Take off the heater: Utility effect and food environment effect in food consumption decisions

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ABSTRACT

In this paper, we describe individual food consumption decisions as driven by a utility effect and a food environment effect. To outline the utility effect, we first develop a new theoretical model of individual food consumption. Next, we introduce the food environment effect by showing how the food environment can affect food consumption decisions and how this can skew the resulting food consumption vector. Finally, we analyse manipulations of the food environment as a potential form of policy intervention. Our key result is that the food environment has several entry points in food consumption decisions and that libertarian paternalistic manipulations of the food environment can be effective, easily implemented, well-accepted and low-cost intervention options to nudge individuals towards healthier food consumption. Thus, a first step in interventions meant to improve diets should always be to attend to the food environment: at the very least to "take off the heater" and ensure that the food environment does not inadvertently guide food consumption decisions in an undesirable direction.

KEYWORDS: behavioural economics, bounded rationality, bounded self-control, cognitive biases, food choice, food consumption, food environment, food intake, health, identity, social norms, visceral factors.

JEL CODES: D03 - Behavioral Economics; Underlying Principles, D11 - Consumer Economics: Theory, I18 - Government Policy; Regulation; Public Health, Z13 - Economic Sociology; Economic Anthropology; Social and Economic Stratification.

1 INTRODUCTION

Individuals must constantly make decisions about food – more than 200 times a day without realizing it (Wansink & Sobal 2007). Many of these decisions concern what food items to consume (food choice) and how much of the selected food items to consume (food intake). Together these two choices materialize as the food consumption of the individual.

Although it is well known that food consumption has important health impacts, there is still a lot of discussion as to the most effective means to encourage the adoption of healthy eating habits. Nayga (2008) argues that existing policies that have been utilized to address the rising problem of obesity have not worked in a satisfactory manner, and suggests that one reason may be that the economic understanding of food consumption that is required for an effective targeting and design of policy interventions has been insufficient. According to Nayga, "*For economists interested in nutrition, diet and health, one of the biggest research challenges is how to fill the gaps in economic models, especially those primarily based on rational choice theory*" (ibid., 295).

In this paper, we model food consumption as the result of the individual's maximization of his or her utility function given a set of constraints related to her budget and effort. As we will see later, the total utility is affected by preferences, visceral factors, self-image and social identity considerations, as well as health impacts. In addition, the food environment plays a significant role in affecting the individual's food consumption.

By food environment we mean, following Just and Payne, the environment in which individuals choose, are served, consume and pay for their meals, as well as the way food is packaged, labelled, placed, or made in any other way salient (Just & Payne 2009, S51). It is also possible to define the food environment as "*factors that directly relate to the way food is provided or presented*" and then define separately the eating environment: the effort related to getting the food, the social interactions present during food choice and consumption, as well as non-food related environmental factors such as lighting, the presence of music and other sounds, and the presence of other distractions (Wansink 2004, 456). However, for the purposes of this paper, distinguishing between the food environment and the eating environment is not necessary, so we use the term food environment as a shorthand to refer to both.

Evidence shows that when individuals present bounded rationality and bounded self-control, default choices, visual cues, and other aspects of the food environment can significantly affect food consumption (see e.g. Downs, Loewenstein & Wisdom 2009, Garg et al. 2007, Wansink, Just & Payne 2009, Wansink & van Ittersum 2007, Wansink & Payne 2007). Consequently, it is interesting to examine how policy-making could take advantage of this fact. This interest stems partly from recent research in behavioural economics that has modified and enriched the neoclassical model of consumer choice. Behavioural economists have suggested that policy makers could "*use decision errors that ordinarily hurt people to instead help them*" (Downs, Loewenstein & Wisdom 2009, 160). In the context of food consumption, this can be done by manipulating the food environment so as to help individuals overcome their bounded rationality and bounded self-control and nudge them towards health-enhancing dietary choices.

Understanding the problematique that revolves around preferences, utility, food environment and behaviour is a prerequisite for effective policy interventions. It calls for distinguishing clearly between the "utility effect" and the "food environment effect" in food consumption decisions so as to be able to select appropriate policy measures to address each effect. To examine this issue, we first outline a utility effect in food consumption decisions by presenting a theoretical model of individual food consumption (Section 2). On the basis of the model, we then introduce a food environment effect by explicating the role of the food environment in food consumption decisions (Section 3) and analyse manipulations of the food environment as a potential form of policy intervention (Section 4). Section five concludes the paper and discusses avenues for further research.

2 THE UTILITY EFFECT

In this section, we present a theoretical model of individual food consumption that captures the utility effect on food consumption decisions.

A key contribution of our model is that it combines the literature on food consumption under bounded rationality and bounded self-control with the literature on individual behaviour and social and self-identity. More specifically, our model integrates in a novel way Loewenstein's (1996) visceral factors model, Akerlof's and Kranton's (2000, 2002) model of social identity, and Brekke's, Kverndokk's, and Nyborg's (2003) model of moral motivation.

In the model, individuals derive direct hedonic utility from food consumption. They have bounded self-control, so that in addition to tastes, their food consumption is affected by visceral factors as in Loewenstein (1996). Besides the direct hedonic utility, individuals also derive indirect utility from food consumption.[1] The indirect utility arises from payoffs from self-image as in Brekke et al. (2003) and from payoffs from social identity as in Akerlof & Kranton (2002) as well as from the health consequences of their diet.

[1] Note that in this paper we do not use the term indirect utility in the usual sense of consumer theory, where the term indirect utility identifies the consumer's maximal utility given a price level and an amount of income.

As in the traditional neoclassical model of consumer choice, consumption is affected by food prices and by the effort required to obtain and prepare the food given the individual income and effort constraints. The individual maximizes his or her total utility under the constraints.

2.1 The individual utility function

Let the utility U from food consumption of individual j at a given time t be

$$U = p\big[u(x_1, \dots, x_{n,} \alpha_1, \dots, \alpha_n)\big] + (1-p)[I_G - s\,(X - X_G)^2 + I_{ideal} - z\,(X - X_{ideal})^2 + I_R - c(X - X_R)^2] \qquad [1]$$

The first term in square brackets, $u(x_1, \dots, x_{n,} \alpha_1, \dots, \alpha_n)$ depicts the direct hedonic utility from food consumption at time t following Loewenstein (1996, 276). The second term in square brackets depicts the indirect utility from food consumption given the payoffs from social identity $I_G - s\,(X - X_G)^2$, from self-image $I_{ideal} - z\,(X - X_{ideal})^2$, and from eating a healthy diet $I_R - c(X - X_R)^2$. Next, we describe the utility function in more detail.

Adapting Loewenstein (1996, 276), $X = (x_1, \dots, x_n)$ is the food consumption vector of individual j at time t. Each element in the consumption vector implies two key dietary choices relevant for the individual's health. The first is food choice, that is, the selection of which food items 1, 2, … n, to consume. The second is intake decision, that is, the decision of how much of the chosen food item to consume. This amount is indicated by the value x for each different food item $x_1, x_2 \dots, x_n$.

Vector $A = (\alpha_1, \dots, \alpha_n)$ is the level of visceral factors at time t. By visceral factors we mean moods, emotions, physical pain, cravings and drive states such as hunger, thirst, and sexual desire (Ibid. 272). Following Loewenstein (1996), we assume that the utility from food consumption is affected by the strength of visceral factors operating at the time of consumption. For instance, being very hungry will increase the utility of eating a slice of cake. The same slice of cake to the same individual will yield a lower utility after an abundant meal. Being in a sad state increases the utility of hedonic foods such as buttered popcorns and M&M's (Garg, Wansink & Inman 2007).

In summary, $u(x_1, x_2, \dots, x_n)$ tells us if the individual prefers broccoli to chocolate cake or pasta to pizza; in other words, it describes the individual tastes in a visceral factor neutral environment, whereas $u(x_1, \dots, x_{n,} \alpha_1, \dots, \alpha_n)$ tells us the value of eating pizza at time t given the level of the relevant visceral factor α_i at that time.

The second term in square brackets depicts the indirect, non-hedonic utility from food consumption. This comprises the payoffs from self-image $I_{ideal} - z\,(X - X_{ideal})^2$, from social identity $I_G - s\,(X - X_G)^2$, and from eating a healthy diet $I_R - c(X - X_R)^2$, where $I_R > 0$, $I_G > 0$ and $I_{ideal} > 0$. For simplicity we let I = $I_G + I_{ideal} + I_R$. The disutility from not adhering to the three ideals, the individual's X_{ideal}, the reference group's X_G and the health authorities' X_R, is given respectively by $z\,(X - X_{ideal})^2, s\,(X - X_G)^2$ and $c(X - X_R)^2$ and is increasing nonlinearly in the distance between the individual's, group's and regulator's ideals and the realized consumption vector.

As shown in Figure 1, the individual's actual food consumption vector X may be located at some distance from the individual ideal X_{ideal}, the group social norm X_G and the health maximizing vector advocated by the health authorities (i.e. by the benevolent regulator) X_R. The longer are any of the sides of the triangle, the greater is the distance between the corresponding ideals. If any two vertices coincide, the triangle becomes a segment of a line, and if $X_{ideal} = X_G = X_R$, it collapses into a single point. If also X is at this point, the individual does not experience any disutility.

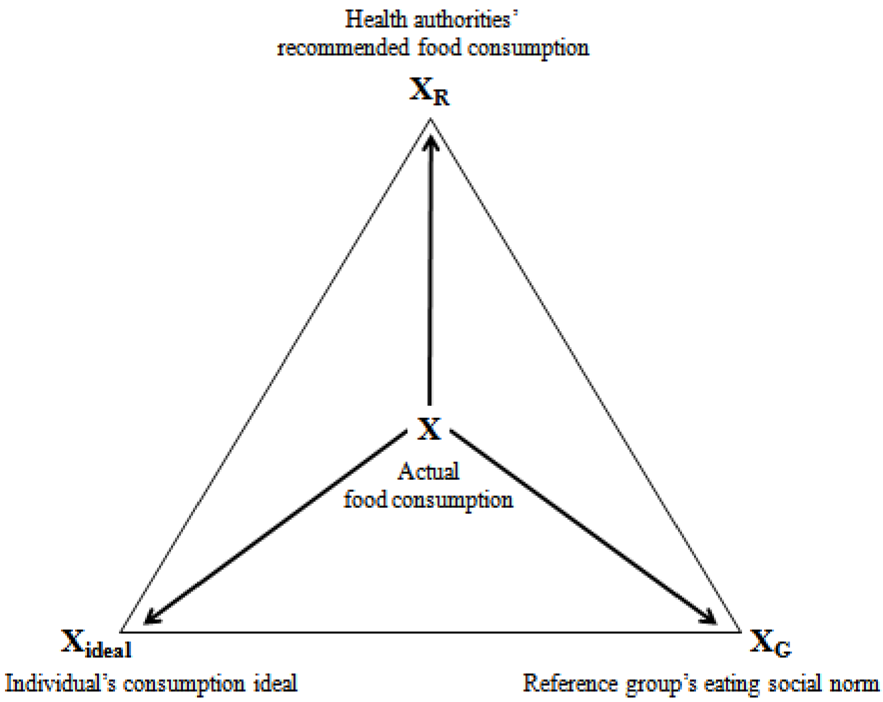

Figure 1. Individual, social and regulatory food consumption ideals and actual consumption

Parameters z and s are assumed to be non-negative. Their size varies according to the characteristics of each individual. Parameter z could be larger for those individuals who tend to feel more regret for not sticking to their consumption ideals or who feel more strongly the cognitive dissonance

(Festinger 1957) that arises when their behaviour, captured by X, does not conform to their ideal X_{ideal}. Parameter s could be taken as a measure of conformism, being smaller for those individuals who do not particularly care about fitting in the reference group. Both z and s could be zero, in which case the individual would not care at all whether his or her consumption vector conforms to the group or own ideal.

Parameter c, instead, is assumed to be strictly positive as we assume that deviations from the recommended food consumption vector $(X - X_R)^2$ always have a negative impact on health. This impact differs between individuals depending, for instance, on their individual genetic make-up and their current state of health, so that also parameter c varies across individuals. Note that this formulation does not necessarily imply that individuals have perfect information on the food consumption vectors best for their health. It only assumes that when choosing the consumption vector, they take into account the possible impact on their health on the basis of their belief about the "healthy" vector X_G and their health-related individual characteristics summarized by parameter c.

As for the individual ideal X_{ideal}, it may be based on the individual's moral beliefs as in Brekke et al. (2003) such as in the case of an ideal diet chosen so as to have a low environmental impact or to enhance animal welfare. However, the ideal could also stem from non-ethics-related motives - even pathological ones - such as the ideal food consumption of individuals suffering from anorexia nervosa.[2] In this paper, we do not analyse the formation of the ideal vector. The idea that deviating from one's ideal produces a disutility is consistent with the self-discrepancy theory, which sees the discrepancy between a person's view or perception of his or her own attributes (here defined in terms of personal food consumption) as opposed to one's aspiration for personal attributes (here the ideal consumption vector) as a cause of negative emotions such as disappointment and dissatisfaction (Higgings 1987, Higgins et al. 1986).

The payoff from social identity $I_G - s\,(X - X_G)^2$ is modelled following and modifying Akerlof and Kranton (2000, 2002). We assume that individuals' identity payoff depends on the social category G they are assigned to or assign themselves to. To each category is associated a social ideal that can be described by a set of behavioral expectations, prescriptions, or social norms. In this model, we assume that the social prescriptions can be expressed as a specific food consumption vector X_G . We also assume that individuals have only one social category G they want to belong to. The social

[2] For an application of Akerlof's and Kranton's (2000) identity model to pathological eating behaviour see Costa-Font and Jofre-Bonet (2010).

category G can be seen as a positive reference group, i.e. a group that is "*psychologically significant for one's attitudes and behavior*" (Turner 1991, 5) and to which the individual wishes to be associated with. I_G is the status that being part of group G gives to the individual. The greater the distance between the individual consumption vector and the social norm of the group X_G, the greater the disutility $-s\,(X - X_G)^2$ due to "*losses in identity*" that cause anxiety, a feeling to the individual of not fitting in (Akerlof & Kranton 2000, 719).[3] In terms of discrepancy theory, this component of utility corresponds to so called "ought discrepancies", which are associated with emotions like anxiety and fear (Higgings 1987, Higgins et al. 1986).

Note that the same individual may follow different food-related social norms depending on whether food is consumed at home or outside and with whom. This is because the appropriate reference group will depend on the context where food consumption takes place, as assumed in the referent informational influence model (Louis et al. 2007, 60). However, we do not discuss the choice of the reference group further in this paper.

Finally, parameter p measures the importance of the indirect identity and health pay-off component compared to the direct hedonic utility component of total utility. When p=1, the model is Loewenstein's model.

2.2 The constraints to individual utility maximization

Individuals maximize their utility subject to two constraints: income and effort. We describe each constraint below.

The income constraint is given by

$$p_1x_1 + p_2x_2 + \ \dots + p_nx_n \leq M, \qquad [2]$$

where p_n is the price of food item n and M is the income allocated to food consumption in a given period.

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[3] Although in the model we assume only positive reference groups, the model could be easily extended to include dissociative (i.e. negative) reference groups, that is, groups an individual does not want to be associated with. Suppose that the individual perceives group F as a negative reference group. Then his or her identity payoff would be increasing in the distance between his or her consumption vector and that of the negative reference group $+s\,(X \quad - X_F)^2$.

The effort constraint takes the form

$$e_1x_1 + e_2x_2 + \ ... + e_nx_n \leq E, \qquad [3]$$

where effort e_n indicates "*the ease, access or convenience with which a food can be consumed*" (Wansink 2004, 461); in other words, the effort required to choose, obtain, and prepare one unit of food item n. E is the total effort expendable in a given period t for food consumption.

3 THE FOOD ENVIRONMENT EFFECT

In this section, we outline the role of the food environment in food consumption decisions and thus describe the food environment effect.

Figure 2 illustrates how food consumption decisions are driven by a utility effect, formally expressed by our model in the previous section, where the individual maximizes the sum of his or her direct and indirect utility under the income and effort constraints. Besides the utility effect, however, we can also single out a separate food environment effect. It rests on a number of channels through which the food environment can affect food consumption decisions.

First, as also discussed in traditional neoclassical consumer theory, the food environment has an impact on the effort required to consume some foods as opposed to others (see e.g. Loewenstein et al. 2007, 2416). This affects the effort constraint in our model.

Second, in line with the intuitions of the behavioural economics literature, the food environment can affect the degree of exposure to tempting stimuli by making food more or less salient and thus either reinforcing or mitigating self-control problems (see e.g. Wansink, Painter & Lee 2006). In this way, the food environment affects the direct hedonic utility.

Third, and again closely linked to the discussion of bounded rationality in behavioural economics, in the presence of cognitive biases the size of available serving utensils such as plates, bowls, glasses, and spoons can affect food intake monitoring accuracy (see e.g. Rolls 2003, Wansink, Ittersum & Painter 2006). Fourth, the way the food is arranged can affect perceived variety by making actual variety feel larger or smaller and thus affect anticipated consumption enjoyment and, consequently, food intake (Kahn & Wansink 2004).

Fifth, manipulations of the way food is paid for (e.g. cash versus prepayment) that exploit individuals' flat-rate bias and their tendency to categorize income into mental accounts can also affect food consumption decisions (Just et al. 2008, 4). Sixth, due to biases such as the endowment effect (Thaler 1980), the status quo bias (Samuelson & Zeckhauser 1988) and loss aversion (Kahneman & Tversky 1984), individuals have a tendency to stay with the default option. These are examples of how the food environment influences food choice through cognitive biases.

Seventh, and touching upon sociological economics, the food environment may send signals about the social norms of consumption. Portion and packaging sizes (see e.g. Smith, Goldstein & Johnson 2009, Wansink & Kim 2005, Wansink, Just & Payne 2009) as well as actual and perceived variety (Kahn and Wansink 2004) can provide benchmarks that affect what is considered the "normal" or appropriate food intake. Eighth, the food environment may make the consumption norm of one's reference group more salient. This greater salience in turn increases the (affective) disutility of deviating from the norm as shown by Costarelli (2005). Moreover, under uncertainty about which level of food intake is appropriate in a given situation, the behaviour of eating companions can give clues as to the relevant norm and thereby affect intake (Herman, Roth & Polivy 2003).

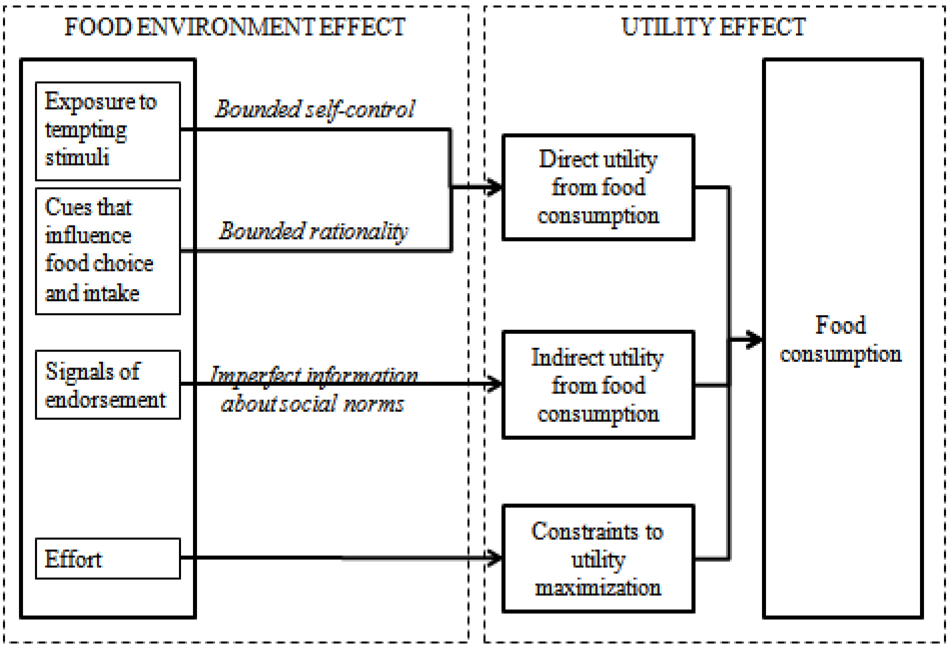

Figure 2. The food environment effect and the utility effect on food consumption

Thus, the food environment has entry points in all of the three major components of our model of individual food consumption: direct and indirect utility as well as constraints to utility maximization (see Figure 2). Moreover, the impact of the food environment is often related to bounded self-control, bounded-rationality, and imperfect information about social norms. Thus, its impact on food consumption can be fully understood only by extending the traditional neoclassical model of consumer choice and incorporating the contributions of both behavioural and sociological economics. We discuss these entry points and their relationship with economic theory in more detail below.

Separating the food environment effect from the utility effect is useful because the food environment can skew food consumption decisions by creating food consumption impacts that the individual did not intend and may not even be aware of. As an analogy, if it is too hot in a room, we may need to put on the air conditioner. But if there is a heater on in the corner of the room, we should make sure to turn off the heater first and then see whether the air conditioner is still needed. The food environment effect is akin to the heater in this example. It can be non-benign in the sense that it is biased against healthy eating, in which case it acts like the heater that should be turned off before applying other policy measures to promote healthier diets.

3.1 The food environment and constraints to individual utility maximization

The food environment can affect the constraints to individual utility maximization by influencing the effort (time, physical effort, or cognitive effort) that is required to consume some foods as opposed to others. We can express this by assuming that effort depends, among other things, on features of the food environment: E = $(e_1(d_1, \ldots), \ldots, e_n(d_n, \ldots))$, where d_i is a vector that portrays the degree of benignness of the food environment associated with the choice of food item i at time t, that is, the degree to which the food environment nudges people towards healthier food consumption. When d_i = 0, the food environment is such that it maximizes the unhealthy intake of item i (either too low or too high depending on the type of food).

Default choices may affect effort via switching costs. For example, to deviate from the default coke - fries - hamburger meal in a fast food restaurant, the individual needs to carry the cognitive burden of examining the alternatives and choosing a new, healthier combination of food items for himself or herself. Or, to obtain a vegetarian alternative in a workplace cafeteria, he or she may have to request it separately at the counter and perhaps also wait longer; to obtain it in an aeroplane the individual needs to have thought about pre-ordering it. Although the existing literature on default choices seems to suggest that the impact of defaults on effort in terms of switching costs is likely to be minor (Smith et al. 2008, 7), this literature focuses on non-repeated choices with large payoffs such as deciding whether to be an organ donor or in which funds to invest one's retirement savings. Food consumption, instead, is a low-involvement behaviour characterized by repeated choice where the effort related to each single choice, although small, can be large in proportion to the payoff from the food consumption decision. When there is a time constraint or cognitive overload in the decision-making situation, even a small incremental effort may have a large impact on the food consumption decision. Moreover the tendency of individuals to stay with the default option can reinforce the impact of even small switching costs.

Other examples of how the food environment affects effort include how far different food items are located. At the micro level, this can mean how many steps you need to take to reach the candy bowl when watching TV, and at the macro level, for instance, how long you need to walk in a city or in a shopping mall to find a restaurant selling healthy fast food.

3.2 The food environment and direct hedonic utility from food consumption

In our model, the direct hedonic utility from food consumption is affected by the relative strength of visceral factors: the hungrier we are, the greater the hedonic utility from eating a chocolate bar given the individual tastes for chocolate. Especially when strict time constraints (stress) are added to hunger, individuals tend to compensate for the missing leisure time with convenience food (Mancino & Kinsey 2004, ref. Just et al. 2007, 11). Being stressed for time may also easily lead to eating less often, which has adverse effects on healthy eating since longer intervals between meals increase food intake and lower the nutritional quality of the meal (Mancino & Kinsey 2008). In summary, the food environment affects direct hedonic utility by moderating the impact of some visceral factors, such as hunger, fatigue or stress, $x_i(d)$.

The food environment, in particular how salient the food is, affects the degree of exposure to tempting stimuli and thus can either mitigate or reinforce the impact of visceral factors on food consumption, thereby reducing or exacerbating bounded self-control problems. For instance, if there is no bowl of chocolate candies in sight or the bowl is opaque rather than transparent, individuals tend to eat less candies (Wansink, Painter & Lee 2006). On the other hand, if calorie dense foods are set close to the cafeteria counter where people have to stand in line before paying and thus are exposed to the temptation to purchase these food items, the impact of visceral factors is reinforced and self-control problems are amplified.

Further, when making food choice and intake decisions, individuals are not only driven by their preferences and the strength of the visceral factors active at the moment, but they are also affected by a series of cognitive biases. It has been shown that most individuals suffer from visual illusions that lead them to change their food intake in response to changes in the size of serving utensils such as plates, bowls, glasses, and serving spoons. For instance, the horizontal-vertical illusion leads individuals to pour more liquid into short, wide glasses than into tall and narrow ones, while the Ebbinghaus-Titchener size-contrast illusion leads individuals to serve themselves more food when using larger bowls as opposed to smaller bowls. (Wansink, van Ittersum & Painter 2006, 240-241.) It also appears that people are not very good at monitoring their food intake using their feeling of satiety. Thus, individuals often rely on visual cues and signals to decide how much to eat and when to stop. The size of food containers (dishes, bowls, spoons) provides such signals and cues. (see e.g. Wansink & Kim 2005, Wansink, van Ittersum & Painter 2006.)

Cognitive biases such as the endowment effect (Thaler 1980), the status quo bias (Samuelson & Zeckhauser 1988) and loss aversion (Kahneman & Tversky 1984) create a tendency in people to stay with the default options offered. Dhar and Wertenbroch (2000) suggest that the endowment effect interacts with the type of food item the individual is acquiring or parting from. When deciding what to acquire, virtuous, healthy food items tend to be salient while when having to choose which items to give up hedonic, less healthy food items are salient. This implies that individuals will more easily add healthy foods to their diet than give up unhealthy ones, so that it may be difficult to reduce overall calorie intake.

Also the variety of food offered can have important effects on food intake since anticipated hedonic utility appears to be affected by the variety of the food offered. Greater actual variety, that is, a larger number of distinct options as well as a larger number of category replicates (more of the same), can increase consumption by increasing anticipated hedonic utility. Different ways of presenting food, for instance by organizing food assortments or not, in turn affect how well the individual perceives increases in variety and therefore how much such increases end up affecting his or her food intake. Increases in actual variety in disorganized food assortments are harder to perceive and thus affect consumption less than corresponding increases in variety within organized assortments (Kahn & Wansink 2004).

3.3 The food environment and indirect utility from food consumption

The food environment can affect the indirect utility from food consumption by sending signals about the social endorsement of specific dietary choices both in terms of food choice and food intake. In other words, the food environment can be seen as providing information as to what is the appropriate vector of food consumption for the relevant reference group, $X_G = X_G(d)$. Wansink, Just and Payne (2009, see also e.g. Wansink & van Ittersum 2005, Wansink & Kim 2005, Wansink & Cheney 2005, Wansink, Painter, & North 2005, Wansink 2004) cite portion and packaging sizes and degree of variety and organization of assortment (Kanhn & Wansink 2004) as examples of subtly implied norms and clues of what is a normal amount of food to consume. The individual can use these signals to infer the reference group's consumption vector X_G.

Also the presence of eating companions can affect food consumption. Herman, Roth and Polivy (2003) suggest that most people want to avoid being seen eating excessively. In terms of our model, they want to avoid the disutility from not conforming to group norms. However, being unsure of what is excessive they engage in social comparison (ibid. 874). Thus, when eating with relatives and friends, they eat more since these meals are special events during which it is socially appropriate and acceptable to eat more than usually (Herman, Roth & Polivy 2003, 875). The presence of eating companions, however, supresses eating when the companions are felt to be observing and evaluating, and the individual tries to convey an image of self-control and politeness by eating less (impression management) (ibid. 882). Finally, the presence of eating companions increases intake when the eating companion consistently eats a lot and decreases intake when he or she consistently eats only a little (modelling) (ibid. 882).

3.4 The individual maximization problem

Summarizing from section 2 and including the food environment effect outlined above, we can formalize our analysis as follows. The individual maximizes utility

$$U = p[u(x_1(d), \dots, x_n(d), \alpha_1, \dots, \alpha_n)] + (1-p)[I_G - s\,(X(d) - X_G(d))^2 + I_{ideal} - z\,(X(d) - X_{ideal})^2 + I_R - c(X(d) - X_R)^2] \qquad [4]$$

by choosing a vector of consumption X subject to the income and effort constraints

$$p_1x_1 + p_2x_2 + \dots + p_nx_n \le M,$$

$$e_1(d_1)x_1 + e_2(d_2)x_2 + \ ... + e_n(d_n)x_n \leq E,$$

Following and extending Loewenstein (1996, 276), we assume that we can partition both visceral factors and the features of the food environment "*into subsets that affect only a single consumption variable*". In such a case the individual's utility function takes the form

$$U = p[u(v_1\,(x_1(d_1),\, \alpha_1)\,, v_2\,(x_2(d_2),\, \alpha_2), \dots, v_n\,(x_n(d_n),\, \alpha_n))] \ + (1-p)[I - s\,(X(d) - X_G(d))^2 - z\,(X(d) - X_{ideal})^2 \ - c(X(d) - X_R)^2], \quad [5]$$

where $u(v_1\,(x_1(d_1),\, \alpha_1)$ describes the utility from consuming food item x_1 given the relevant subset α_1 of visceral factors and the features of the food environment d_1 affecting the consumption of item x_1 at a certain time t. Both α_1 and d_1 should thus be though as vectors including these subsets. As in Loewenstein (1996, 277), we assume that when x_i = 0 then α_i does not by itself affect the individual utility. We also assume that direct hedonic utility increases as $x_i$increases $\frac{\partial v_i}{\partial x_i} > 0$. In the model both $\frac{\partial v_i}{\partial \alpha_i} > 0$ and $\frac{\partial v_i}{\partial \alpha_i} < 0$ are possible (Loewenstein 1996, 277), that is, visceral factors may increase or decrease the utility from x_i.

Recall that d_i is a vector that portrays the degree of benignness of the food environment associated with the choice of food item i at time t, that is, the degree to which the food environment nudges people towards healthier food consumption. When d_i = 0, the food environment is such that it maximizes the unhealthy intake of item i (either too low or too high depending on the type of food).

Assuming that both constraints hold as strict equalities, the Lagrangian for the maximization problem is

$$L = p[u(v_1\,(x_1(d_1),\, \alpha_1)\,, v_2\,(x_2(d_2),\, \alpha_2), \dots, v_n\,(x_n(d_n),\, \alpha_n))] \ + (1-p)[I - s\,(X(d) - X_G(d))^2 - z\,(X(d) - X_{ideal})^2 \ - c(X(d) - X_R)^2]$$
$$-\lambda_M\,[p_1x_1 + p_2x_2 + \ ... + p_nx_n - M] - \lambda_E[e_1(d_1)x_1 + e_2(d_2)x_2 + \ ... + e_n(d_n)x_n - E] \quad [6]$$

This yields the first-order condition for food item i at time t

$$\frac{\partial L}{\partial x_i} = p\frac{\partial v_i(x_i(d_i),\alpha_i)}{\partial x_i} * \frac{\partial U}{\partial v_i} + (1-p)\big[-2s * |x_i(d_i) - x_{Gi}(d_i)| - 2z * \big|x_i(d_i) - x_{ideal,i}\big| - 2c * |x_i(d_i) - x_{Ri}|\big] - \lambda_M p_i - \lambda_E e_i(d_i) = 0 \quad [7]$$

Note that the absolute values $|x_i - x_{Gi}|$, $|x_i - x_{ideal,i}|$, $|x_i - x_{Ri}|$ in the first-order condition reflect the assumption that deviations from the group, individual and health authorities' ideals always decrease utility regardless of the direction of the deviation.

Let us next examine with the help of comparative statics how changes in the food environment, d_i, affect the consumption of food item i. We have that $\frac{dx_i}{d\,d_i} = -\frac{\frac{\partial L^2}{\partial x_i \partial\, d_i}}{\frac{\partial L^2}{\partial^2 x_i}}$

$$= -\frac{\frac{\partial^2 v_i(x_i(d_i),\, \alpha_i)}{\partial x_i \partial\, d_i} * \frac{\partial U}{\partial v_i} + (1-p)\left[-2s * \left|\frac{\partial x_i(d_i)}{\partial d_i} - \frac{\partial x_G(d_i)}{\partial d_i}\right| - 2z * \left|\frac{\partial x_i(d_i)}{\partial d_i}\right| - 2c * \left|\frac{\partial x_i(d_i)}{\partial d_i}\right|\right] - \lambda_E \frac{\partial e_i(d_i)}{\partial\, d_i}}{p\frac{\partial^2 v_i(x_i(d_i),\, \alpha_i)}{\partial {x_i}^2} * \frac{\partial U}{\partial v_i} + (1-p)[-2s - 2z - 2c]} \quad [8]$$

We should consider two cases:

(1) the regulator wants to encourage the consumption of item i (e.g. vegetables, fruit) so that $\frac{\partial x_i(d_i)}{\partial d_i} > 0$, $\frac{\partial x_G(d_i)}{\partial d_i} > 0, \frac{\partial e_i(d_i)}{\partial\, d_i} < 0$ so that the numerator of equation [8] is positive.

(2) the regulator wants to discourage the consumption of item i (e.g. chips, sodas) so that $\frac{\partial x_i(d_i)}{\partial d_i} < 0$, $\frac{\partial x_G(d_i)}{\partial d_i} < 0, \frac{\partial e_i(d_i)}{\partial\, d_i} > 0$ so that the numerator of equation [8] is negative.

The denominator of equation [8] is negative given that the marginal utility from consuming item i is decreasing in its quantity x_i , that is, $\frac{\partial^2 v_i(x_{ti},\, \alpha_{ti})}{\partial {x_{ti}}^2} < 0$ and that the total hedonic utility U increases in the hedonic utility v_i from consuming item i, that is, $\frac{\partial U}{\partial v_i} > 0$.

It follows that increasing the degree of benignness d_i of the food environment with respect to item i leads to $\frac{dx_i}{dd_i} > 0$ for healthy items and $\frac{dx_i}{dd_i} < 0$ for unhealthy ones.

4 MANIPULATIONS OF THE FOOD ENVIRONMENT AS A POLICY OPTION

The interest in the health impacts of food consumption has led to the development of an abundant literature on policy interventions aimed at affecting individuals' dietary choices. Intervention options include the provision of information about what constitutes a healthy diet, restrictions of choice such as banning certain food types or ingredients, other command-and-control policies such as compulsory labeling of nutritional content, as well as taxes (subsidies) on food items or ingredients that are considered unhealthy (healthy). These policy interventions target the utility effect: they attempt to influence the components of an individual's total utility (like the individual's ideal consumption vector) as well as the constraints to utility maximization, so that the actual food consumption X_t determined by these would be closer to the regulator's ideal X_R.

In addition, a relatively less discussed form of intervention is the manipulation of features of the food environment so as to affect food consumption. Such policies can be called libertarian paternalistic because they try to nudge individuals towards decisions that will improve their well-being without restricting choice (Sunstein & Thaler 2003, Thaler & Sunstein 2008). They target the food environment effect in an attempt to remove the undesirable skewness it brings to decision-making, or to purposefully skew food consumption decisions in a health-promoting direction. Manipulations of the food environment can address all the entry points that we identified for the food environment in the previous section, so they bring several opportunities to affect food consumption.

4.1 Empirical evidence of the impact of manipulations of the food environment

In this section, we present empirical evidence of the impact of various manipulations of the food environment on food consumption.

Modifying proximity. Studies show that consumption can be increased by decreasing effort, for instance by placing a milk dispenser closer to the dining area (Lieux & Manning 1992, ref. Wansink 2004, 461), a water pitcher on the table rather than 20 feet away (Engell et al. 1996, ref. Wansink 2004, 461), chocolate candies on one's desk rather than 2 meters away (Wansink, Painter & Lee 2006), by offering shelled almonds rather than unshelled ones (Schachter & Gross 1968, ref. Wansink 2006, 84), or by leaving the lid of an ice-cream cooler open (Meyers, Stunkard, & Coll 1980, ref. Wansink 2004, 461).

There is evidence that proximity to food has effects not only at the micro level but also at the meso level. Kapinos and Yakusheva (forthcoming, 2010) found that freshmen assigned to dormitories that had on-site dining halls gained more weight in their freshman year compared with students in dorms without on-site cafeterias. This effect was found especially with female freshmen who had gained 0.85 kg more in the spring than female freshmen in dorms without cafeterias.

Manipulating salience. Wansink, Painter and Lee (2006) showed that putting chocolate candies on an office desk in a clear bowl led the person sitting at the desk to eat 67% more candies than when the candies where put at 2 meters distance from the desk. When the bowl was opaque (lower salience) the increase in intake was 48%, showing that salience is an independent effect from proximity.

The salience of food products can also be manipulated by stockpiling that makes the product more visible in one's pantry or kitchen. Chandon and Wansink (2002) found that stockpiling increased food consumption, with a stronger effect for high-convenience products for which it not only increased consumption quantity given incidence (as with all products), but also increased consumption incidence, that is, how often the product is consumed. For instance, when families bought promotional packs of cookies, their average daily consumption following these purchases increased by 92% (ibid. 325).

Changing variety. Rolls et al. (1981) found that increasing the variety of sandwich fillings from one to four increased consumption by a third. In another study, increasing the flavours of yogurt from one to three flavours clearly differentiated in texture, colour and taste, led participants to eat on average 23% more yogurt (Rolls et al. 1981). Interestingly, significant effects on food consumption can also be achieved by manipulating perceived variety without changes in actual variety by simply changing the way the options are presented to the consumer. Kahn and Wansink (2004) offered the same number of jelly beans of different colour, the only difference across treatments being that in one the jelly beans were organized by colour while in the other they were mixed; subjects exposed to the disorganized assortment ate 69% more jelly beans.

Changing the size of serving bowls. In a study where participants queuing to serve themselves ice cream were randomly assigned either a large bowl (34 oz) or a small bowl (17 oz), those who were assigned the large bowl consumed on average 31% more ice-cream (6.25 oz vs. 4.77 oz) (Wansink, Ittersum & Pantier 2006, 241-242).

Varying portion size. Larger portions have been shown to increase the food intake of relatively energy dense food such as macaroni and cheese, where a doubling of the portion from 500 to 1000 g led to a 30% increase in caloric intake (Rolls 2003, 43). More recently, similar effects have been found for non-energy-dense food such as vegetables and fruit. Spill et al. (2010) found that 3-5-year-old children increased their consumption of carrots by 47% when the portion size was doubled from 30 to 60 g. Tripling the portion size of carrots from 30 to 90 g led to an increase of 54% in consumption. In the case of changes in portion size - as well as with the other manipulations of the food environment - the ultimate impact of the food environment effect, however, depends on the relative strength of the preferences towards specific food items, in other words, on the utility effect. This was evidenced in the study of 5-6-year-old subjects by Kral et al. (2010), who found that doubling the portion size of fruit and vegetables (unsweetened apple sauce, broccoli and carrots) offered as a side dish increased the intake of apple sauce on average by 43%, but not that of carrots and broccoli. The impact of portion size on vegetable consumption is not limited to children. In a study with adult subjects, Rolls, Roe and Meengs (2010) increased the portion size of broccoli and found that an increase in portion size from 180 to 270 g led to an average increase in intake of 29%. When the portion size was doubled from 180 to 360 g, broccoli intake grew on the average by 49%.

It is not clear, however, how increases in the portion size of one food item affect the total food intake. In Kral et al. (2010), when the larger portion of broccoli was simply added to the rest of the meal consisting of rice and meat, the total weight of food consumed increased. When it was substituted, by decreasing the meat and rice portions, broccoli intake increased while meat and rice intake decreased. In Spill et al. (2010) the increase in apple sauce intake was accompanied by a decrease in the intake of the main entrée of pasta by about a half even though the pasta portion size had been left unchanged.

Increasing portion size can also increase the intake of non-palatable foods such as 14 days old, stale popcorns. Wansink and Kim (2005) assigned moviegoers either a large (240 g) or a small (120g) bucket of free fresh or stale popcorns. Although increasing the size of the bucket had a greater impact on the consumption of fresh popcorns, people nevertheless ate on average 34% more stale popcorns when given the large bucket rather than the small one.

Modifying payment methods. In a study with university students, Just et al. (2007) gave the subjects 20 dollars (a prepaid debit card, cash, or a combination of the two) to buy food from the cafeteria. The prepaid card was either restricted, so that only nutritious items could be bought but no desserts and sodas, or unrestricted, allowing the student to pay for any item sold in the cafeteria. Compared to those students paying in cash, the ones that were given the unrestricted debit card were about 25% more likely to purchase brownies and 27% more likely to buy a soda but 7% less likely to buy skimmed milk. If one considers the cumulative effect of these seemingly small differences in terms of food choice and calorie intake, it is easy to see why Just and Wansink (2009) regard requiring payment in cash for sodas and other unhealthy items in school cafeterias as the most promising manipulations of the food environment to nudge students towards healthier diets.

4.2 An analysis of manipulations of the food environment as a policy instrument

It is useful to examine libertarian paternalistic manipulations of the food environment against the criteria of effectiveness, acceptability, cost-efficiency, and administrative practicality.

The first criterion, effectiveness, is about how powerful manipulations of the food environment are in achieving change in food consumption. As discussed above, empirical evidence shows that they can be very effective. However, it should be borne in mind that manipulations of the food environment are this effective only insofar as there is an important food environment effect that these manipulations can address. When there is a relatively stronger utility effect, the impact of manipulations of the food environment is limited. For example, Just and Wansink (2009) found in an experiment that when students were offered French fries as a default, with an opportunity to switch for pealed apple slices, 95 per cent of the students wanted to stay with the default option. However, when the options were reversed two days later, 96 per cent of the students wanted to switch away from the default to receive the French fries. Thus, the utility effect created by a strong preference for French fries apparently overrode the food environment effect of a tendency to stick to the default option. On the other hand, the impact of the food environment can be so strong as to override preferences. For instance, with regard to the interaction between social norms and visceral factor driven utility, Goldman, Herman and Polivy (1991) found that individuals who had been deprived of food for more than 24 hours reacted to a confederate eating minimally by also eating minimally.

One reason why manipulations of the food environment are so effective can be that they directly affect actual food consumption X. This is, for example, in contrast to measures that attempt to produce changes in preferences through awareness raising, as there are indications that the provision of information is more effective in affecting the ideal consumption vectors of individuals X_{ideal} than their actual behavior X. In fact, the chain of causality between attitudes and behaviour can go both ways: changes in behaviour resulting from libertarian paternalistic manipulations of the food environment may trigger changes in attitudes and habits, thus reinforcing behavioural changes.

A further point about effectiveness is also related to acceptability. Libertarian paternalistic manipulations of the food environment have the desirable feature that they do not restrict freedom of choice. Restrictions to freedom of choice, such as the removal of soda machines from schools (see e.g. American Academy of Pediatrics Committee on School Health 2004) and the ban of trans fats in restaurants (see e.g. Unnevehr & Jagmanaite 2008) have been recently advocated as a component of food policy. Such proposals are controversial for two main reasons.[4] Firstly, they limit freedom of choice and can open the door to excessive government interference (the so called slippery slope argument, Resnik 2010). Secondly, they may backfire by causing consumers' psychological reactance (Brehm 1966, see also Brehm & Brehm 1981), which may reinforce the behaviour the policy originally meant to reduce. According to Brehm's (1966) psychological reactance theory, individuals value their freedom to choose among alternatives. Whenever such freedom is restricted, individuals tend to try to restore it (reactance restoration). Thus, individuals may react to paternalistic interventions to control their eating behaviour in one food environment such as schools by increasing consumption of the banned food or beverage in another food environment (boomerang effect). By contrast, manipulations that do not restrict choice can teach individuals to make healthy choices even in other food environments that are without such benign manipulations (Just & Wansink 2009).

With regard to cost-efficiency, Table 1 groups examples of food environment manipulations in three different groups based on a rough estimate of their cost impacts. Although there is a range of manipulations with different cost impacts, it is notable that a number of manipulation options are either low-cost or without any costs. Often, thus, manipulations of the food environment can be very cost-efficient.

Table 1. Examples of food environment manipulations with different cost impacts

No costs or low costs	Medium costs	High costs
Varying portion size	Changing plate and bowl sizes	Changing packaging sizes
Manipulating salience	Changing variety	
Modifying effort		
Rearranging the order in which food items are presented		
Changing default options		

[4] See, for instance, the discussion on banning trans fats in the March 2010 Issue (3) of the American Journal of Bioethics.

The administrative practicality and ease of implementation of manipulations of the food environment depend crucially on both the level of implementation (micro, meso, macro) and on the level of regulations already in place. At one extreme are micro food environments such as school cafeterias, whose operations already have to comply with quite specific guidelines and for which strong evidence exists of the cost-effectiveness of different types of manipulations. At the other extreme are macroenvironments such as cities with their constellation of fast-food outlets, grocery stores, etc. for which manipulations are administratively more costly, politically less acceptable and for which there is less evidence of cost-effectiveness. Although there is correlational evidence that neighbourhoods with a greater population of overweight people also have a greater than average concentration of fast-food outlets and a lower than average concentration of grocery stores from where to purchase fruit and vegetables (see e.g. Kipke et al. 2007), it is unclear what explains this correlation (different preferences, income, social norms, or the food environment). Nevertheless, at the theoretical level, it can be reasonably assumed that the same channels operating at the micro or meso level (exposure to tempting stimuli, cues that influence food choice and intake, signals of endorsement and effort) could be significant also at the macro level.

In sum, thus, libertarian paternalistic manipulations of the food environment can be effective, low-cost intervention options that are easy to implement and generally well accepted. Thus, a first step should always be to attend to the food environment: at the very least to ensure that the food environment does not inadvertently guide food consumption decisions in an undesirable direction (”take off the heater”) and possibly even to consciously manipulate the food environment to nudge food consumption decisions in a desirable direction. When the food environment effect is small compared to the utility effect, manipulations of the food environment may not be effective enough to achieve change in food consumption. In such instances, other forms of policy are likely to be required to improve dietary choices (“put on the air conditioner”), but manipulations of the food environment may still be useful complements to these policies.

5 DISCUSSION AND CONCLUSIONS

In this paper, we described individual food consumption decisions as driven by a utility effect and a food environment effect. To outline the utility effect, we proposed a new behavioural and sociological economics model of food consumption that integrates Loewenstein’s (1996) visceral factors model, Akerlof's and Kranton's (2000, 2002) model of social identity, and Brekke's, Kverndokk's, and Nyborg's (2003) model of moral motivation. Our model identifies four main sources of utility from food consumption: the direct hedonic utility from consuming food and the indirect utility of food consumption related to self-image, to social identity and to health. To this model, we then introduced the food environment effect by showing how the food environment can affect food consumption decisions and how this can skew the resulting food consumption vector. Thus, we offer a comprehensive framework to understand food consumption and fill some major gaps in the existing economic models.

From a policy perspective, the distinction between a utility effect and a food environment effect is important to select appropriate measures to affect dietary choices. Our key result is that the food environment has several entry points in food consumption decisions and that libertarian paternalistic manipulations of the food environment can be effective, low-cost intervention options that are easy to implement and generally well accepted. Thus, a first step should always be to attend to the food environment: at the very least to "take off the heater" and ensure that the food environment does not inadvertently guide food consumption decisions in an undesirable direction.

There are many opportunities to extend the current model in future research. We discuss some of these opportunities briefly below.

Introducing an intertemporal dimension in the model. Our analysis is static in nature in that it examines the individual utility from food consumption within one time period. One important extension would be to make the model dynamic, since only a dynamic model would allow us to explore issues such as habit formation, the development of the individual ideal, and changes in the individual's reference groups. A dynamic model would also allow us to examine how policy can encourage individuals to actively try to affect their future food consumption by manipulating the food environment and the level of visceral factors they will experience in the future. For instance, individuals could affect the future level of the visceral factor hunger by eating at regular intervals. Or, they could have only small plates in the home, or put calorie dense foods out of sight or not stock them at all, so that when visceral factors hit, their impact will be reduced.

Discussing the formation of and interactions between the vertices of the triangle in Figure 1. One criticism made on Akerlof's and Kranton's (2000) social identity model applies to our model as well: self-image and social identity are exogenous in the model, so that the model cannot explain how social identity comes about and how it relates to self-image. For more details on this line of criticism, see Davis (2006). Moreover, our model does not consider the fact that as Kirman and Teschl (2006, 304) point out, "*people choose to belong to social groups in order to become who they want to be and to realize their self-image*". Finally, also the regulator's ideal can have an impact on the formation of the individual's ideal food consumption vector. Hence, exploring more deeply the links between reference group choice, the regulator's ideal, and self-image would be an important avenue for further study.

Including profits. A third possible extension to the model would be to discuss how benign manipulations of the food environment by policy makers with the objective of nudging individuals toward healthier food consumption may interact with manipulations by service providers aimed at maximizing profits.

Taking account of situational factors. In this paper, we have made a distinction between a utility effect and a food environment effect on food consumption. The relative weight of these effects may vary between situations, so that the effect of the food environment on food consumption decisions may range from negligible to significant. Possible determinants of the relative strength of the food environment effect may include, for example, the strength of the preferences and the characteristics of the decision-making situation. These and other situational factors could be examined both theoretically and empirically.

Addressing other policy objectives besides health. In addition to health consequences, individual food consumption decisions can also have other policy-relevant impacts. Notably, food consumption can have significant environmental impacts (see e.g. Baroni et al. 2007). For example, it has been estimated that food is responsible for 20-30% of the total environmental impacts of consumption (Tukker & Jansen 2006, 169). The model can be easily modified to apply also to the environmental problematique.

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