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## Conference Paper

# Subsidizing Health-Conscious Behavior Now or Later

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# Subsidizing Health-Conscious Behavior Now or Later

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Preliminary Draft

## Abstract

We examine subsidies for health care when consumers have present-biased preferences, which lead them to underestimate the effect of today's consumption on future health. We compare immediate subsidies paid for health-conscious consumption and future subsidies rewarding a good health outcome. We show that, while both policies can implement the first best choice, doing so by future subsidies results in higher costs for the government. This arises since the individual anticipates that, from today's perspective, she will make biased use of future subsidies. Hence, in order to create the same incentive effect, a future subsidy must be higher in present value terms.

Keywords: Present-biased preferences; Health-conscious behavior; Paternalism

JEL classification: H31; D91; I18

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# 1 Introduction

Life consists of three cycles – past, present and the future. We regret our past, fully appreciate the present pleasures and very often refuse to move forward. Sometimes there is not even an inch of movement, although we consistently plan to direct our behavior towards the future, currently the most immediate moment gets still the highest weight. This so called present-bias is reflected in one of the popular sayings - *Eat, drink and be merry, for tomorrow we diet*. According to that people either underestimate the effect of today's consumption on future health or postpone health investments to a later date, since unpleasant activities seem to be even more unpleasant the closer they are to the present. Tomorrow they may recognize their mistake and change their behavior or persist in their postponing game.

Already implemented paternalistic instruments such as sin taxes and subsidies on health-conscious behavior are aimed to counterbalance the inter-temporal distortion of consumption toward the present and hence to improve the health status. In our paper we concentrate on subsidizing health-conscious behavior of present-biased individuals, which can be designed in two different ways, depending on the timing and the target of the subsidy: Subsidies can be used either for immediately rewarding individual's health-conscious consumption, or for rewarding individual's health outcome in the future. This difference might be of importance for present-biased individuals, who are time-inconsistent and thus have a high preference for immediate gratification. In this paper, we argue that the government should consider this when designing the best feasible paternalistic policy. We show that, while immediate and future paternalistic policies can both implement the first best choice, future subsidies result in higher costs for the government. This arises since the individual anticipates that, from today's perspective, she will make biased use of future subsidies. Hence, in order to create the same incentive effect, a future subsidy must be higher in present value terms.

Both forms of subsidies are already existent and are often subject to many discussions from different social perspectives. For example, the United States Department of Agriculture (USDA) developed a new nutrition program, Healthy Incentives Pilot (HIP), which has been tested for 12 months in Hampden County (Massachusetts). HIP is an incentive-based program to empower low-income people, SNAP recipients, to consume more fruits and vegetables. For every Dollar spent with the SNAP Electronic Benefit Transfer cards on fruit and vegetables, participants earned an incentive of 30 cents. The incentive was immediately added to their SNAP account, thus cutting the

costs for fruit and vegetables by almost one third. The evaluation of the HIP program will occur by the end of the year, but the researchers are already very optimistic of the positive impact the project will have on the consumers' behavior. There are many studies supporting the effectiveness of immediate subsidies. So, for example, Volpp *et al.* (2009b) examine the effect of immediate financial incentives on smoking cessation within the employees of a multinational company based in the United States. The results of their analysis demonstrate that, contrary to one's belief, even relatively small financial incentives lead to a significant increase in the rates of smoking cessation and, what was shown by Volpp *et al.* (2008), to a short-term weight loss. The importance of financial rewards has been also highlighted in the CHIPS study of French *et al.* (2001), that examined the effects of pricing and promotion strategies on purchases of low-fat snacks from vending machines and work-site settings. Lowering prices by 10%, 25%, and 50% was associated with significant increases in low-fat snack purchases, sales increased by 9%, 39%, and 93%, respectively. On the contrary, promotional labelling affected sales in a relatively minor way. The above results suggest that price, in addition to factors such as preferences and availability, affects in a significant way the consumption of healthy foods. The price sensitivity of consumers can be also observed in the research field of sin good control, where the consumers reduce their sin good consumption due to price increases.<sup>1</sup>

There are some studies which have shown that subsidies do get people to consume things they might not otherwise purchase. Since subsidies in form of money could also be spent for unhealthy items, one could argue that subsidizing good health outcomes might lead to even lower health care costs in the long run. The consumption of healthy food would then be a part of achieving the goal rather than a goal itself. Future subsidies rewarding a good health outcome are already implemented in the United States, where companies offer *Healthy Rewards Cards* and other rebate programs as an incentive to promote healthy lifestyles. In opinion of many employers, adopting healthier lifestyle behavior within employees leads to reduced healthcare costs. Thus, participants of health reward programs earn points and gift cards for engaging in healthy behaviors such as quitting tobacco, taking the general health assessments or exercising regularly. FedEx, for example, rewards employees with diabetes for participation in its disease-management program. IBM introduced Healthy Living Rebate program, which includes e.g. smoking cessation rebate or preventive care rebate to rewards employees

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<sup>1</sup>See Wagenaar *et al.* (2009), Gallet and List (2003) and Chaloupka and Pacula (2001).

for identifying their preventive care needs and personal health risks.<sup>2</sup> Also in Germany future subsidies in form of bonus programs are a part of modern life. Their goal is centered around promoting personal responsibility, while reducing overall health-care expenditures. Bonus program participants receive rewards for activities that improve their health, e.g. dental care and health courses. One has to take part in at least three quality assured activities to get a reward after one year of program participation. In contrast to immediate subsidies, here the reward is given after a certain period of time. Another example for a subsidy on future health outcomes is provided by the widespread use, in health insurance contracts, of rebates granted to clients who do not claim any expenses during some period.

Our paper contributes to the assessment of these and similar policies by emphasizing that the timing is relevant for their effectiveness. The result suggests that policies of the second kind, where the reward is delayed, are less effective in the presence of present-biased preferences than policies of the first kind, where health conscious behavior is subsidized immediately.

Present-biased preferences and efficiency of paternalistic policies in improving individual decision making under hyperbolic preferences have received increasing attention in public finance. O'Donoghue and Rabin (2003, 2006) study optimal sin taxes in an economy with heterogeneity in preferences for the sin good and in the degree of time inconsistency. They show that when there is some degree of self-control problems in the population such taxes not only counteract overconsumption by consumers with self-control problems, but can even create Pareto improvements.

Cremer *et al.* (2012) study the interaction between sin goods and health spending within two settings: persistent error and dual self. They show that the first-best optimum can be decentralized by individualized taxes and subsidies. In the first setting, sin goods should be taxed and health-care expenditures subsidized. In the second there is no need for subsidizing health-care expenditures, but a subsidy on saving is desirable.

But not only governments, researchers and companies pay more attention to health outcomes and health-related interventions. The results of a cross-sectional telephone survey in Israel done by Brezis and Marans (2010) suggest that the general public would support discounting health insurance taxes for individuals with healthy habits such as exercise and abstention from smoking. Support of a policy of differential taxing according to lifestyle was high across all sectors of society, even among smokers.

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<sup>2</sup>See Business Roundtable (2007)

From all this we may conclude, that firstly paternalistic instruments to promote long-term changes in individual's behavior are welcomed by different social groups, subsidies related to health-conscious behavior could improve health outcomes and thirdly not only the extent of a subsidy but also its timing in individual's decision process seems to determine the outcome.

This paper is organized as follows. In Section 2, we set up a framework to analyze optimal subsidies when individuals may have present-biased preferences. We consider a simple economy with two goods where, additional to a numeraire good, there is a healthy good that creates, besides benefits from consumption, positive health consequences in the future. In Section 3 we characterize the reference-case solving the optimization problem for time-consistent individuals. Since in the absence of present-biased preferences the current self gives full weight to any future health benefit, there will be no distortion in the healthy good consumption in the present. In Section 4, we examine policy intervention in form of immediate and future subsidies, when there is under-consumption of healthy good due to a time-inconsistent preference for immediate gratification. We show that the first-best outcome can be implemented with both policies, though resulting in different costs for the government. Finally, we conclude in Section 5 by discussing the implications of our findings for health policy.

## 2 The Model

An individual consists of a sequence of autonomous temporal selves, which are indexed by the corresponding periods,  $t = 0, 1, 2, \dots$ . In each period  $t$ , a self with the exogenous per-period income  $y_t$  and the cash-on-hand  $x_t$ , which may differ from income because of taxes or subsidies, consumes a healthy good  $c_t$  and a numeraire good  $d_t$ . We assume throughout that individuals cannot borrow or save. Normalizing current commodity prices to 1, in the absence of government intervention, her budget constraint is then given by  $x_t = y_t = c_t + d_t$ . The self's instantaneous utility in period  $t$  is

$$u_t \equiv w(c_t) + v(d_t) + h_t, \tag{1}$$

where  $w(c_t)$  and  $v(d_t)$  denote, respectively, a self's period- $t$  utility from consumption of healthy good and the numeraire. The function  $h_t = h(c_{t-1})$  represents the positive health consequences from past healthy good consumption. We assume that  $v'(d_t) > 0$ ,

$w'(c_t) > 0$  and  $w''(c_t) < 0$ ,  $v'(d_t) < 0$ , so that there are positive and decreasing marginal benefits of consumption. Similarly, consumption of the healthy good has positive but non-increasing marginal benefit for health,  $h'(c_{t-1}) > 0$  and  $h''(c_{t-1}) \leq 0$ . Moreover, in order to rule out corner solutions, we assume  $w'(0) + \delta h'(0) > v'(y_t)$  and  $w'(y_t) + \delta h'(y_t) < v'(0)$ .

Following Laibson (1994, 1997) and O'Donoghue and Rabin (1999), we adopt in our model  $(\beta, \delta)$ -preferences which have the form:  $1, \beta\delta, \beta\delta^2, \dots, \beta\delta^t, \dots$ . A self's intertemporal preferences at time  $t$  are thus given by

$$U = u_t + \beta \sum_{i=1}^{\infty} \delta^i u_{t+i}, \quad (2)$$

where  $\delta \in (0, 1)$  represents time-consistent discounting whereas  $\beta \in [0, 1]$  represents the bias for the present. Within this preference structure we can distinguish two cases: for  $\beta = 1$ , the preferences are time-consistent and reduced to exponential discounting, for  $\beta < 1$  the preferences are present-biased and the discount rates decline over time. Since a time-inconsistent individual consists of multiple selves, she is not able to commit to a particular future consumption behavior. Every self has a tendency to pursue immediate gratification in a way that their future selves do not appreciate and will therefore choose a consumption level  $(c_t, d_t)$  that maximizes her current preferences  $u$  plus a biased version of future utilities, as in (2), and not the individual's long-run utility as expressed by  $U$  when  $\beta = 1$ . Against this background we will treat such short-time desire as an error, which results in poor consumption of healthy good in the present and hence poor health status in the future.

In our analysis we examine three cases. The first one is the reference case where  $\beta = 1$ , so that there is no need for government's intervention. The two other cases, devoted to present-biased preferences with  $0 < \beta < 1$ , consider government's interventions in form of (2) immediate subsidies paid for health-conscious consumption and (3) future subsidies rewarding a good health outcome.

### 3 Reference-case

In each period  $t$ , a self with cash-on-hand  $x_t$  chooses consumption  $c_t$  and  $d_t$ . In the absence of present-biased preferences, the first state variable  $x_t$  is given exogenously

and evolves according to the equation  $x_{t+1} = y_{t+1}$ . The second state variable  $h_t$  is influenced by the past healthy good consumption and evolves according to the equation  $h_{t+1} = h(c_t)$ . We are mainly interested in steady state situations, where exogenous income is  $y_t = y$  for all  $t$  and the resulting choices and the other state variable  $h_t$  are constant over time.

The optimal unbiased choice is derived from the value function

$$V(h_t, x_t) = \max_{c_t, d_t} \{w(c_t) + v(d_t) + h_t + \delta V(h_{t+1}, x_{t+1}) | y_t - c_t - d_t = 0\}. \quad (3)$$

Denoting optimal choices as functions of cash-in-hand by  $c(x_t)$  and  $d(x_t)$ , one finds the first-order conditions

$$w'(c(x_t)) + \delta \left[ \frac{\partial V(h_{t+1}, x_{t+1})}{\partial h_{t+1}} \cdot h'(c(x_t)) \right] = v'(d(x_t)) = \lambda_t, \quad (4)$$

where  $\lambda_t$  is the Lagrangian multiplier associated with the budget constraint. From the envelope theorem, one has  $\partial V(h_{t+1}, x_{t+1}) / \partial h_{t+1} = 1$ . Using this in (4) shows that, for any time-constant exogenous per-period income  $y_t = y$ , the optimal solution of the above optimization problem  $c = c(y)$  and  $d = d(y)$  is stationary and given by the simultaneous solution to the budget constraint  $c + d = y$  and

$$w'(c) + \delta h'(c) = v'(d). \quad (5)$$

Notice that from  $w'' < 0$ ,  $h'' < 0$  and  $v'' < 0$  and the boundary assumptions on  $w' + \delta h'$  and  $v'$ , this solution is unique and satisfies  $0 < c(y), d(y) < y$ . Intuitively, in the absence of present-biased preferences, marginal utilities of the numeraire and the healthy good are equalized, with the latter consisting of the immediate marginal benefit of consumption and of the delayed marginal impact on health.

## 4 Corrective Policy

We now consider the case where the individual has present-biased preferences, so that she underestimates the impact of the healthy good consumption on future health status. We analyze two measures to counterbalance the inter-temporal distortion of consumption toward the present: an immediate subsidy related to the health investment, and a future subsidy related to the health outcome.



## 4.1 Immediate Subsidy

Suppose that the government introduces a subsidy  $\tilde{z}_t$  on the individual's health investment - healthy good consumption  $c_t$ . To finance the subsidy payments, the government imposes a lump-sum tax  $\tau_t$ . The binding budget constraint is then given by

$$y_t = c_t + d_t + \tau_t - \tilde{z}_t c_t$$

and the state variable  $x_t$  evolves, similar to the reference case, according to the equation  $x_{t+1} = y_{t+1} - \tau_{t+1}$ . The state variable  $h_t$  depends on the past healthy good consumption, so that  $h_t$  evolves to  $h_{t+1} = h(c_t)$ , with the difference that this consumption is now influenced by the subsidy  $\tilde{z}_t$ .

At time  $t$  the current self  $t$  uses the discount factor  $\beta\delta$  and her current-value function can be written as

$$W(h_t, x_t) = \max_{c_t, d_t} \{w(c_t) + v(d_t) + h_t + \beta\delta V(h_{t+1}, x_{t+1}) | y_t + \tilde{z}_t c_t - \tau_t - c_t - d_t = 0\}. \quad (6)$$

Denoting optimal choices again by  $c(x_t)$  and  $d(x_t)$ , the first order condition is

$$\frac{w'(c(x_t)) + \beta\delta \left[ \frac{\partial V(h_{t+1}, x_{t+1})}{\partial h_{t+1}} \cdot h'(c(x_t)) \right]}{(1 - \tilde{z}_t)} = v'(d(x_t)). \quad (7)$$

Solving for  $\tilde{z}_t$  yields

$$\tilde{z}_t = 1 - \frac{w'(c(x_t)) + \beta\delta \left[ \frac{\partial V(h_{t+1}, x_{t+1})}{\partial h_{t+1}} \cdot h'(c(x_t)) \right]}{v'(d(x_t))}. \quad (8)$$

Using  $\partial V(h_{t+1}, x_{t+1})/\partial h_{t+1} = 1$ , substituting the optimal unbiased choices  $c = c(y)$  and  $d = d(y)$  from the stationary condition and rearranging, we get

$$\tilde{z} = \frac{v'(d) - w'(c) - \beta\delta h'(c)}{v'(d)}. \quad (9)$$

Using (5), this can be written as

$$\tilde{z} = \frac{\delta(1 - \beta)h'(c)}{v'(d)}. \quad (10)$$

This subsidy rate implements the first-best outcome despite the present-biased prefer-

ences. For  $\beta = 1$ , the numerator in (10) is zero so that there is no need for subsidizing health-conscious consumption. For  $\beta < 1$ , the numerator gives the present value of the undervaluation of the marginal health benefit. The denominator is the marginal utility of income, so that the fraction  $\tilde{z}$  describes by how much the marginal willingness to pay for the healthy good differs between the unbiased and the biased consumer. Thus, the optimal immediate subsidy  $\tilde{z}$  balances the wedge between the biased and unbiased evaluation of health by present-biased individuals.

## 4.2 Future Subsidy

Now we examine the second form of subsidies, namely, future subsidies rewarding good health outcomes. As mentioned above, the past consumption of a healthy good  $c_t$  influences the individual's current health outcome  $h_{t+1}$ . Since future subsidies are related to health outcomes, the reward for present health-conscious behavior will occur in the next period.

Suppose now that the government grants a subsidy  $z_t$  on health outcome  $h_t$  and imposes a lump-sum tax  $\tau_t$  in order to finance the subsidy payments. The binding budget constraint is then given by

$$y_t = c_t + d_t + \tau_t - z_t h_t.$$

In the case of future subsidies the state variable  $x_t$  evolves according to the equation of motion  $x_{t+1} = y_{t+1} + z_{t+1} h_{t+1} - \tau_{t+1}$  and the state variable  $h_t$  according to the equation  $h_{t+1} = h(c_t)$ .

The maximization problem of the present self  $t$  is given by the current-value function

$$W(h_t, x_t) = \max_{c_t, d_t} \{w(c_t) + v(d_t) + h_t + \beta \delta V(h_{t+1}, x_{t+1}) \mid y_t + z_t h_t - \tau_t - c_t - d_t = 0\}. \quad (11)$$

From the first-order conditions we get, for the optimal choices  $c(x_t)$  and  $d(x_t)$ ,

$$w'(c(x_t)) + \beta \delta \left( \frac{\partial V(h_{t+1}, x_{t+1})}{\partial h_{t+1}} + \frac{\partial V(h_{t+1}, x_{t+1})}{\partial x_{t+1}} \cdot z_{t+1} \right) \cdot h'(c(x_t)) = v'(d(x_t)). \quad (12)$$

Inserting optimal choices in the current-value function for the present-biased consumer gives

$$W(h_t, x_t) = w(c(x_t)) + v(d(x_t)) + h_t + \beta \delta V(h_{t+1}, x_{t+1}). \quad (13)$$

Using the laws of motion for  $x_{t+1}$  and  $h_{t+1}$ , one derives from (13)

$$\frac{\partial W(h_t, x_t)}{\partial x_t} = [w'(c(x_t)) + \beta \delta (\frac{\partial V(h_{t+1}, x_{t+1})}{\partial h_{t+1}} + \frac{\partial V(h_{t+1}, x_{t+1})}{x_{t+1}} \cdot z_{t+1}) \cdot h'(c(x_t))] \cdot c'(x_t) + v'(d(x_t)) \cdot d'(x_t), \quad (14)$$

$$\frac{\partial W(h_t, x_t)}{\partial h_t} = 1. \quad (15)$$

The first-order conditions associated with (12) imply that the amount that self  $t$  should be just willing to pay if the associated constraint were relaxed by one unit equals the marginal utilities of consumption

$$\frac{\partial W(h_t, x_t)}{\partial x_t} = v'(d(x_t)) \cdot [c'(x_t) + d'(x_t)]. \quad (16)$$

Furthermore, we know from the budget constraint that  $c'(x_t) + d'(x_t) = 1$  so that we can write (16) as

$$\frac{\partial W(h_t, x_t)}{\partial x_t} = v'(d(x_t)). \quad (17)$$

Substituting optimal choices  $c(x_{t+1})$  and  $d(x_{t+1})$  into the continuation-value function yields

$$V(h_{t+1}, x_{t+1}) = w(c(x_{t+1})) + v(d(x_{t+1})) + h_{t+1} + \delta V(h_{t+2}, x_{t+2}). \quad (18)$$

From (13) and (18), the current-value function and the continuation-value function are linked by the equation

$$\beta \cdot V(h_{t+1}, x_{t+1}) = W(h_{t+1}, x_{t+1}) - (1 - \beta)[w(c(x_{t+1})) + v(d(x_{t+1})) + h_{t+1}].$$

By differentiation and substitution of (17) we get<sup>3</sup>

$$\beta \cdot \frac{\partial V(h_{t+1}, x_{t+1})}{\partial x_{t+1}} = v'(d(x_{t+1})) - (1 - \beta)[w'(c(x_{t+1})) \cdot c'(x_{t+1}) + v'(d(x_{t+1})) \cdot d'(x_{t+1})] \quad (19)$$

with  $w'(c(x_{t+1})) \cdot c'(x_{t+1}) + v'(d(x_{t+1})) \cdot d'(x_{t+1})$  as the current marginal utility of consumption. From the equation (12) we have

$$\beta \cdot \frac{\partial V(h_{t+1}, x_{t+1})}{\partial x_{t+1}} = \frac{v'(d(x_t)) - w'(c(x_t)) - \beta \delta \frac{\partial V(h_{t+1}, x_{t+1})}{\partial h_{t+1}} \cdot h'(c_t)}{\delta z_{t+1} \cdot h'(c_t)}. \quad (20)$$

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<sup>3</sup>For the self  $t+1$  the shadow value of cash-on-hand also equals the marginal utilities of consumption.

The Euler equation can be derived from combining (19) and (20)

$$v'(d(x_t)) = w'(c(x_t)) + \beta\delta h'(c(x_t)) + [v'(d(x_{t+1})) - (1 - \beta)(w'(c(x_{t+1})) \cdot c'(x_{t+1}) + v'(d(x_{t+1})) \cdot d'(x_{t+1}))]\delta z_{t+1} h'(c(x_t)). \quad (21)$$

Solving for  $z_{t+1}$  yields

$$z_{t+1} = \frac{v'(d(x_t)) - w'(c(x_t)) - \beta\delta h'(c(x_t))}{\delta h'(c(x_t))[v'(d(x_{t+1})) - (1 - \beta)(w'(c(x_{t+1})) \cdot c'(x_{t+1}) + v'(d(x_{t+1})) \cdot d'(x_{t+1}))]}. \quad (22)$$

By substitution of  $c = c(y)$  and  $d = d(y)$  from the stationary first best condition, and observing that we have  $x_{t+1} = y$  if the government runs a balanced budget, we get with (5)

$$z = \frac{(1 - \beta)}{v'(d) - (1 - \beta)[w'(c)c'(y) + v'(d)d'(y)]}. \quad (23)$$

Subsidizing health outcome at this rate  $z$  induces the first-best despite the present-biased preferences. Again, according to (23), for  $\beta = 1$  the numerator is zero and there is no need for subsidizing health-conscious consumption. For  $\beta < 1$ , the expression in the numerator describes the disregarded health in the future and the expression in the denominator reflects the total marginal utility of  $t + 1$ -consumption, as evaluated by period  $t$ 's self.

Comparing (23) to the optimal subsidy rate in case of immediate subsidization in (10), one first notices the discount factor  $\delta$  and the marginal health impact of consumption  $h'(c)$  in the numerator of (10). These differences reflect the facts that the immediate subsidy is paid one period earlier and based on consumption of the healthy good rather than on health outcome. Moreover, and less obviously, in (23) the marginal utility of income in the denominator is reduced by the term  $(1 - \beta)[w'(c) \cdot c'(y) + v'(d) \cdot d'(y)]$ . This term is required since from self  $t$ 's perspective, self  $t + 1$  discounts health benefit in  $t + 2$  too heavily. Thus, the current self anticipates that the future self will use the additional income procured by the subsidy in a way which the current self considers suboptimal. Therefore, the future subsidy appears less useful to the current self, so that, in order to create the same incentive effect as with an immediate subsidy, the subsidy rate has to rise.

This observation leads to our main result, which compares the tax revenue necessary to induce first best behavior by immediate subsidies on consumption of the healthy good with the taxes required to reach the same goal by future subsidies on the health

outcome. The present values of immediate ( $T_c$ ) and future ( $T_h$ ) subsidies are

$$T_c := \sum_{t=0}^{\infty} \delta^t \tilde{z}c = \frac{\tilde{z}c}{1-\delta}, \quad (24)$$

$$T_h := \sum_{t=1}^{\infty} \delta^t zh(c) = \frac{\delta zh(c)}{1-\delta}. \quad (25)$$

In these expressions,  $c = c(y)$  is the first best consumption of the healthy good, and the subsidy rates  $\tilde{z}$  resp.  $z$  are as given in (10) resp. (23).

**Proposition 1.** *If  $\beta < 1$ , inducing unbiased choices by immediately subsidizing healthy consumption requires a lower present value of taxes than inducing unbiased choices by subsidizing the future health outcome,  $T_c < T_h$ .*

**Proof:** Using (5) in the denominator of (23) and observing that  $c'(y) + d'(y) = 1$ , one finds that the optimal future subsidy rate can be written as

$$z = \frac{1-\beta}{\beta v'(d) + (1-\beta)\delta h'(c)c'(y)}, \quad (26)$$

where  $d = d(y)$  is the first best consumption of the numeraire commodity. Inserting (10) and (26) in (24) and (25) shows that  $T_c < T_h$  is equivalent to

$$\frac{\delta}{1-\delta} \cdot \frac{(1-\beta)h'(c)c}{v'(d)} < \frac{\delta}{1-\delta} \cdot \frac{(1-\beta)h(c)}{\beta v'(d) + (1-\beta)\delta h'(c)c'(y)}.$$

For  $\beta < 1$ , this inequality is equivalent to

$$h'(c)c \cdot [\beta v'(d) + (1-\beta)\delta h'(c)c'(y)] < v'(d)h(c). \quad (27)$$

Now observe that  $c'(y) = v''/(w'' + \delta h'' + v'') < 1$  and that the concavity of  $h(c)$  implies  $h'(c)c \leq h(c)$ . Therefore, if  $\beta < 1$ , one has

$$h'(c)c \cdot [\beta v'(d) + (1-\beta)\delta h'(c)c'(y)] < h(c) \cdot [\beta v'(d) + (1-\beta)\delta h'(c)].$$

With (5), this inequality is equivalent to

$$h'(c)c \cdot [\beta v'(d) + (1-\beta)\delta h'(c)c'(y)] < h(c) \cdot [v'(d) - (1-\beta)w'(c)],$$

from which (27) and hence  $T_c < T_h$  follow. *Q.E.D.*

## 5 Comments and Conclusion

This paper analyzes the intrapersonal game that arises when a consumer with present-biased preferences faces an inter-temporal consumption decision. Since the present self cannot commit her future selves to a particular consumption path, the consumption choice might be modified every single period. Time inconsistency basically means that there is disagreement between individual's different selves about the consumption decision. The present self is aware of time-consistency and thus will try to influence her future selves' behavior through her today's consumption choice.

In this setting, we examine two forms of subsidizing health conscious behavior: immediate subsidies related to healthy consumption and future subsidies paid for a good health outcome. We show that while both subsidies can achieve the first-best outcome, implementing the second one results in higher costs for the government. From self  $t$ 's perspective, her future self discounts health benefit too heavily and thus might use the subsidy in a way which the current self disapproves. Hence, the immediate subsidy appears more useful to the current self, so that, compared to a future subsidy, a lower subsidy rate is sufficient in order to create the same incentive effect. Other possible explanation for our result might lie in the fact that present-biased consumers are interested in immediate gratification and thus are not ready to wait for a reward till the next period. The level of impatience could depend on art of reward. We could imagine that for present-biased consumers money seem to be a very attractive immediate reward, free fitness card on the other hand not necessarily. These consideration is beyond the research objectives of this paper, but could be the subject for further research.

According to our result the government should concentrate on rewarding health-conscious behavior, e.g. lowering the prices of healthy goods and introducing discounts on quantities, rather than promising future rewards for successful health investments. The idea that prevention is necessarily better than cure is well known. Prevention implies 'to stop doing something bad' or 'to start doing something good'. Cure means 'to find a solution'. Immediate subsidies increase health outcome, future subsidies are paid for given health outcome. Hence, the consumption seems to be the starting point of any effort. The reinforced current consumption of healthy goods will have positive impact on health outcome in the future, thus reducing costs for health care.

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