing socially less desired traits may establish stronger peer ties, and therefore coordinates behavior towards unhealthier options.

In *self-esteem, moral and social scrutiny* models, a norm level of behavior is exogenously given in a social group, and an individual loses utility if he or she is seen as deviating from the norm (for example, Battaglini et al., 2005; Etile, 2007; Dragone and Savorelli, 2012). Dragone and Savorelli (2012) assume that the desired level of body shape is determined by social environments, e.g. media and fashion industry. They investigate the effect of manipulating the norm level of body shape by legislations such as banning underweight fashion models. Of course, social psychologists have long recognized the significance of social interactions (e.g., Asch, 1955; Bond and Smith, 1996). These behavioral economics models potentially add specific policy relevant predictions. For example, if we are to believe in Dragone and Savorelli (2012), public health marketing policies to reduce the risk of anorexia may lead to negative health costs in terms of promoting obesity that more than offset the health benefits. Because of this, there is at least the potential for Test 1 to be passed, i.e. for insights to be provided that would not just be gleaned from non-behavioral economics research.

[4] Here and below we do *not* seek to provide reviews of the literature, let alone complete reviews, but rather simply to identify key points emerging from it in the context of our tests.

3.2 Combining motivations from social interactions models

We present a model which describes how health behavior is influenced by social interactions. Social influence on health behavior including these three motives has been investigated separately in the literature. In this sub-section we combine the three motives within one simple framework. For simplicity, we do not consider pecuniary motives of health behavior (such as cost of medical treatments). We introduce two types of norms, following Bicchieri (2006) and Bicchieri and Xiao (2009). The first norm is based on empirical expectation, i.e. the observation of peers' actual behavior. The second norm is based on normative expectation, i.e. the observation of peers' desire or what peers expect him or her (not) to behave. These two norms are often distinctive in health contexts. For example, we observe people who smoke but share the idea that one should not smoke.[5]

Consider a person j's health behavior x_j, x_{-j}^E denoting the empirical expectation of peers' behavior, and x_{-j}^N capturing the normative expectation. The individual maximizes the following utility by choosing the optimal x_j:

$$U_j = -\frac{\alpha}{2}\left[x_j - x_j^0\left(x_{-j}^E, \epsilon\right)\right]^2 - \frac{\beta}{2}\left[x_j - x_{-j}^E\right]^2 - \frac{\gamma}{2}\left[x_j - x_{-j}^N\right]^2$$

The utility comprises three distinctive motives, and deviation from them decreases utility. The first term represents the social learning motive, by which x_j^0 is her subjective ideal level of behavior, which is influenced by observation of peers' actual behavior x_{-j}^E and an idiosyncratic probabilistic component ϵ. This means that the person may not be fully certain about what his or her best choice will be (due to lack of information), and he or she uses peers' behavior to form her preference (i.e. social learning). The second term of the utility function captures social comparison conformism in the sense that the person sets peers' behavior as a reference point, and prefers to conform even if it does not meet his or her self-interest motive (i.e. social comparison). Finally, the third part gives self-esteem and moral concern, where the person wants to behave as he or she perceives it is desired by peers x_{-j}^N to avoid disapprovals.[6] Ignoring corner solutions, the first order condition is:

$$x_j^* = \frac{1}{\alpha + \beta + \gamma}\left[\alpha x_j^0\left(x_{-j}^E, \epsilon\right) + \beta x_{-j}^E + \gamma x_{-j}^N\right] \qquad (1)$$

[5] It is possible that these different norms influence each other in the long run (e.g. empirical expectation may converge to normative expectation), but again for simplicity we focus on the short run decision making. Nyborg and Rege (2003) consider a dynamics of norms for smoking within an evolutional game theoretic framework.

[6] Some individuals may want to behave differently from peers or from what they are expected to. For example, some teenagers smoke in order to discriminate them from peers, even when smoking is against the law (so they are not expected to smoke). In such a case β and γ are negative. Note, however, that a better way of modelling this may be in terms of a better identification of reference groups. For example, contrarian sub-cultures may exhibit conformism *within* the sub-culture. Also, note that we model the terms as additively separable for simplicity, but of course they may not be.

This is simply a weighted average of the subjective ideal, the empirical expectation, and the normative expectation. This implies that the individual's behavior is determined by the relative importance of three motives. When the self-interest motive is important (i.e. large α), the individual's behavior is more consistent with her subjective ideal level x_j^0. The same logic applies to other cases, i.e. when social comparison is prominent the individual acts as others do; when self-esteem is more important, she behaves as (she thinks) is desired by others.

As shown later, most of the econometric analyses estimate the effect (or association) of empirical expectation x_{-j}^E on behavior x_j^*. Totally differentiating the first order condition equation (1) yields:

$$\frac{\mathrm{dx_j^*}}{\mathrm{dx_{-j}^E}} = \frac{1}{\alpha+\beta+\gamma}\left[\alpha\frac{\partial \mathrm{x_j^0}}{\partial \mathrm{x_{-j}^E}} + \beta\right] \qquad (2)$$

This representation of the effect suggests that without an elaborate estimation strategy the analysis does not distinguish the three motives. We return to this point in sub-section 3.4.

3.3 Test 2: Policy implications

There are clear policy implications from models embodying different motivations related to social interactions, and in this sense Test 2 is satisfied. The bad news is that each motive suggests meaningfully different implications for policies to promote healthy outcomes. If social learning is most prominent, an appropriate policy would be to provide precise information about others' health behavior, and also the consequence of the behavior, through health educational policies. There is evidence that over-estimation of peers' smoking rate is a significant determinant of smoking among adolescents (Reid et al., 2008). Also, if the reason for conformity is uncertainty in preference, labeling and setting a default option in favor of healthier behavior would be helpful (Wisdom et al., 2010).

If social comparison is important, giving information about the "right" behavior will not work, because individuals follow peers irrespective of how healthy or unhealthy the behavior may be. A possible policy would then require incentivizing a shift to a healthier behavior equilibrium. For example, the government or schools can increase punishment for youth smoking. The government could also subsidize healthier options such as gym charge. Babcock and Hartman (2011) claim that such an intervention's effects depend on social networks. They find that subsidized individuals are more likely to exhibit healthier behavior when their peers are also subsidized.

If self-esteem, moral or social scrutiny is a main driver of peer effects, a less resource-intensive policy could be effective to manipulate the perceived norm. For example, media has strong power on one's perception over what others think desirable. Therefore campaigning to change normative expectation through media, or restricting the exposure to unhealthier norms, may prove to be an effective intervention.

3.4 Test 3: Empirical evidence

Test 3 requires us to find evidence able to corroborate specific motivations of our composite model of section 3.2 and, therefore, back up policy implications.

Experimental evidence. Interventions through social interactions to health behavior have been mainly outside the economics literature. Most of such experimental studies examine information-giving type interventions. For example, in a laboratory, providing information about norms, such as others' attitude towards food and actual food consumption, can influence own behavior (Croker et al., 2009; Pliner and Mann, 2004). Also, providing web-based and face-to-face feedback about norms can reduce alcohol misuse among college students (Moreira et al., 2009). While evidence of the effectiveness of providing information seems most consistent with a social learning story, it could equally be consistent with the other two motivations: it could provide information relevant for social comparison and, in a social scrutiny perspective, it could make clear what the norm is and indeed what the experimenter wants experimental subjects to do.[7] Zafar's (2011) experiment usefully tries to decompose social comparison and social scrutiny motives on charitable behavior. Image concern is controlled by restricting the observability of one's donating behavior, so that there is no chance to earn esteem. The result indicates that both motives effectively influence behavior. However, the experiment is not in a health context and does not control for not social learning.

Non-experimental evidence. Econometric studies in this particular field - perhaps understandably - do not appear to be well connected to theoretical implications. So far the main purpose of the econometric studies has been to identify the effect of peers' behavior on one's own behavior, without fully addressing the motives underlying peer effects. Table 1 lists 33 relevant econometric studies (as well as two experimental studies cited above). Out of these, 13 studies investigate the peer associations in food consumption and body weight (Anderson, 2009; Auld, 2011; Blanchflower et

[7] For an overview of experimenter demand effects in experiments, see Zizzo (2010). In an experiment unrelated to health outcomes, Fleming and Zizzo (2014) have shown that a measure of sensitivity to experimenter demand effects helps predict behavior when (and only when) social information is provided.

al., 2009; Burke and Heiland, 2007; Christakis and Fowler, 2007; Cohen-Cole and Fletcher, 2008; Costa-Font and Jofre-Bonet, 2013; Etilé, 2007; Fowler and Christakis, 2008; Halliday and Kwak, 2009; Renna et al., 2008; Trogdon et al., 2008; Yakusheva et al., 2011). We identified 17 studies on substance use, in particular, on smoking and alcohol consumption among youth (Clark and Etile, 2006; Clark and Loheac, 2007; Duarte et al., 2013; Fletcher 2010; Fletcher 2012; Gaviria and Raphael, 2001; Harris and López-Valcárcel, 2008; Jones, 1994; Kawaguchi, 2004; Krauth, 2005, 2006, 2007; Lundborg, 2006; Nakajima, 2007; Norton et al., 1998; Powell et al., 2005; Svensson, 2010). Other studies investigate physical activity (Bramoullé et al., 2009; Carrell et al., 2011) and health plan choice (Sorensen, 2006). The definition of social group (peers) varies remarkably from broader level (e.g. same sex, same country) to narrow levels (classmates, roommates and close friends). Some studies build theoretical models (as shown in the previous subsection), or explicitly mention some background theoretical implications to motivate their empirical investigations.

The interpretability of regression coefficients is one of the most challenging points for econometric studies. A simple statistical association between peers behavior and one's own behavior may not reveal peer effects for two reasons. First, peers' behavior influences one's behavior, and vice versa. Therefore behaviors in a group are determined simultaneously, which may lead to over-estimation of the size of the peer effect. Second, unobservable factors may be correlated with both peers' behavior and own behavior. For instance, peers are likely to share similar (often unobservable) background characteristics such as ability, preference and family background, which may lead them to self-select into the group and behave similarly ('*contextual effects*'). Also, peers are exposed to similar environmental influences, which may also induce them to behave similarly ('*correlated effects'*) (Manski, 1993; 2000). Previous studies present various strategies to control for these confounding effects (for example, Nakajima, 2007; Krauth, 2006; Lee, 2007).

However, even when a researcher successfully controls for these confounds, the question remains about *why* there are the peer effects in health behavior. As shown by equation (2) and our earlier discussion, establishing a peer effect is a necessary but not a sufficient condition to corroborate a specific health-related behavioral motivation and its policy implications, since it does not distinguish possible motives to conform. In this sense, there exists another fundamental identification problem.

3.5 Summary

The domain of social interactions is an illustration where behavioral economics models hold potential for Tests 1 and 2, but there is an identification gap between models and evidence. While

enough evidence can be conjured that social interactions in some sense matter, there is an insufficiently sharp evidence base from *specific* motivations connected to social interactions motives. Therefore Test 3, on evidence corroborating models and policies, is a stumbling block.

4. Applying Self-Control Models to Health Behavior

4.1. Self-control devices models and Test 1

Behavioral economics models of self-control are paradigmatic examples of behavioral economics. In psychology, self-control is typically seen as part of self-regulatory control processes (e.g., Carver and Sheier, 1982) or as response inhibition in the context of modern neuropsychological models of behavior (Diamond, 2013). Within behavioral economics, self-control models encapsulate a basic game-theoretical intuition, which is that having less options can be good as it works as a commitment device. Because of the natural way in which this research stems from this intuition from economics rather than psychology, the case for satisfying Test 1 is reasonably straightforward, and specific policy predictions follow from these models in health contexts to support this. Self-control devices can work as commitment devices to promote positive health outcomes (Bryan et al., 2010).

Three approaches have been followed to model self-control problems: choice-set utility, intertemporal choice and multiple selves.

Choice-set dependent utility. Gul and Pesendorfer (2001, 2004) introduce a choice-set dependent utility, where individuals can prefer not to have tempting options in their behavioral menu, because the foregone utility from the tempting goods could directly affect the utility from a not-tempting option. Removing the tempting options from the choice set may therefore improve welfare. As an implication, individuals can commit to have a restricted choice set, i.e. excluding less healthy but tempting options by shopping at a store which displays healthier foods only.

Intertemporal choice (O'Donoghue and Rabin, 1999; Frederick et al., 2002; Bénabou and Pycia, 2002). These studies assume that the self-control problem occurs due to intertemporal inconsistency of preferences induced by hyperbolic or quasi-hyperbolic discounting. For example, O'Donoghue and Rabin (2006) show that individuals may end up consuming more unhealthy food than they have originally planned.[8] Increasing the price of unhealthy food via taxation can potentially increase net

[8] Ikeda et al. (2010) find evidence that hyperbolic discounting is positively associated with body weight.

utility because it reduces consumption to the originally planned level, and can therefore be welfare improving. Similarly, Gruber and Köszegi (2001) analyze a smoking case in which an individual has a dynamically inconsistent preference and also current smoking increases the utility of future smoking (i.e. habit formation). The theoretical implications are often used to justify fiscal interventions (e.g. cigarette tax) to 'correct' behavior.

Multiple selves. Bernheim and Rangel (2004) analyze the situation in which a person has two different states of mind - hot and cold. The hot state emerges by environmental stimuli (such as drinking with friends), where temptation becomes too hard to resist. Brocas and Carrillo (2008) consider a situation where the impulsive and reflective selves have different preferences over tempting goods, i.e. the impulsive self finds a tempting good more attractive than the reflective self does, which leads to overconsumption of the tempting goods. Fudenberg and Levine (2006) analyze a situation where the impulsive self is myopic and therefore do not consider future consequences of current behavior. These models commonly consider the optimal behavior for the reflective self to impose the impulsive self in order to maximize long-run utility. Self-control devices are employed by the reflective self to restrict the behavior of the impulsive self.

While these models try to variously model a similar intuition, they sometimes do draw different policy implications. For example, on the one hand studies employing a hyperbolic discounting function generally suggest the use of fiscal interventions such as tax to manipulate the price of tempting goods (Gruber and Köszegi, 2001). On the other hand, Bernheim and Rangel (2004) predict that a price increase may not discourage consumption of tempting goods when self-control is restricted in the hot state of mind. They suggest that avoiding environmental stimuli that drive individuals to impulsive behavior may be a potential solution to address self-control problem. While the specificity of these predictions ensures that Test 1 is passed, they create potential problems of identification of the kind we discussed in the context of social interactions.

4.2 An illustrative model and Test 2

This section presents a simple model of self-control problems based on quasi-hyperbolic discounting (Phelps and Polak, 1968).[9] For illustrative purpose, we consider a smoking decision. Similarly to O'Donoghue and Rabin (2006), we assume that smoking gives positive immediate utility, but it also affects health in the next period. Let S denote smoking, which takes 1 if the person smokes and 0

[9] For more elaborated models see for example Gruber and Köszegi (2001) and O'Donoghue and Rabin (2002).

otherwise. The immediate utility of smoking is represented by $v(S)$, and the health damage is represented by $-h(S)$, where we assume $v(0) = h(0) = 0$. The cost of smoking is p. The rest of the person's instantaneous budget M is spent on the composite good (which gives linear positive utility) and the price is normalized to 1. Finally, we assume that the intertemporal utility is given by the following standard quasi-hyperbolic discounting formulation:

$$u_0 + \beta \sum_{k=1}^{T} \delta^k u_k,$$

where β, $\delta \leq 1$. The parameter β is often interpreted as the degree of self-control problem. If $\beta = 1$, the function is the usual exponential discounting function.

For simplicity we consider three periods (t=0, 1 and 2). In period 0, the person plans whether or not to smoke in period 1; then, in period 1, the utility from smoking materializes; and finally, the health damage of smoking is incurred in period 2. In period 0 the person just plans (i.e. *planner*), and the actual behavior is taken in period 1 (i.e. *doer*). From the planner's perspective in period 0, the utility in period 1 is given by $\beta\delta[v(1) + M - p]$ if she smokes, and $\beta\delta M$ if she does not smoke. Also, the utility in period 2 is given by $\beta\delta^2[-h(1)]$ if he or she smokes in period 1 and 0 otherwise. The planner decides to smoke in period 1 if the net utility of smoking exceeds the net utility of non-smoking: $\beta\delta[v(1) + M - p] + \beta\delta^2[-h(1)] \geq \beta\delta M$. Hence, the person plans to smoke if:

$$p \leq v(1) - \delta h(1).$$

For the planner, the reservation price of a cigarette is given by $p^* = v(1) - \delta h(1)$. In period 0, the person plans to smoke in period 1 if the cost of smoking is lower than the immediate utility of smoking minus the discounted future health damage.

We turn to consider the *doer*'s problem in period 1. The immediate utility of smoking is given by $v(1) - M - p$ if she smokes, and M if she does not. The utility in the next period is given by $\beta\delta[-h(1)]$ if she smokes, and 0 if she does not. The individual smokes in period 1 if $v(1) - M - p + \beta\delta[-h(1)] \geq M$. The doer smokes if:

$$p \leq v(1) - \beta\delta h(1).$$

The doer's reservation price is given by $p^{**} = v(1) - \beta\delta h(1)$. Compared to the previous condition to smoke for the planner, the doer discounts the future health damage more heavily by $\beta\delta$ (where β, $\delta \leq 1$). This means that the doer accepts a higher cigarette price than the planner. More specifically, if the actual cigarette price is between p^* and p^{**}: $v(1) - \delta h(1) < p < v(1) - \beta\delta h(1)$, the doer smokes in period 1 even though he or she planned not to smoke, a *preference reversal.*

When this preference reversal is likely to happen, there are ways for the planner to restrict the doer's behavior. The planner should make the doer's reservation price of cigarette (p^{**}) closer to the planner's original reservation price p^{*}. Stronger restriction will be needed depending on the degree of the self-control problem, which is represented by the parameter β: a smaller β (i.e. larger discount) implies the need for stronger restrictions.

Commitment helps restrict the doer's behavior. For instance, the planner can commit to pay a higher price for a cigarette in period 1, so that the doer faces the higher price. Similarly, he or she can commit to paying some amount of money in case she smokes. Both commitments directly decrease the reservation price of cigarette for the doer $p^{***} = v(1) - \beta\delta h(1) - C$, where C is either the increased price or the punishment. Incurring additional cost to smoke in this way brings the doer's reservation price closer to p^{*}.

The general message of the usefulness of self-control devices therefore does pass Test 2, in the sense that it accurately follows from these models. Some interventions can be regarded as self-control devices of a similar kind. For example, fiscal interventions, such as tax or income transfer, can alter the reservation price for the doer in the same way as the self-commitment.[10] As discussed in O'Donoghue and Rabin (2006) and elsewhere, exercising a higher tax on cigarettes may prevent self-control lapses. Rewarding individuals for not smoking by lump-sum transfer will work in the same direction as the price intervention. Immediate rewards may be more effective, if the individual discounts the future rewards heavily (Lowenstein et al., 2007).

Sometimes commitments may be considered as not involving (only) pecuniary incentives but, for example, may include social image costs. In the above example, the (shadow) price of cigarette p may include social image costs (e.g. of smoking being seen as 'uncool'), and people may use this to correct their future behavior. As another example, Babcock and Hartman (2011) conduct a field experiment to examine the impact of financial incentives on attending sports gym. They find that participants whose peers are also treated are more likely to attend the gym. The potential problem here is that, unless we add some psychological or behavioral economics story of why these should

[10] For literature reviews on the effect of financial (dis)incentives for healthier behavior, such as tax and subsidy on particular service and products, see Epstein et al. (2012), Paul-Ebhohimhen and Avenell (2009), Jeffery (2012), and Paloyo et al. (2013).

matter in the given setting,[11] this prediction does not in itself follow from the self-control models and therefore does not pass Test 2.

Individuals may not be able to predict their own future preference correctly (i.e. *projection bias*, Loewenstein et al., 2003). The models of self-control (including the one presented above) typically assume that individuals are fully aware of the extent to which the future selves' behavior differs from their long-run taste. Nevertheless, the empirical evidence suggests that the long-run preference is changeable and is quite dependent on current (rather temporal) state. For example, Giordano et al. (2002) show that current deprivation for drugs increases perceived future rewards of the drug. As another example, those who perceive a need for exercise at present may (wrongly) estimate that they want to exercise in the future periods. However, individuals adapt to being unfit and sedentary more easily than they expect, and therefore they fail to exercise as they had planned. This may be as important as the bias due to over-confidence or lack of will-power (DellaVigna and Malmendier, 2006). As such, the prediction bias can lead to behavioral lapses that are observationally equivalent to what the self-control model predicts. If the former bias is more prominent, the commitment device would not be an appropriate tool to improve the long-run welfare. Hence, again the self-control model is unlikely to pass Test 2.

4.3 Test 3: Empirical evidence

There is a significant body of research on the potential usefulness of self-control devices in health settings. This is summarized in Table 2. For example, Gruber and Mullainathan (2005) show that even current smokers are in favor of higher tax on cigarettes, and the tax can improve their subjective happiness.

Voluntary use of self-control devices. People may deliberately seek contracts that could be construed as implying a desire to constrain their choice set as predicted by self-control models (Halpern et al., 2012). In a field experiment, Gine et al. (2010) investigated the effect of a voluntary commitment device on smoking cessation, i.e. Committed Action to Reduce and End Smoking (CARES). Smokers were offered a saving account in which after six months they are refunded subject to passing a nicotine test. Some smokers took up the scheme, with social pressure possibly having played a role. The smoking cessation rate was higher for the participants than for the control group, and the effects persisted in surprise tests one year later. Similarly, Royer et al.'s (2012) field

[11] Babcock and Hartman provide several alternative explanations of their findings: i) complementarities in the utility; ii) imitation; and iii) information exchange among peers.

experiment found that the combination of financial incentives and self-funded commitment contracts (participants were asked to deposit the amount they chose to an account against them not smoking for a further two months after the end of the financial incentive period) increases longer-lasting exercise in company gyms. However, given the well-documented frequent failure of consumers' best intentions when enrolling in gym membership (e.g., London, 2013), there is again a question of whether something else, such as social pressure, may have also been at work. Using US sports gyms data, Della-Vigna and Malmendier (2006) find that consumers tend to enter fixed-term contracts and end up paying more per visit than they would have paid in fees for single visits. They interpret this as a form of overconfidence about either future self-control or future efficiency of gym visits. Burger and Lynham (2010) examined the effect of weight loss betting that is offered by a bookmaker. They reported that 70% of the participants stated that they used the betting as self-commitment devices; however, the participants were rarely successful in their betting (80% lost their bets).

In the existing empirical literature it is not clear how much commitment one should make and it is also not clear how predictions from the self-control models would be verified, either in terms of learning (Ali, 2011) or in terms of trade-off between flexibility and commitment (Amador et al., 2006). Moreover, if long run tastes change (Loewenstein et al., 2003), predicting the optimal commitment from the self-control model (which typically assumes perfect knowledge about one's long term preferences) may not be appropriate.

Policy interventions. Charness and Gneezy (2009) conducted a field experiment with university students to evaluate the impact of financial incentives on attendance to a sports gym. Participants received money if they attended the gym as they were assigned. Charness and Gneezy found that this incentive scheme increased gym attendance even after the experimental intervention period, at least in the short term. Similarly, Volpp et al. (2008) showed that providing financial incentives (using deposit and lottery) was more likely to lead to successful weight loss. Volpp et al. (2009) also found significant effects for smoking cessation. However, Kohler and Thornton (2012) showed that conditional cash transfers did not help HIV/AIDS prevention in rural Malawi. Econometric studies typically use ex-ante evaluation of simulated tax scenario based on econometric modeling of demand system, rather than ex-post evaluation of actual policy impacts. For foods and beverage purchases, supermarket scanner data have been widely used to estimate price elasticities (Allais et al., 2010; Nordstrom and Thunstrom, 2008; Griffith et al., 2010; and others). Estimated price elasticity are used to simulate the effect of interventions. The studies typically find that fiscal interventions may work,

but should involve drastic price increases to accomplish significant population level behavior change. There is therefore a potential contrast between policy work and econometric findings.

Taking the policy interventions research at face value, a problem in interpreting findings on the effect of price changes (or equivalent) on healthy behavior is that a more straightforward interpretation would be in terms of law of demand from basic microeconomics: as the price goes up, demand goes down. This would not explain why there would be an effect beyond the intervention period, and other theories would be needed for that, such as reinforcement theories from traditional behavioral psychology (e.g., Fantino and Logan, 1979; Rachlin, 1989), modern psychological habit system theories (e.g., Daw et al., 2005, 2011) or economic theories of rational addiction or habit formation (Becker and Murphy, 1988; Rabin, 2011). Self-control models however *also* do not explain effects beyond the intervention period, unless they are combined with other theories.

This brings us to the more general problem: these studies are all generally about the link between policy recommendations and empirical evidence (the link 6 of Figure 1), but the empirical evidence is largely consistent with self-control models *as well as* a number of other models, and therefore is not the strong support of self-control models that we would like in terms of Test 3.[12]

4.4 Summary

Self-control models have potential to pass Tests 1 and 2, but again there is an identification gap between models and evidence. There is also, in practice, often a need to combine self-control models with other kinds of behavioral economic models, such as ones on social interactions. Behavioral economics models of self-control *have* helped to bring self-control devices back in the policy debate, and, in this sense at least, they have proved practically important and useful. Nevertheless, the jury is out for moving beyond a general message about the usefulness of self-control devices.

5. Applying Prospect Theory to Message Framing

5.1 The standard treatment of prospect theory and Test 1

Although the originators of prospect theory were two psychologists – Amos Tversky and Daniel Kahneman –, the original paper and its main theoretical follow-up were published in economics

[12] Burger and Lynham's (2009) evidence on 70% of bettors explicitly referring to the need of a self-commitment device is obviously potentially more directly relevant evidence, though, as noted earlier, the same bettors ended up being money pumps for betting companies to take advantage of.

journals (Tversky and Kahneman, 1979; Kahneman and Tversky, 1992) and the modeling approach blends psychological insights with economic modeling, which is the trade-mark of behavioral economics. Prospect theory innovatively combines dependence on a reference point, relative to which gains and losses can be identified; a value function implying that subjects are loss averse, i.e. they dislike losses more than they like gains; risk aversion in the domain of gains and risk lovingness in the domain of losses, as identified again in the value function; and probability weighting.[13] Because of the modeling framework and of the parsimonious way it combines and draws implications from these features, it is plausible to assume that prospect theory is as good a candidate as any to pass Test 1. Indeed, it is referred to in the psychological research on health message framing starting from Rothman and Salovey (1997).

In relation to Test 2, health psychologists have been interested in drawing implications from prospect theory for policy makers. They have done so with a focus on the framing of the decision problem in terms of gains or losses and on the risk attitude differential features of the value function. A classic example was shown in experimental work by Tversky and Kahneman (1981): when people choose between two treatment programs framed in terms of the number of lives that will be lost, they risk the possibility of greater losses to avoid a certain loss; when the same programs are described in terms of the number of lives that will be saved, people become more conservative in their preferences. Hence they forego the opportunity for greater gains, in exchange for an alternative that provides a certain gain. Although the frame shifts in the two scenarios from lives lost to lives saved, the objective features of the proposed interventions remain constant (Tversky and Kahneman, 1981).

In the health psychology research, the expectation has been that gain- and loss-framed appeals will be differentially persuasive for disease detection behaviors (such as mammography, HIV testing, or cholesterol screening) and disease prevention behaviors (such as healthy dieting, exercising, or dental hygiene), by virtue of the differences in the risk associated with those behaviors (Rothman and Salovey, 1997; Schneider et al., 2001). The underlying idea is that prevention behavior entails reducing the risk of the bad health outcome relative to the present health status, and so a gain frame encouraging risk aversion should lead to greater engagement in prevention behavior. Conversely, detection behaviors can be construed as involving a risk that illness may be discovered. A more risk loving attitude, as induced by a loss frame, would then be preferable.

[13] We follow Barberis (2013) in this list and the cumulative prospect theory of Kahneman and Tversky (1992) in the treatment below. For broader developments in the study of decision making under risk in behavioral economics, see Starmer (2000).

5.2 Test 2: Identifying predictions from prospect theory

This sub-section considers whether the typical prediction from prospect theory in a health context of prevention and detection activity passes Test 2: that is, is it generally the case that prospect theory implies that a loss frame is better than a gain frame for encouraging detection activity, and vice versa for prevention activity? As it turns out, the picture is more nuanced, and this can be shown even in a very simple application of prospect theory to our setting.

Assume for simplicity that there are two time periods, 1 and 2. There are two possible health outcomes, negative and positive. A negative health outcome occurs in period 2 with probability p in a state of the world in which prevention or detection activity has not taken place; if it has taken place, and purely to simplify the presentation below, we assume the negative health outcome never occurs. Prevention and detection behaviors take place in period 1. Prevention and detection activities have a financial and/or psychological cost of $z > 0$. If detection activity takes place in period 1, in a gain frame there is a 'pleasure' $d > 0$ of learning one is healthy, while in a loss frame there is a pain $-d$ of learning that one is sick. Define $w()$ as a weighted probability. We assume that the likelihood of the bad health outcome is not large and it is perceived and weighted by the person as not large relative to how the likelihood of a good health outcome is perceived:

Assumption 1: $w(p) << 0.5 << w(1-p)$.

Note that Assumption 1 permits the difference $w(p) - w(1-p)$ to be smaller than that between p and $(1-p)$, i.e. it allows for overweighting of small probabilities; it plausibly assumes however that people will typically still be able to clearly identify what is more likely and what is not.

In a gain frame (+), the utilities of a positive and a negative health outcome in period 2 are perceived as x and 0 respectively, with $x > 0$. In a loss frame (-), the utilities of a positive and a negative health outcome in period 2 are perceived as 0 and $-x$, respectively. We further assume that agents discount period 2 according to a discount factor $\delta \geq 0$, and that utility is additively separable between periods 1 and 2. Agents follow prospect theory and, in the absence of detection and prevention activity, we can write their utility function as:

$$U_+ = \frac{w(1-p)v(x)}{1+\delta} \quad \text{in a gain frame}$$

$$U_- = \frac{w(p)v(-x)}{1+\delta} \quad \text{in a loss frame,}$$

where U_+ and U_- are an increasing function of $w()$ and $v()$; $v()$ is the monotonically increasing prospect theory value function, and, for simplicity and without loss of generality, $v(0) = 0, v(x) > 0, v(d) > 0$. Our second assumption reflects the loss aversion and differential risk attitude in the domain of losses that is highlighted in the usual applications of prospect theory, with $k_x > 0$ and $k_d > 0$ being coefficients embodying the difference in valuation if x is perceived in the domain of losses rather than in that of gains:

Assumption 2: $|v(-x)| = v(x) + k_x$ and $|v(-d)| = v(d) + k_d$.

Figure 2 shows a value function as an example.

Prevention behavior. In a gain frame, the agent will engage in prevention behavior in period 1 if the expected discounted gains from prevention are higher than the prevention cost:

$$\frac{w(1-p)v(x)}{1+\delta} - z > 0 \quad . \qquad (3)$$

In a loss frame, the agent will engage in prevention behavior if the expected discounted avoided loss from prevention is higher than the prevention cost:

$$-\frac{w(p)v(-x)}{1+\delta} - z = \frac{w(p)v(x) + k_x}{1+\delta} - z > 0 \,. \qquad (4)$$

If we restrict ourselves to Assumption 2 alone, k_x implies that equation (4) is more likely to be satisfied than equation (3): intuitively, in a loss frame, the risk of a loss should naturally lead the loss averse person to engage in more prevention behavior to avoid the loss than if there is the possibility of a gain in a gain frame. Note however that, as long as the probability of the negative health outcome is small and remains perceived reasonably as such (Assumption 1), it is reasonable to hypothesize that $w(1-p)v(x) > w(p)v(x) + k_x$. If Assumption 1 does not hold, a negative frame may be roughly as good or even better than a gain frame. However, if Assumption 1 holds, a gain frame will generally be better for encouraging prevention, if not for the reason normally used.

Detection behavior. In comparing detection behavior with prevention behavior, there is an additional term to be considered, namely the psychological value $v(d)$ in period 1 from knowing about a negative health outcome in period 2. In a gain frame, equation (3) now becomes:

$$\frac{w(1-p)v(x)}{1+\delta} - z - w(1-p)v(d) = w(1-p)\left[\frac{v(x)}{1+\delta} - v(d)\right] - z > 0 \qquad (5)$$

while equation (4) for a loss frame becomes:

$$-\frac{w(p)v(-x)}{1+\delta} - z + w(p)v(-d) = w(p)\left[\frac{v(x)+k_x}{1+\delta} - v(d) - k_d\right] - z > 0. \qquad (6)$$

Predictions here are generally ambiguous: while (6) could hold while (5) does not, implying that a loss frame is better in encouraging detection behavior, it is also entirely possible that (5) holds while (6) does not. Assume that (5) holds; equation (6) then may not hold if $k_x/(1+\delta) - k_d < 0$, that is depending on the degree of intertemporal discounting and on the precise shape of the value function in the loss domain relative to that in the gain domain.

5.3 Test 3: considering empirical evidence on health message framing

We now move on to Test 3: how predictions of prospect theory fit with evidence on health message framing. Virtually all of this work has been carried out in a randomized experimental study design, as opposed to an observational one. A major difference among existing studies is the outcome variables, which comprise attitudes, intentions[14] or actual behavior. Obviously as economists we are interested in behavior, and behavior is what prospect theory is about. Table 3a summarizes a non-exhaustive list of primary studies on prevention behaviors, most of which focus on oral health and physical activity promotion. Table 3b assembles studies on detection behaviors, of which a majority is on breast cancer screening. All of the studies in Tables 3a-b use behavioral measures as their relevant outcomes.

Prevention behaviors. The studies covering prevention behaviors include a majority of studies on prevention of skin cancer, oral health problems and on the promotion of physical activity, while most of the detection behavior studies relate to breast cancer screening, followed by skin cancer screening. We list a few studies where *p* and as a result *v*(*p*) may be perceived as high: Knapp (1991) and Mann et al. (2004) are about oral health, and cavities may be seen as likely if oral health measures are not undertaken; in Richardson et al. (2004), the probability of HIV contagion may be perceived as high

[14] See e.g. Rothman et al. (1993) as a widely cited early study testing the effect of gain vs. loss framing on the *intention* to seek skin cancer screening.

by the HIV-positive subject sample that was used; and in Trupp et al. (2011), again with a sample of patients. Other than Mann et al. (2004), where there is no aggregate effect of framing, in the other three cases a loss frame was superior in inducing prevention behavior (Knapp, 1991; Trupp et al., 2011); these results are consistent with the prospect theory once Assumption 1 is relaxed (see section 5.2). Gallagher et al. (2011) explicitly look at the perceived probability $v(p)$ and find the superiority of a loss frame when the perceived probability of breast cancer is average or high.

Where Assumption 1 is more likely to be satisfied, the picture is different. An influential early study exploring the impact of message framing on skin cancer prevention was by Detweiler et al. (1999). The field experiment recruited a demographically and economically fairly diverse sample of 217 adult beach-goers in southern New England. Participants were given a brochure containing the framing manipulation as well as general information about skin cancer. A strong gain-framed advantage was found for the behavioral measure employed (requests for free sunscreen with protection factor 15), though the lack of follow up allowed no assessment of any sustained behavior change effect. Rothman et al. (1993) also found the superiority of a gain frame with a behavioral measure in relation to skin cancer prevention. In three out of six studies on physical activity or healthy diet reported in Table 3a, a gain frame was superior at least to some degree (Jones et al., 2003; Latimer et al., 2008; Lawatsch, 1990), with no significant effect of the frame in the other three (Gallagher and Updegraff, 2011 and Jones et al., 2004; Bannon and Schwartz, 2006).

Latimer et al. (2008) is a good example of a study with a slightly longer intervention and follow-up period and more adequate behavioral outcome measures relative to a number of others. They recruited 322 sedentary, healthy callers to the US National Cancer Institute's Cancer Information service, providing gain-, loss- or mixed-framed messages by phone at baseline, at week 1 and week 5. Alongside a range of intentional measures, the principal behavioral measure assessed - also on three occasions: baseline, week 2 and week 9 - was self-reported physical activity (using the International Physical Activity Questionnaire (IPAQ) telephone-administered short form (Craig et al., 2003). Controlling for a range of potential confounders, significantly greater physical activity was reported at week 9 for the gain-framed messages than for the loss- and mixed-framed messages.

Detection behaviors. Breast cancer screening has thus far been the most frequently examined detection behavior in this field. While fewer studies have confirmed the original Rothman and Salovey (1997) prediction of loss-framed messages outperforming gain-framed ones when it comes to detection behaviors (in Table 3b, Banks et al., 1995; Williams et al., 2001; Lauver and Rubin,

1990; Myers et al., 1991), most studies failed to find support (Consedine et al., 2007; Finney and Iannotti, 2002; Lalor and Hailey, 1990; Lerman et al., 1992; Park et al., 2010) or even found, if anything, greater support for a gain frame (Apanovitch et al., 2003; Gintner et al., 1987). As an example, Finney and Iannotti (2002) explored an intervention aimed at increasing women's adherence to recommendations for annual mammography screening. The intervention involved sending out one of three reminder letters (positive frame, negative frame, or standard hospital prompt) to 929 randomly selected women who were due for mammography screening and had been identified as having either a positive or negative family history of breast cancer. There was no significant effect of a gain vs. loss frame.

Meta-analyses. The discussion above has been selective, but, fortunately, a number of recent meta-analyses have been undertaken to examine the considerable empirical evidence base more systematically (O'Keefe and Wu, 2012; O'Keefe and Nan 2012; O'Keefe and Jensen, 2011; and Gallagher and Updegraff, 2012). Meta-analyses are especially useful as the effects may be comparatively small in size (though potentially not in health relevance) and so may not be picked up by individual studies; that is, there may be an effect but this may not be picked up because of lack of power. No relevant meta-analysis that we are aware of supports the Rothman and Salovey (1997) interpretations of prospect theory as such. The meta-analysis of interest is Gallagher and Updegraff (2012), as it is the only one that focuses exclusively on studies that measured behavioral outcomes rather than attitudes or intentions. It is consistent with what we predicted in section 5.2 based on a proper application of prospect theory: overall, gain-framed messages were more effective for prevention behaviors than loss-framed messages, while there was no clear superiority of either framing approach in the case of detection behaviors. Therefore, a properly applied prospect theory, but only a properly applied prospect theory, can make a claim to broadly pass Test 3.

5.4 Summary

Based on Test 1, prospect theory is a good candidate as a behavioral economics model that may matter for health outcomes. This section considered health message framing as an area of policy relevance where prospect theory can be applied. The traditional interpretation of prospect theory does not follow from a basic model applying prospect theory, and so such a traditional interpretation does not pass Test 2. It also does not pass Test 3, given the empirical evidence.

The bad news is that, once prospect theory is properly applied, there are no clear predictions for detection activities, nor should they be expected. The good news is that a gain frame encourages

prevention activity, though this does not apply if the perceived probability of the bad health outcome is large enough.

6. Conclusions

We have proposed a triple test to evaluate the usefulness of behavioral economics models for public health policy. Test 1 is whether they say something reasonably new. Test 2 is whether what has been said in relation to applications to policy is correct. Test 3 is whether there is a triangulation between model, policy and evidence. Where a test is not passed, in particular Tests 2 or 3, this may point to directions for needed further research.

We have illustrated our analysis by considering three cases where a plausible claim can be made that Test 1 is passed. Social interactions can be influenced by social learning; by social comparisons; or by self-esteem, moral and social scrutiny. Existing evidence suffers from a fundamental identification problem in distinguishing among motivations (if any), and this in turn has implications for policy. While this problem is present to some degree also in our second illustration, that of self-control models, there is at least a sense in this area that the key common message among self-control models has been a driver in the recent interest for policy interventions based on self-control devices; nevertheless, again the evidence has largely explanations which have nothing do with these models. Furthermore, these models alone may not be useful unless combined with other theories to explain the long-term effectiveness of policy interventions, i.e. its effectiveness after self-control devices are withdrawn. In both illustrations, that of social interactions and that of self-control models, the problems are with Test 3, and addressing these problems would help strengthen the case for them.

We have considered prospect theory in the context of health message framing as our third application. The alleged policy messages from the theory do not seem to match the evidence. By a simple example model, we have shown how the reason is that the theory has been misapplied. Once this problem with Test 2 is fixed, we find that, in broad agreement with the evidence, a gain frame does encourage disease prevention activity, though this does not apply if the perceived probability of the bad health outcome is large enough.

We see our tests as being useful to identify how much health policy weight to assign to specific behavioral economic models; and, constructively, to verify what next steps would be most useful in further research.

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Figure 1 – Identifying the Value Added of Behavioral Economics

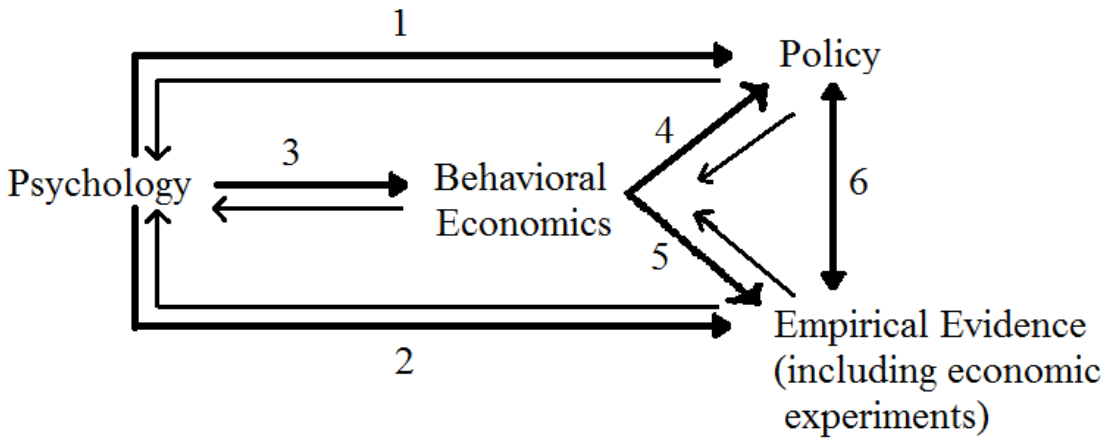

Figure 2 – A Prospect Theory Value Function

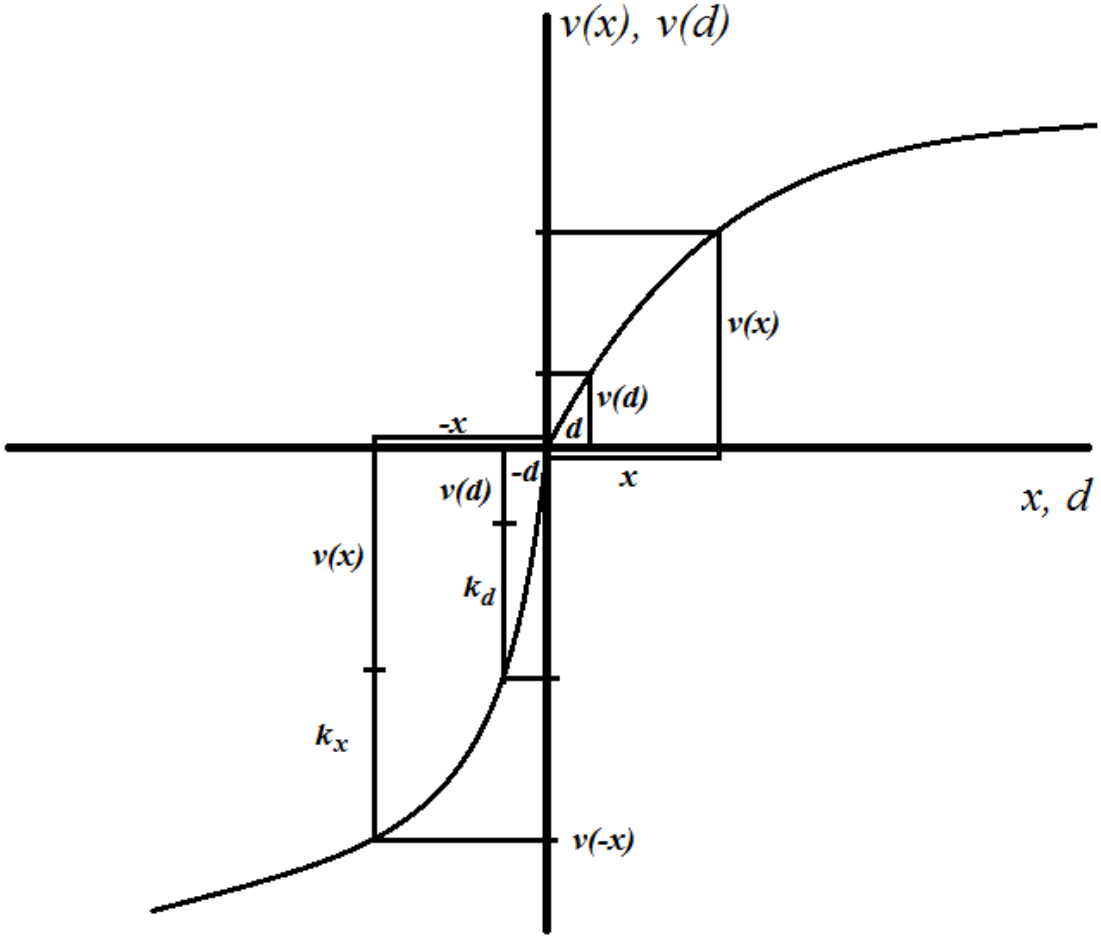

Table 1. Social interactions

Paper	Study design	Outcome	Subjects	Reference group	Claimed background economic theory	Key results
Anderson, 2009	Statistical analysis of survey data	Perceived weight; weight goal	US High school students	Other students	N/A	Students in a heavier group perceive themselves as thinner than those in a thinner group.
Auld, 2011	Analysis of survey data	Body Mass Index	US adults	People in the same country/state	Social comparison; Self-esteem	Country and state average weight are not associated with own weight. No clear evidence of country/state level socioeconomic characteristics on own weight.
Blanchflower et al., 2009	Analysis of survey data	Overweight perceptions and diet/ Life satisfaction	Europeans	People in the same country, gender, and age group	Social comparison	Relative position of own weight in the peer group influences overweight perception, dieting, and wellbeing.
Bramoullé et al., 2009	Analysis of survey data	Consumption of recreational services	US secondary school students	Best friends	N/A	Recreational activities by friends increase one's own use of recreational services.
Burke and Heiland, 2007	Modelling and simulation	Body Mass Index	US female adults	American female adults	Social comparison; Endogenous aggregate behavior of social group	(Prediction:) as price of foods declines, body weight increases; then the norm level of weight increases, which leads to further increase of weight.
Carrell et al., 2011	Analysis of survey data	Physical fitness (measured by fitness score)	Students at US Air Force Academy	Squadrons	N/A	There is a positive association between peers' fitness score in high school and own current fitness score.
Christakis and Fowler, 2007	Analysis of survey data	Likelihood of being obese	US adults	Friends, siblings, spouse	N/A	There is a positive association between peer's obesity status and the likelihood of being obese.
Clark and Etile, 2006	Analysis of survey data	Likelihood of smoking	British individuals	Partner	Social learning (also bargaining in marriage market)	There is a positive association between partner's smoking and own smoking. The association is due to assortative matching in marriage, rather than peer influence.
Clark and Loheac, 2007	Analysis of survey data	Commission of risky behavior (cigarette, alcohol, marijuana)	US junior high and high school students	Students in the same school	N/A	Peers' behavior is correlated with own risky behavior.
Cohen-Cole and Fletcher, 2008	Analysis of survey data	Body Mass Index	US junior high and high school students	Students in the same school	N/A	Peers' body weight has no effect on own weight (no network effect).

Costa-Font and Jofre-Bonet, 2013	Analysis of survey data	Suffering from anorexia	European young females	Self-image on own weight; people with same education, age, rural/urban, and region	Social comparison; Identity theory	Peer's body mass is negatively associated with likelihood of being anorexia.
Duarte et al., 2013	Analysis of survey data	Likelihood of smoking	Spanish adolescents	Students in the same class and school	N/A	The statistical significance of the peer effect is sensitive to the choice of estimator of standard error.
Croker et al., 2009	Analysis of survey data/ experiment	Intention to eat fruits and vegetables	UK adults	Other people in the same country	N/A	Although individuals are less aware of importance of social norm compared to cost and health, giving information about norm influences the intention to eat fruit and vegetables.
Etilé, 2007	Analysis of survey data	Ideal body weight; Food attitudes	French adults	People of same sex, occupation, and age	Social comparison; Identity theory	Social norm is associated with one's ideal body weight only for females who want to reduce weight (and not for other groups). Social norm does not predict food attitudes.
Fowler and Christakis, 2008	Analysis of survey data	Body Mass Index	US adults	Named friends	N/A	There is a correlation between friends' body mass and own body mass.
Fletcher, 2010	Analysis of survey data	Likelihood of smoking	US secondary school students	Classmates	N/A	Larger proportion of classmates who smoke increases the likelihood of smoking.
Fletcher, 2012	Analysis of survey data	Likelihood of alcohol drinking	US secondary school students	Classmates	N/A	Larger proportion of classmates who drink alcohol increases the likelihood of alcohol use.
Gaviria and Raphael, 2001	Analysis of survey data	Likelihood of drug use, Alcohol, smoking, church attendance, high school drop-out	US students at tenth grade	Students in the same school	N/A	There is a correlation between peers' behavior (drug use, alcohol, smoking, church attendance, and drop-out) and own behavior.
Halliday and Kwak, 2009	Analysis of survey data	Body Mass Index	US secondary school students	Ten nominated students	N/A	There is an association between peers' weight and own weight. The association is particularly strong among heavier students.

Harris and López-Valcárcel, 2008	Analysis of survey data	Likelihood of smoking	US young individuals	Siblings	Social learning	Presence of sibling who smokes in household increases the likelihood of smoking; presence of non-smoking sibling decreases the likelihood of smoking.
Jones, 1994	Analysis of survey data	Smoking cessation; attempt to quit smoking	British adults	Other smokers within the household	N/A	Presence of other smokers in the same household is associated with lower probability of successful smoking cessation or probability of attempting to quit smoking.
Kawaguchi, 2004	Analysis of survey data	Substance use (drug, cigarette, alcohol)	US teenagers	Students in the same grade	Social comparison	There is an association between peers' behavior (drug use, alcohol, smoking) and own behavior.
Krauth, 2005	Analysis of survey data	Likelihood of smoking	Canadian youth	Close friends	N/A	Presence of peers who smoke is associated with the likelihood of smoking.
Krauth, 2006	Analysis of survey data	Likelihood of smoking	US teenagers	Four same-sex friends	N/A	The association between presence of close friends who smoke and the likelihood of smoking is positive but nearly zero.
Krauth, 2007	Analysis of survey data	Likelihood of smoking	US teenagers	Close friends	N/A	The association between presence of close friends who smoke and the likelihood of smoking is positive but nearly zero.
Lundborg, 2006	Analysis of survey data	Teenage binge drinking, smoking, drug use	Swedish youth	Classmates	N/A	There is an association between peers' behavior (drug use, alcohol, smoking) and own behavior.
Nakajima, 2007	Analysis of survey data	Likelihood of smoking	US students (6-12 grades)	Same school cohort (middle and high school)	Self-image	There is an association between prevalence peers who smoke and the likelihood of smoking. The effect is stronger in the same gender and race.
Norton et al., 1998	Analysis of survey data	Use of alcohol and smoking	US upper elementary student	Students from same elementary school	N/A	There is an association between peers' behavior (alcohol use and smoking) and own behavior. Peer influence is more important than peer selection effect.
Pliner and Mann, 2004	Laboratory experiment	Amount of food consumed/ food choice between palatable and unpalatable one	US female psychology students	Other participants	N/A	The amount of palatable food consumed is increased if participants are informed that other participants ate a lot of the same food. Food choice between palatable and unpalatable food is not

						affected by information of other participants' choice.
Powell et al., 2005	Analysis of survey data	Likelihood of smoking	US high school students	Other students in the same high school	N/A	There is an association between prevalence peers who smoke and the likelihood of smoking.
Rena et al., 2008	Analysis of survey data	Body Mass Index	US secondary school students	Close friends	N/A	There is an association between peers' weight and own weight. Once the instrumental variable estimation approach is employed, the effect is significant only for female students.
Sorensen, 2006	Analysis of survey data	Health care plan choice	University of California staff	Colleagues in the same department	Social learning	Information about peers' choice influences one's own choice of health care plan.
Svensson, 2010	Analysis of survey data	Alcohol use and binge drinking	Swedish youth	Students in the same school	Social comparison; social learning; pay-off interaction	Prevalence of peers who frequently drinks alcohol and commit binge drinking is associated with
Trogdon et al., 2008	Analysis of survey data	Adolescent weight	US secondary school students	Students within the same grade in the same school	N/A	There is an association between peers' weight and own weight. The association is larger for female students.
Yakusheva et al., 2011	Analysis of survey data	Weight gain after one year	US college students	Roommate	N/A	The amount of weight gained is lower if roommate's initial weight is lower. Female students adopt their roommates' weight reducing effort.

Table 2. Self-control devices

Paper	**Study design**	**Outcome**	**Subjects**	**Self-control device**	**Intervention period**	**Key results**
Babcock and Hartman, 2011	Field experiment	Gym attendance	US university students	Conditional cash transfer and peer effects	4 weeks	Gym attendance for the incentivized group increased when their peers were also incentivized
Burger and Lynham, 2010	Analysis of survey data	Weight reduction	UK adults	Self-commitment betting for successful weight loss with a bookmaker	N/A (Observational study; Betting period vary across bettors)	Weight loss was rarely successful
Charness and Gneezy, 2009	Field experiment	Gym attendance	US university students	Conditional cash transfer	4 Weeks; and 7 weeks follow-up for Study 1 and 13 weeks follow-up for Study 2	Financial incentive was effective and also the effect was sustainable

Della-Vigna and Malmendier, 2006	Analysis of survey data	Gym attendance	US adults	Contracts with sports gyms for monthly fixed free	N/A	Those who made fixed term contract tended to overestimate their will power
Gine et al., 2010	Field experiment	Smoking cessation	Clients of a bank in Philippines	Self-commitment saving account (refunded subject to successful smoking cessation)	6 weeks, and a follow-up test after 12 months of the treatment	The use of the commitment saving account was associated with successful smoking cessation; the effect was sustainable
Goldhaber-Fiebert et al., 2011	Field experiment	Length of contract with sports gym	US adults	Longer default contract periods	N/A	Setting a longer contract length as a default option is associated with longer actual contract
Kohler and Thornton, 2012	Field experiment	HIV prevention	Adults in rural Malawi	Conditional cash transfer for maintaining HIV status	Around one year (two rounds of HIV tests were conducted)	Conditional cash transfer had no effect on the HIV status
Royer et al., 2012	Field experiment	Gym attendance	Employees of a Fortune 500 company (US)	Conditional cash transfer and self-commitment deposit (refunded subject to gym attendance)	4 weeks for financial incentive treatment; 8 weeks for commitment deposit, with 12 months follow-up	Gym attendance was increased, and the effect was maintained but diminished in the post-treatment periods
Volpp et al., 2008	Field experiment	Weight reduction	US adults	Lottery incentive; or deposit contract	16 weeks; and additional 6 months for selected participants only. Follow-up tests were conducted after 7-8 months of the intervention	The intervention increased successful weight reduction in the treatment period, but the effect diminished in the follow up test
Wisdom et al., 2010	Field experiment	Food choice at a cafeteria	Customers of a US fast-food restaurant	Providing calorie information; making healthy option convenient	N/A	The interventions were largely effective

Table 3a. Selected experimental studies testing message framing in prevention behavior

Paper	Outcome /behavior	Subjects	Intervention content	Intervention delivery	Key results
Bannon and Schwartz, 2006	Healthy diet promotion	Elementary school children, mean age 5 (3 classrooms) (US)	(a) A gain-framed nutrition message (i.e. the positive benefits of eating apples) ; (b) a loss-framed message (i.e. the negative consequences of not eating apples); (c) control scene (children playing a game)	Video (commercial)	Among the children who saw one of the nutrition message videos, 56% chose apples rather than animal crackers; in the control condition only 33% chose apples. (no significant difference between gain and loss frame)
Detweiler et al., 1999	Skin cancer prevention	Beach visitors (US)	Gain framed messages (including value of skin protection) vs. loss framed messages	Brochure	18% increase in collection of sunscreens
Gallagher and Updegraff, 2011	Physical activity	"Mostly sedentary" undergraduate students (US)	Gain and loss framed messages (incl value of more PA) with intrinsic and extrinsic exercise outcomes	Article on exercise	Loss framed messages not significantly more effective in promoting PA
Gerend and Cullen, 2008	Other (alcohol)	College students (US)	Gain framed message	Read a message	Gain-framed message significantly effective in reducing (self-reported alcohol use) compared to loss framed message (but only for short term consequences)
Jones et al., 2003	Physical activity	Introductory psychology students (US)	Gain and loss framed message (+ background reading from credible / less credible source)	Read a message (after background material from credible/less credible source)	Gain framed messages from a credible source more effective in promoting exercise than other interventions
Jones et al., 2004	Physical activity	Introductory psychology students (US)	Gain framed messages attributed to credible / non-credible source	Read messages	No significant effects
Knapp, 1991	Oral health	Elementary school children age 10-12 (US)	Gain or loss framed messages; control group (basic information, no mention of consequences)	Audio taped slide show	Loss framed messages more effective than gain framed and standard message
Latimer et al., 2008	Physical activity	Sedentary, healthy callers to the US National Cancer Institute's Cancer Information Service	Gain-, loss-, or mixed-framed messages	Reading material in print	Gain frame messages generally significantly more effective than comparators

Lawatsch, 1990	Healthy diet promotion	Pre-school children (US)	Gain-framed, loss-framed, control	Reading of adjusted fairy tales	modest significant advantage of gain frame message
Mann et al., 2004	Oral health (flossing)	Undergraduate students (US)	Gain or loss framed messages	Articles to read	no significant effect of framing; but when given a loss-framed message, avoidance-oriented people reported flossing more than approach-oriented people, and when given a gain-framed message, approach oriented people reported flossing more than avoidance-oriented people
Richardson et al., 2004	Safe sex prevention	HIV positve, sexually active prior to enrollment (US)	Gain-framed, loss-framed, control	Prevention counseling from medical providers supplemented with written information	Significant effects in the loss-framed education only
Rothman et al., 1993	Skin cancer prevention	Undergraduate students (US)	Gain and loss framed messages	Brochure	Gain framed messages more effective in making women buy sun protection crème
Schneider et al., 2001	Smoking prevention	Undergraduate students (US)	Gain, loss framed	Video	Gain framed messages more effective than loss framed
Trupp et al., 2011	Other (adherence to continuous positive airway pressure (CPAP) therapy) to prevent obstructive sleep apnea [OSA])	Adults with a history of CVD who were newly diagnosed with OSA (US)	Loss and gain framed messages about CPAP	Video	CPAP use was greater in the group receiving negative message framing

Table 3b. Selected experimental studies testing message framing in detection behaviors

Paper	Outcome/behavior	Subjects	Intervention content	Intervention delivery	Key results
Apanovitch et al., 2003	HIV testing	Low income ethnic minority women (US)	Two gain framed and two loss framed videos to motivate HIV testing	Video	Loss-framed messages only more effective than gain-framed messages for people who were uncertain about what the outcome of the test. Those certain that the test would not find the presence of HIV, gain-framed messages were more effective in promoting testing than loss-framed messages.
Banks et al., 1995	Breast cancer screening	Woman workers aged > 40 with history of poor utilization of screening (US)	Loss framed messages (emphasizing risk of not being screened) vs. gain framed messages	Video	14.7% increase in uptake of mammography
Consedine et al., 2007	Breast cancer screening	Low-income, low-screening women (US)	Loss, gain, or empowerment frame telephone intervention and re-contacted at 6 and 12 months.	Phone	No main effect for framing condition,
Finney and Iannotti, 2002	Breast cancer screening	Women due for screening and either positive or negative family history of breast cancer; in rural area not for profit hospital (US)	Loss framed messages (emphasizing risk of not being screened) vs. gain framed messages	Reminder letter	No significant differences
Gallagher et al., 2011	Breast cancer screening	Women recruited from an inner city hospital, non-adherent to guidelines for receiving annual screening mammograms (US)	Gain- or loss-framed message about the importance of mammography	Video	Women with average and higher levels of perceived susceptibility for breast cancer were significantly more likely to report screening after viewing a loss-framed message compared to a gain-framed message. No such framing effects for women with lower levels of perceived susceptibility.
Gintner et al., 1987	Blood pressure screening	Undergraduates with and without a hypertensive parent (US)	Loss or gain framed messages about hypertension and the importance of early detection	Printed material handed out	Gain frame found more than twice effective with subjects with history of parental hypertension

Lalor and Hailey, 1990	Breast cancer screening	Undergraduate women, self-reporting to do breast self-examinations (US)	Loss vs. gain framed messages	Written (pamphlets)	No significant differences
Lauver and Rubin, 1990	Other (cervical smears testing)	Women with abnormal smears and no previous colposcopy (US)	Loss framed messages (emphasizing risk of not being screened) vs. gain framed messages	Telephone contact + written	5.2% increase in uptake of colposcopy
Lerman et al., 1992	Breast cancer screening	Female HMO members aged 50-74 with abnormal mammogram (US)	Loss framed messages (emphasizing risk of not being screened) vs. gain framed messages	Written	No significant differences
Myers et al., 1991	Other (colorectal screening)	Men aged 50-74, members of HMO (US)	Loss framed messages (emphasizing risk of not being screened) vs. gain framed messages	Telephone contact + written	3.4% increase in adherence t screening
Park et al., 2010	Type 2 diabetes screening	High risk individuals aged 40-69 years in two general practices (UK)	Loss and gain framed messages in an invitation to screening for type 2 diabetes	Written invitation	No significant differences in attendance to the screening between the loss and gain frame arms
Williams et al., 2001	Breast cancer screening	Women randomly selected from telephone directory (Australia)	Loss framed, gain framed and neutral messages in brochure	Telephone contact + brochure	Loss-framed brochures led to significantly greater change in a positive direction than did gain-framed brochures, which were more effective than were neutral (no frame) brochures