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Who reacts to food taxes? How a multiple-selves model can help to explain the effects of food taxes

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INTRODUCTION

Food consumption is a deeply ingrained part of human cultural traditions and social interactions (Kjaernes and Holm 2007; Carrus et al. 2018), reflects individual identity and is also highly habitual. These characteristics make promoting large changes in food consumption challenging. These changes, however, are urgently needed, as producing food for an increasing world population entails serious environmental impacts, and it is an increasing challenge to keep food production and consumption within the planetary boundaries (Campbell et al. 2017). In developed countries, the food system is responsible for up to a quarter of all greenhouse gas emissions (GHG-emission) (IPPC 2014), is a major driver of land-use change and biodiversity loss (European Environment Agency 2015, 2017; Newbold et al. 2015), is a large user of freshwater resources (Coates et al. 2012) and a large polluter of terrestrial and aquatic systems (Parris 2011). Moreover, the prevalence of diet-related non-communicable diseases is increasing globally (WHO 2021) and adherences to dietary recommendations are low (Springmann et al. 2016; Mertens et al. 2019). A number of theoretical models show that it is possible to design diets that are healthy but also have moderate environmental impacts (for reviews see, for example, Quam et al. 2017; Doro and Réquillart 2020). The question is, however, how to design a toolkit of food policy instruments that effectively promote a shift of behaviour towards healthier and more climate-friendly diets, given the complexity and richness of motives that guide food consumption.

Policy-makers trying to change dietary choices generally have three main types of instruments at their disposal: Those targeting the information environment, those targeting the price environment and those aimed at the product environment, such as standards for product reformulation (see Chapter 6 in this volume), as well as different forms of nudging (for a review, see Reisch et al. 2021). Soft instruments, such as targeting the information environment or nudging, rank high from a political perspective compared with instruments targeting the price environment, as they allow more freedom of choice for the consumer and are easier to implement (Sunstein et al. 2019). Provision of information is certainly important. Without information about the content of sustainability characteristics of food, such as the GHG-emission, and/or health characteristics of foods, such as nutritional composition, these are impossible to evaluate for the consumer, often even after consumption has occurred.[1] Unfortunately, the effects of instruments targeting the information environment appear to be limited, hard to predict and insufficient to alter food choices to the extent required for food consumption to be healthy and/or sustainable (Garnett 2011; Latka et al. 2021). For instance, food labelling that signals healthier or more climate-friendly choices, appears to impact mostly those who already have a preference for the attributes that the label signals (Grunert and Wills 2007; Grunert et al. 2014). Furthermore, the provision of information about the health or environmental impacts of meat consumption does not appear to influence actual behaviour (for a literature review, see Bianchi et al. 2018). As for nudges geared to encouraging more climate-friendly food consumption, the evidence is still limited (Bianchi et al. 2018) and to some degree mixed, as for the example of nudges aimed at social norm manipulations (Cialdini and Jacobson 2021)

Owing to the limited effect of the softer instruments, several institutions, among others the World Health Organization (WHO), promote the use of food taxes to ensure that food prices incorporate the negative externalities of food consumption and production (Thow et al. 2018). Appropriately set Pigouvian taxes can ensure that food prices reflect the full social costs of food production and consumption, thereby closing the gap between individually and socially optimal consumption. A challenge here is that, while it is possible to construct diets that are both healthy and climate-friendly (Willett et al. 2019; Mertens et al. 2021), studies analysing observed diets frequently find higher GHG-emission associated with healthier diets (for example, Vieux et al. 2013; Payne et al. 2016; Doro and Réquillart 2020). Thus, with two conflicting goals, taxes need to be designed to explicitly target both goals, as health and climate friendliness will not necessarily arrive as a co-benefit of GHG-emission taxes.

Finally, the nutritional health attributes of food are best characterized as an attribute similar to a private good, while climate-friendliness is best characterized as an attribute similar to a public good, with the consequent under-provision of this attribute owing to free riding. Consumers' willingness to contribute to public goods is strongly related to personal values and social norms (Fehr and Gächter 2000). Therefore, in order to develop effective food taxes, we need to base our empirical research on models that are able to account for the complexity of motives driving food consumption, including personal values and social norms. This will help us to understand the substitution patterns between health and climate-friendliness, that is, between the private- and a public-good attributes in food. To do this, we need detailed data on food consumption and prices, combined with survey data reflecting the consumers' motives for consumption of food with public-good attributes.

We start this chapter with a brief review of the limitations of the literature on the impact of food taxes aimed at obtaining more climate-friendly diets and the derived health consequences of these taxes. We then argue that climate-friendly food choices are driven by a complexity of factors that ought to be taken into account in the design of food taxes. We suggest a model, that draws on behavioural economics and social psychology, to characterize individual's utility in relation to both climate-friendly and healthy food consumption. The model characterizes food consumption as a habitual behaviour that is not only a source of health and hedonic utility, but also a contributor to the individual's social identity and self-image. The model provides the theoretical framework through which we then suggest a new way of combining empirical data in food policy research to incorporate these factors when designing food taxes as one of the tools in the food policy mix. The final section provides a discussion and conclusions.

A BRIEF REVIEW OF THE EFFECTS OF FOOD TAXES

There is a huge body of literature estimating the effects of food taxes and subsidies on the consumption of various healthy and unhealthy foods (for recent reviews see, for example, Niebylski et al. 2015; Teng et al. 2019; Dodd et al. 2020), as well as considerable literature estimating the effects of GHG-emission taxes (for recent studies see, for example, Abadie et al. 2016; Caillavet et al. 2016; Kehlbacher et al. 2016; García-Muros et al. 2017; Bonnet et al. 2018). A common outcome is that a product-specific tax decreases the consumption of the targeted food; for example, a tax on soft drinks decreases the consumption of soft drinks. However, product-specific taxes do not always reach the broader goal of the tax as the consumer might substitute to other, not necessarily healthier, foods. Outcomes that are more efficient are often obtained by taxing closer to the target. This implies imposing a tax proportional to the content of added sugar, if reduced sugar consumption is the broader goal, or a tax proportional to the level of GHG-emission per kilogram of food if reduced GHG-emission is the broader goal (Jensen and Smed 2007; Revoredo-Giha et al. 2018; Dodd et al. 2020). Yet, even these taxes may lead to unintended effects (Niebylski et al. 2015), as occurred with the tax on saturated fat in Denmark, which led to an increase in the consumption of salt (Smed et al. 2016). These adverse effects may be owing to simple substitution as relative prices change, but they may also arise if consumers find other ways to fulfil their more generic food preferences. Salt, saturated fats and sugar, for example, add taste to foods and are thus, to some extent, substitutes; so when saturated fat is taxed, consumers will search for salty or sugary foods to fulfil their taste preferences. Therefore, even with taxes aimed at a single goal, consumer responses may be difficult to predict.

Modelling studies on the effect of GHG-emission based taxes, have to some extent also considered the co-benefits of these taxes with respect to dietary health impacts. The results are mixed, and the impact on health of imposing a tax on GHG-emission depends to a large extent on the design of the tax, that is, which foods are included in the tax base (Kehlbacher et al. 2016; García-Muros et al. 2017; Bonnet et al. 2018; Revoredo-Giha et al. 2018; Forero-Cantor et al. 2020; Edjabou and Smed 2013). The largest reduction in GHG-emission which also lead to increases in dietary health are found in scenarios that combine taxes on high-emitting foods with subsidies on low-emitting and healthy foods (Briggs et al. 2013; Dogbe and Gil 2018, Caillavet et al. 2019). Even better effects are obtained when environmental taxes are combined with additional taxes on unhealthy foods. Abadie et al. (2016) find a reduction in food-related GHG-emission by imposing a mix of taxes and subsidies, but the effect is diminished if the taxes and subsidies are designed to decrease overall calorie intake and improve dietary health. This is in line with the Tinbergen rule that states that the number of policy instruments should be equal to or greater than the number of policy targets (Tinbergen 1952).

Modelling studies show that a full internalization of the externalities related to both unhealthy and climate-unfriendly food consumption might lead to substantial price increases for many food products (Springmann et al. 2018; Pieper et al. 2020). There is also agreement across the literature, that taxes need to be substantial to have a significant impact on GHG-emission (Kehlbacher et al. 2016; Bonnet et al. 2018; Caillavet et al. 2019), which might be problematic since GHG-emission taxes are found to be regressive (Kehlbacher et al. 2016; García-Muros et al. 2017; Caillavet et al. 2019). Whether in reality comparably high tax rates would be necessary to reach substantial demand changes remains speculative, as validated price elasticities for this size of demand shift are missing. Increasing consumer awareness may change consumer price responsiveness beyond the elasticities used in current modelling analyses.

Some effort has been put into estimating the heterogeneity in responses to health-related food taxes based on observable socio-demographic characteristics or habits. Low-income households are found to be more price sensitive than high-income households (Smed et al. 2007; Green et al. 2013; Ni Mhurchu et al. 2013). By contrast, habitual consumers (Li and Dorfman 2019) and heavy users of a product (for example, Etilé and Sharma 2015; Debnam 2017; Taillie al. 2017; Ng et al. 2019) are less price sensitive, which might weaken the response to health-related food taxes. Less effort has been allocated to analysing how unobservable differences between consumers affect the efficiency of food taxes. This might, however, be important in order to address the complicated substitution patterns that may arise when multiple goals, as healthier and less GHG-emitting diets, are pursued. Hedonic differences with respect to differences in taste preferences might well determine which products are considered as relevant substitutes to the taxed food, and can thereby determine the overall changes in health or GHG-emission that arise from introducing a tax. For example, Bertail and Caillavet (2008) divided a panel of French consumers into six segments based on similarities in their fruit and vegetable consumption to represent similar tastes. Each of the groups varied in employment status, age, educational level and income, and showed very different response patterns to price changes. The level of self-control might play a role in the efficiency of food taxes. Schmacker and Smed (2020) find that consumers with low self-control reduce purchases less strongly than consumers with high self-control when taxes increase, while there is no significant difference between the two groups when taxes are repealed. To the best of our knowledge, no studies have analysed heterogeneity in responses to GHG-emission based taxes.

In summary, this brief literature review has shown that sufficiently high taxes might be effective to reduce GHG-emission from food consumption. However, the effect on dietary health of these taxes depends crucially on how the tax is designed. Taxation schemes specifically aimed at addressing both health and environmental targets are the most efficient. Finally, there is evidence of variation between responses to food taxes based on observed heterogeneity, such as income and habits, but only to some extent on unobserved heterogeneity. Unobserved heterogeneity owing to, for example, differences in social and personal norms, might determine which food items are considered acceptable substitutes for a taxed food. This could influence how effective a tax is in reaching the overall goal of the tax. Without a better understanding of the influence of this heterogeneity on demand, it will be difficult to design effective food taxes based on modelling studies.

THE CLIMATE AND HEALTH ATTRIBUTES OF FOOD AND SOCIALLY OPTIMAL FOOD CONSUMPTION

The different properties of food can be located along a private good–public good axis. Let us take taste, healthiness and low GHG-emission as key characteristics of food. Taste is best described as a private good, since there is excludability and rivalry in consumption, and there are no significant externalities to others from consuming tasty food. Healthiness, in turn, can be characterized as a private good with public-good characteristics. Most benefits from consuming healthy food accrue to the individual, though a healthy diet also creates positive externalities to others owing to decreased public health-care costs (and vice versa for an unhealthy diet). Finally, climate-friendliness can be seen as mostly a public good as the benefits to society from lower GHG-emission are non-rival and non-excludable by nature.

The presence of these public-good characteristics implies that policy intervention is necessary to achieve socially optimal consumption. Thus, when encouraging a shift towards diets that are both healthy and climate friendly, the different weight of private- and public-good components in these properties requires careful fine-tuning of policy tools.

The theoretical literature, mostly rooted in social psychology, identifies various models to explain why consumers engage in green or climate-friendly food consumption. Most of these models suggest that positive attitudes towards the environment are not sufficient for consumers to choose foods with strong public-good components, and that consumption of this food is strongly driven by contextual and sociocultural parameters. The empirical literature finds that individualistic values, such as health, safety and hedonistic values (for example, the pleasure of eating and taste), have a stronger influence on engaging in sustainable food consumption, than do public values such as environment or climate-friendliness (Joshi and Rahman 2015; Hartmann and Siegrist 2017; Stoll-Kleemann and Schmidt 2017). For instance, significant barriers to a decrease in meat consumption are the enjoyable taste of meat and the valuation of meat as pleasurable (Stoll-Kleemann and Schmidt 2017; Austgulen et al. 2018).

These findings and models are in line with the results from economics, that consumers usually are not willing to pay for the public-good characteristics of food, unless they obtain some private utility from other factors related to green consumption. Generally, personal values and norms, social identity and social reference groups were found to be important determinants of green consumption (Joshi and Rahman 2015; Stoll-Kleemann and Schmidt 2017). Habits, cultural norms and traditions were significant barriers to adopting a more sustainable diet and to eating less meat. Limited knowledge about the climate impact of meat and about how to cook in a more climate-friendly manner reduced the willingness to engage in climate-friendly food consumption, while increased knowledge had a positive influence on consumer intention and purchase (Joshi and Rahman 2015; Stoll-Kleemann and Schmidt 2017; Austgulen et al. 2018).

To understand how taxes aimed at reducing GHG-emission and increasing health affect food behaviour, we need to consider how the above-mentioned factors affect consumer choices. In the following section, we therefore propose a simple means of integrating multiple factors affecting food consumption into a conceptual model, where consumer utility is formulated over the demand for goods. We have in this approach drawn from other strands of theory linked to behavioural economics and social psychology, which give useful insights into how consumer attitudes to, and perception of, healthy and climate-friendly foods can affect the responses to food taxes. The model also allows integration of the impact of information on food choice.

A MULTIPLE SELVES MODEL OF UTILITY

Let us assume that individuals derive hedonic utility from food consumption and have bounded self-control, so that, in addition to tastes, visceral factors affect the hedonic utility. In addition to hedonic utility, food consumption yields utility from the payoffs from social identity, from moral self-image and from the current evaluation of the future health consequences of our diet, and the disutility from deviating from habitual food consumption. We could think of total utility as the weighted sum of the utility of these five coexisting selves, as illustrated in Figure 12.1.

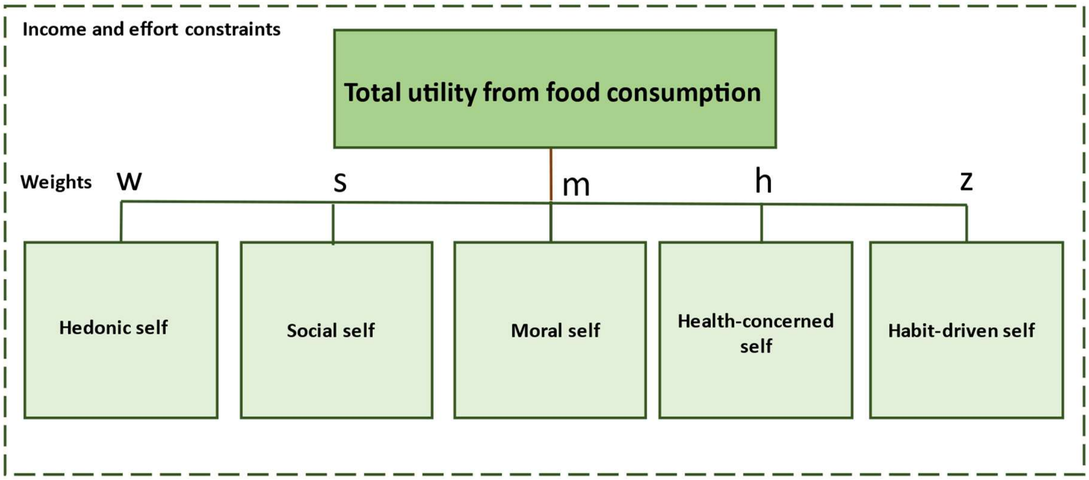

Figure 12.1 Total utility from food consumption derived from five coexisting 'selves' within the individual

We formulate individual total utility U_t from food consumption, at time *t* as the sum of these five sources of utility, which are explained in detail next. Individuals differ in the (non-negative) weight that they assign to each source of utility among other things:[2]

$$U_t = w(\mathbf{A_t})[u_t(\mathbf{X_t}, \mathbf{A_t})] + s\left[I_G - \sum_{i=1}^{n}\left(x_{it} - x_{iG}(\mathbf{K_t})\right)^2\right]$$

$$+ m(\mathbf{A_t})\left[I_{ideal} - \sum_{i=1}^{n}\left(x_{it} - x_{iideal}(\mathbf{K_t})\right)^2\right] \quad + \frac{h}{1+r(\mathbf{A_t})}\left[\sum_{i=1}^{n} n_i\left(x_{it} - x_{iMIN}(\mathbf{K_t})\right) - \right.$$

$$\left.\sum_{i=1}^{n} d_i\left(x_{it} - x_{iMAX}(\mathbf{K_t})\right)\right] \quad - z\sum_{i=1}^{n}(x_{it} - x_{i,t-1})^2.$$

(12.1)

Overall utility, U_t, is constrained to be positive otherwise the consumer would not consume. However, each single element of the utility function can be negative in principle. For instance, although unlikely, it is possible that a consumer could decide to consume a food vector he or she finds distasteful, so that $[u_t(\mathbf{X_t}, \mathbf{A_t})] < 0$ owing to significant gains in social image, self-image or health.

The weights of the different elements of the utility functions can be thought of as decision weights that measure the relative importance of a particular self at the moment of choice. Their value is normalized so that they sum to one. These weights partly depend on relatively stable individual characteristics, such as the individual's culture, age, income and level of education, partly by the internal state of the individual at the moment of choice, for example, by the degree of activation of different visceral factors, and partly by the way the choice environment makes some selves more salient than others. For instance, messages reminding of the healthiness of a certain food may activate the health-concerned self through the information vector $\mathbf{K_t}$.

The Hedonic Self

The first term in square brackets in equation (12.1) depicts the hedonic utility from food consumption. $\mathbf{X_t} = (x_{1t}, \dots, x_{nt})$ is the consumer's food consumption vector, where x_{it} is the amount of food item i consumed at time *t*. $\mathbf{A_t} = (\alpha_{1t}, \dots, \alpha_{nt})$ is the food-specific level of visceral factors operating at time *t*. By visceral factors we mean moods, emotions, physical pain, cravings and drive states such as hunger and thirst (Loewenstein 1996). The functional form $u(\mathbf{X_t}, \mathbf{A_t}) = u(x_{1t}, \dots, x_{nt,} \alpha_{1t}, \dots, \alpha_{nt})$ implies that visceral factors have direct hedonic consequences, that is, if the consumer becomes hungrier or more fatigued, this affects their hedonic utility even with constant food consumption (Loewenstein 1996). Moreover, as visceral factors intensify, individuals increase their focus on the form of consumption that is related to the visceral factor, while their interest for other forms of consumption decreases. In summary, $u(\mathbf{X_t}) = u(x_{1t}, x_{2t}, \dots, x_{nt})$ describes the tastes of the individual in a visceral-factor-neutral environment (whether the individual prefers broccoli or meat), whereas $u(\mathbf{X_t}, \mathbf{A_t}) = u(x_{1t}, \dots, x_{nt,}\ \alpha_{1t}, \dots, \alpha_{nt}\ )$ tells us about the individual's preferences for broccoli and meat given the level of the relevant visceral factors. Parameter *w* measures the weight of hedonic utility as a component of overall utility. This allows the importance given to taste and other hedonic characteristics of food to vary across individuals. We assume $u(\mathbf{X_t}) > 0, \frac{\partial u_t}{\partial x_{i,t}} > 0$ and $\frac{\partial^2 u_t}{\partial x_{i,t}^2} < 0$, that is, marginal hedonic utility is positive and a decreasing function of the amount consumed.

The Social Self

In the second term in equation 12.1, individuals define their identity partly through how well their food consumption adheres to that of their salient reference group. They obtain payoffs from the sense of belonging to the group and suffer a disutility whenever their choices deviate from that of their reference group. Following Akerlof and Kranton (2002), the individuals' identity payoff depends on parameter I_G which measures the social status from belonging to group *G*, as perceived by the consumer, that is, the maximum utility that the individual gets from belonging to that group. The identity payoff also depends on the degree to which individual consumption departs from the social norm of the group, expressed as a specific food consumption vector $\mathbf{X_G} = (x_{1G}, x_{2G}, \dots, x_{nG})$. This is captured by the payoff from social identity $I_G - \sum_{i=1}^{n}(x_{it} - x_{iG}(\mathbf{K_t}))^2$, in which the disutility from deviating from the group norm is assumed to be an increasing function of the deviation. The individual's maximum utility from social identity is equal to I_G at $x_{it} = x_{iG}(\mathbf{K_t})$. The higher the distance between the individual's consumption and the social norm, the higher the disutility owing to losses in identity, a feeling of the individual of not fitting in (Akerlof and Kranton 2002), regardless of whether the individual over- or under-consumes the food compared with the social norm of the reference group $x_{iG}(\mathbf{K_t})$. The social category G is conceptualized as a positive reference group, that is, a group that is 'psychologically significant for one's attitudes and behavior' (Turner 1991, p. 5) and that the individual wishes to be associated with.[3] Information affects the individual's perception of the social norm of the group through the elements of the set of information vectors $\mathbf{K_t}$ that are of relevance for the social reference group. $\mathbf{K_t}$ is a collection of vectors, where each vector reflects the individual's knowledge about the environmental impacts, social impacts, healthiness and social acceptability of a given food. For instance, with red meat, the vector could include the amount of greenhouse gases associated with consumption of red meat, the content of macro- and micro-nutrients of red meat, as well as the social acceptability of red meat in the individual's reference group. The collection of vectors $\mathbf{K_t}$ can be affected by news, social media, campaigns, food labelling or other information sources, and can for some consumers include misinformation instead of information. Parameter s is the weight of the utility from social identity as a component of overall utility: the more the individual cares about the status that being a member of that group gives them, the higher the s. The weight that the consumer put on the social self s is assumed only indirectly to be influenced by visceral factors through the fact that the weight being placed on hedonic and moral utility depends on visceral factors and that the weights sum to one.

The Moral Self

The third term $m(\mathbf{A_t})[I_{ideal} - \sum_{i=1}^{n}(x_{it} - x_{iideal}(\mathbf{K_t}))^2]$ represents the utility from the self-image of the moral self. In line with self-discrepancy theory (Higgins et al. 1986; Higgins 1987), we assume that the discrepancy between a person's perception of his or her actual self, here defined in relation to actual food consumption, $\mathbf{X_t}$, as opposed to the ideal self, here the ideal food consumption vector $\mathbf{X_{ideal}}(\mathbf{K_t}) = (x_{1idea}\ , x_{2ideal}, \dots, x_{nideal})$, is a cause of negative emotions that decrease utility. Adapting (Brekke et al. 2003), we model the disutility from deviating from the ideal as $-\sum_{i=1}^{n}(x_{it} - x_{iideal}(\mathbf{K_t}))^2$. This functional form is such that the individual's utility from self-image is maximal and equal to I_{ideal} when $x_{it} = x_{iideal}(\mathbf{K})$. I_{ideal} is a parameter measuring the maximum utility that the individual gets from self-image when adhering exactly to his ideal food consumption for all *i*. The higher the discrepancy between actual and ideal consumption, the higher the loss in utility regardless of whether the individual overconsumes or under-consumes the food compared to the ideal. The individual knowledge $\mathbf{K_t}$ of the environmental, health and social impacts of different foods affects the individual ideal vector $\mathbf{X_{ideal}}(\mathbf{K_t})$. The weight of this component of utility is given by parameter $m(\mathbf{A_t})$, which is assumed to be non-negative and to vary across individuals as some individuals will feel the disutility from the discrepancy between their actual and ideal selves more strongly than others. The value of $m(\mathbf{A_t})$ also depends on the intensity of visceral factors, $\mathbf{A_t}$. Following Loewenstein (1996), we assume that as visceral factors intensify, the individual focuses more on their own immediate gratification than on moral considerations.

The Health-concerned Self

The fourth term $\frac{h}{1+r(\mathbf{A_t})}[\sum_{i=1}^{n} n_i(x_{it} - x_{iMIN}(\mathbf{K_t})) - \sum_{i=1}^{n} d_i(x_{it} - x_{iMAX}(\mathbf{K_t}))]$ represents the present value of the utility from eating a healthy diet. Let x_{iMIN} be the minimum perceived recommended intake for food *i* and x_{iMAX} the maximum perceived recommended intake. Note that the individual's beliefs about healthy intakes of food are affected by their level of knowledge $\mathbf{K_t}$ and may not be in line with official dietary guidelines. Some foods will generally have minimum recommended intake x_{iMIN}, for instance fruit and vegetables, others such as red meat a maximum recommended intake x_{iMAX} , some will have both. Vectors $\mathbf{N} = (n_1, \dots, n_n)$ and $\mathbf{D} = (d_1, \dots, d_n)$ contain non-negative, food-specific parameters whose value measures, respectively, the benefit (n_i) per unit of food from consuming food i above the minimum recommended intake $x_{iMIN}(\mathbf{K})$ and the damage (d_i) per unit of food *i* from an intake above the maximum recommended intake $x_{iMAX}(\mathbf{K})$. The value of n_i (d_i) is zero if overconsumption (under-consumption) of food *i* relative to the recommended amount is perceived not to have any health effects. Not all consumers care equally about their health, in that it relates to food consumption, as captured by the non-negative parameter *h*, which varies across individuals. The health impacts of food consumption emerge with a delay in the following periods and individuals differ in the weight they assign to present as opposed to future benefits and costs. This weight is measured by discount rate $r(\mathbf{A_t})$. Following Loewenstein (1996, p. 275), the discount rate is assumed to depend on the intensity of the relevant visceral factors $\mathbf{A_t} = (\alpha_{1t}, \dots, \alpha_{nt})$, so that an intensification of visceral factors tends to produce a collapse of the individual's time perspective towards the present, thus increasing $r(\mathbf{A_t})$.

The Habits-driven Self

The fifth element of the utility function $z\sum_{i=1}^{n}(x_{it} - x_{it-1})^2$, illustrates the disutility of deviating from habitual food consumption, approximated here by the consumption adopted in the previous period, so that food choices are dynamically dependent on each other. This disutility is increasing in the discrepancy between current and past consumption regardless of the direction of the discrepancy. Deviations from habitual behaviour affect the utility of some individuals more than others, as captured by parameter *z*, whose level depends on individuals' characteristics. The weight *z* that the consumer put on habitual behaviour depends only indirectly on visceral factors as they affect the weights placed on hedonic and moral utility. Given that weights sum to one, higher weights on moral and hedonic utility imply a lower weight on the habit-driven as well as on the social-self.

Constraints to Individual Utility Maximization

Individuals' choice of food consumption is constrained by their available income and resources in terms and mental and physical energy. Thus, in the model, individuals maximize their utility subject to an income and an effort constraint. Here we assume that the constraints hold as equalities.[4] The income constraint is given by:

$$p_{1t}x_{1t} + p_{2t}x_{2t} + \ \dots + p_{nt}x_{nt} = M_t, \quad (12.2)$$

where p_i is the price of food item i, x_{it} is its quantity and M_t is the income allocated to food consumption in period *t*. The effort constraint is given by

$$e_{1t}(\mathbf{A_t})x_{1t} + e_{2t}(\mathbf{A_t})x_{2t} + \ \dots + e_{nt}(\mathbf{A_t})x_{nt} = E_t, \ (12.3)$$

where E_t is the total effort or resources available in period *t* for food consumption and e_{it} indicates effort, that is, the time, physical and mental energy required to choose, obtain, prepare and consume one unit of food item *i*. $\mathbf{A_t} = (\alpha_{1t}, \dots, \alpha_{nt})$ is the food-specific level of visceral factors operating at time *t*, as before. Mental effort includes the effort related to the exercise of self-control. It is assumed that visceral factors affect the effort needed to choose certain categories of food differently and, when activated, visceral factors generally tend to increase the self-control and mental effort needed to choose, prepare and consume healthy food, such as broccoli, but have no significant impact on the effort linked with comfort food.

Impact of Price Changes and Moral and Social Identity on Optimal Food Choice

This multiple-self utility function presented previously introduces two sources of heterogeneity in food choice and consumption: heterogeneity across situations encountered by a given consumer and heterogeneity across consumers. The former is owing to changes in the activation of visceral factors that affect how the same consumers choose and consumes food in different situations. The food environment in which consumers make food choices can affect this activation. The second form of heterogeneity is owing to differences in hedonic preferences, key reference groups, different moral beliefs, knowledge about the health impacts of food consumption, sensitivity to various diseases, habits and differences in the weight attributed to these sources of utility. This will affect how sensitive consumers are to changes in food prices.

The Lagrangian for the maximization problem is

$$L = w(\mathbf{A_t})[u_t(\mathbf{X_t}, \mathbf{A_t})] + s\left[I_G - \sum_{i=1}^{n}\left(x_{it} - x_{iG}(\mathbf{K_t})\right)^2\right] + m(\mathbf{A_t})\left[I_{ideal} - \sum_{i=1}^{n}\left(x_{it} - x_{iideal}(\mathbf{K_t})\right)^2\right]$$
$$+ \frac{h}{1+r(\mathbf{A_t})}\left[\sum_{i=1}^{n} n_i\left(x_{it} - x_{iMIN}(\mathbf{K_t})\right) - \sum_{i=1}^{n} d_i\left(x_{it} - x_{iMAX}(\mathbf{K_t})\right)\right] - z\left[\sum_{i=1}^{n}(x_{it} - x_{it-1})^2\right]$$
$$- \lambda_M[p_{1t}x_{1t} + \cdots + p_{nt}x_{nt} - M_t] - \lambda_E[e_{1t}(\mathbf{A_t})x_{1t} + \ldots + e_{nt}(\mathbf{A_t})x_{nt} - E_t], \ (12.4)$$

where the Lagrange multipliers measure the marginal utility of income, λ_M, and effort, λ_E.

This yields the first-order condition for utility maximization for food item *i* at time *t* at given levels of information and knowledge $\mathbf{K_t}$, and of visceral factors **A**.

$$\frac{\partial L}{\partial x_{it}} = w(\mathbf{A_t}) \times \frac{\partial u(\mathbf{X_t}, \mathbf{A_t})}{\partial x_{it}} - 2[s \times |x_{it} - x_{iG}(\mathbf{K})| + m(\mathbf{A_t}) \times |x_{it} - x_{iideal}(\mathbf{K})| + z|x_{it} - x_{it-1}|]$$
$$+ h \times \frac{1}{(1+r(\mathbf{A_t}))(n_i - d_i)} - \lambda_M p_{it} - \lambda_E e_{it}(\mathbf{A_t}) = 0. \ (12.5)$$

To illustrate how the inclusion of moral and social identity in the utility function affects the optimal choice, let us consider two goods (say, vegetables and meat) and focus on the social, moral and hedonic selves only. At the optimum, the marginal rate of substitution between two goods should be equal to the price ratio:

$$\frac{p_{meat,t}}{p_{vegt,t}} = \frac{w(\mathbf{A_t})\frac{\partial u_t(\mathbf{X_t},\mathbf{A_t})}{\partial x_{meat,t}} - 2\left[s\left|x_{meat,t} - x_{G,meat}(\mathbf{K_t})\right| + m(\mathbf{A_t})\left|x_{meat,t} - x_{ideal,meat}(\mathbf{K_t})\right|\right]}{w(\mathbf{A_t})\frac{\partial u_t(\mathbf{X_t},\mathbf{A_t})}{\partial x_{veg,t}} - 2\left[s\left|x_{veg,t} - x_{G,vegt}(\mathbf{K_t})\right| + m(\mathbf{A_t})\left|x_{veg,t} - x_{ideal,veg}(\mathbf{K_t})\right|\right]} \quad (12.6)$$

For a meat-eating consumer who places a high weight on the utility from social identity and thus has a large *s*, the overall marginal utility $\frac{\partial U_t}{\partial x_{meat,t}}$ from consuming meat will be lower if their reference group is vegans rather than flexitarians since for vegans $x_{Gvegan,meat}(\mathbf{K_t}) = 0$ while for flexitarians $x_{Gflexi,meat}(\mathbf{K_t}) > 0$ thus $\left|x_{,meat,t} - x_{Gvegan,meat}(\mathbf{K_t})\right| > \left|x_{,meat,t} - x_{Gflexi,meat}(\mathbf{K_t})\right|$. This implies that the individual with the vegan reference group will have *ceteris paribus* a lower meat consumption. The same argument applies to an individual who places a high weight on moral identity, that is, has a large *m*, and thinks that meat consumption is not morally acceptable, that is, $x_{ideal,meat} = 0$. All other things being equal, their optimal consumption of meat will be lower than that of an individual who does not see meat consumption as morally problematic.

The effect of a change in the price of food *i* can be examined calculating the total derivative $\frac{dx_{it}}{d\, p_{it}}$ from the first-order condition using the implicit function rule. This gives:

$$\frac{dx_{it}}{dp_{it}} = -\frac{\frac{\partial L^2}{\partial x_{it}\partial\, p_{ti}}}{\frac{\partial L^2}{\partial^2 x_{ti}}} = -\frac{-\lambda_M}{w(\mathbf{A_t})\frac{\partial^2 u_{it}(\mathbf{X_t},\mathbf{A_t})}{\partial {x_{it}}^2} - 2[s + m(\mathbf{A_t}) + z] + \frac{h}{1+r(\mathbf{A_t})}(n_i - d_i)} \quad (12.7)$$

Given the assumption that $\frac{\partial U_t}{\partial x_{it}} > 0$ and $\frac{\partial^2 U_t}{\partial x_{it}^2} < 0$ and that $\lambda_M > 0$, the sign of this total derivative is always negative.

Thus, the price elasticity of demand is

$$\varepsilon = \frac{dx_{it}}{dp_{it}} \cdot \frac{p_{it}}{x_{it}} = -\frac{-\lambda_M}{w(\mathbf{A_t})\frac{\partial^2 u_{it}(\mathbf{X_t},\mathbf{A_t})}{\partial {x_{it}}^2} - 2[s + m(\mathbf{A_t}) + z] + \frac{h}{1+r(\mathbf{A_t})}(n_i - d_i)} \cdot \frac{p_{it}}{x_{it}} \quad (12.8)$$

This formulation of price elasticity of demand allows us to better understand differences in the price elasticity of demand among heterogeneous consumers. For consumers, who have the same hedonic utility function and the same weight attached to it, that is, for whom $w(\mathbf{A_t})\frac{\partial^2 u_{it}(\mathbf{X_t},\mathbf{A_t})}{\partial {x_{it}}^2} < 0$ is equal, it applies that those, who also see food consumption as a source of other forms of utility, such as utility from habitual behaviour, self-image and social identity, will be less reactive to changes in prices. That is, they will have a lower $\frac{dx_{it}}{dp_{it}}$ since the denominator of (12.8) will be larger as $-2[s + m(\mathbf{A_t}) + z] + \frac{h}{1+r(\mathbf{A_t})}(n_i - d_i)$ is also negative. The higher the marginal utility of income λ_M, the higher the sensitivity to taxes.

DATA REQUIREMENTS FOR THE ESTIMATION OF THE MODEL

To design appropriate food taxes with the joint aim of obtaining healthy and climate-friendly diet, we need to be able to allow for observed socio-demographic heterogeneity between consumers (for example, education and income) and for the heterogeneity arising owing to the complex factors determining especially climate-friendly consumption (for example, taste, social identity and moral values). This will impose new requirements on the data used for these analyses.

First, to obtain reliable estimates of the effect of food taxes we need observed data on purchasing behaviour, as there exists a discrepancy between consumers' declaration of positive environmental attitudes and intentions to reduce their climate impacts, and their actual behaviour (Moser 2016; Sarti et al. 2018; ElHaffar et al. 2020). This is also in line with Grunert et al. (2014) who find that respondents expressed relatively high levels of concern about sustainability issues at an abstract level, but lower levels of concern in the context of concrete food choices. This attitude–behaviour gap is especially important when we consider the consumption of food with strong public-good traits. Second, it is necessary that the data we use contain information on prices as well as the content of nutrients together with climatic indicators if we want to model the consumers' trade-off between these two characteristics. Finally, since climate-friendly and healthy food consumption depends on a range of complex factors, we need to be able to combine observed data on consumers' purchases with survey data that can give us information about these factors.

Household scanner data[5] offer the possibility to conduct analyses at the required granular level, but are not free from selection and desirability bias, since people might be influenced by their participation in the panel. Those who choose to participate in home-scan panels (or similar) may also be different from the general population, and for data obtained from private sources the recruitment process may be uncertain (Zhen et al. 2009; Lusk and Brooks 2011; Muth et al. 2019). Furthermore, as the data are at household level, no information is given about the distribution within the household and there is no information about food waste. Both issues will veil the relationship between purchase and intake (Muth et al. 2019). Despite this, there are some evident advantages of household scanner data in respect of analysing the consumption of jointly healthy and climate-friendly foods. The first advantage is that, in most cases, the data contain repeated observations of expenditures and purchase volumes for a considerable number of households, which allows the analysis of changes over time and, thereby, to include the effect of habits. Another advantage is that the data are often at barcode level, where the barcodes represent a unique manufacturer, brand, product, flavour and size of a product. This level of detail makes it possible to link the data with nutritional information from, for example, label data or official dietary composition databases. This approach has been used extensively in food policy and public health nutrition research (Bandy et al. 2019; Muth et al. 2019). A less explored possibility is to link the purchase data with environmental and climate data. Data on the environmental and climate effects of various food items can be obtained through, for example, life cycle analysis (LCA) that examines, among other things, foods' carbon footprint that occur during the entire lifetime of a product from production over usage to disposal (or consumption). There exist a number of databases that compile data on the climate impact of food on the global market, for example, the World Food LCA database (Nemecek et al. 2014) and the Agri-footprint database (Durlinger et al. 2017), and there are several initiatives to standardize the calculation of the climate impact of foods (British Standards Institution 2011, 2012; De Camillis et al. 2012; European Commission 2018). The International Organization for Standardization (ISO) 14067 standardization program provides a guide on how to calculate the emissions from foods. The combination of household scanner data with nutrition composition and climate data has already been used in the analysis of the joint effects of food taxes on health and sustainability of diets in recent papers (Bonnet et al. 2018; Dogbe and Gil 2018; Revoredo-Giha et al. 2018; Caillavet et al. 2019).

Household scanner data often also contain socio-demographic information about the panel members, such as age, household composition, and education. However, several studies confirm that socio-demographic characteristics are not sufficient to explain sustainable consumption (Verain et al. 2012; Sarti et al. 2018). Therefore, we should include information about the respondents' food-related knowledge and beliefs, their perception about the moral correct food consumption and of their reference group, as well as how they weight habits, health, social identity, self-image and taste in future studies describing the effect of food taxes on health and sustainability. To obtain this type of data, we need to combine observed purchase data with surveys issued to the panel members. This approach of using survey data to extract some of the complex factors affecting food demand and, thereafter, analyse consumers' responsiveness to food taxes including these, would represent a promising new avenue for designing effective food taxes.

DISCUSSION

In the previous sections, we showed how factors such as moral self-image, social-identity, health considerations, habits and tastes can be integrated in the utility function and how they affect demand. We also showed that it is possible to illustrate the effects of these factors on the reactivity of the quantity demanded of a given food to changes in its price. When consumers have the same hedonic preferences and place the same weight on the hedonic component of utility, those who care more about social identity, self-image, health and habitual behaviour will be less sensitive to price changes. In most instances, consumers do not have the same hedonic preferences, and the model therefore suggests that to understand climate-friendly and healthy food consumption and to design effective food taxes, we need to estimate the weights that the consumer places on these factors. We also need to better understand which diets consumers perceive as their moral ideal, as the social norms of their key reference groups and as healthy. Current price elasticity of demand estimates implicitly include the impact of these different selves at an average level. Understanding individual utility as the product of the interaction of these multiple selves, allow us to better understand variations of elasticity around this average. Consider for instance, an individual who identifies as male. Several studies note the association of meat consumption with male identity (for example, Rozin et al. 2012; Rothgerber 2013). Owing to this association, making maleness salient will probably reduce the price elasticity of meat for individuals who want to identify with this stereotype of maleness, as increased saliency would increase s.

Understanding the interplay of different selves can thus help to explain the stickiness of food taxes in respect of behavioural change for specific groups, or give scope for interventions that are not price based in a situation in which price increases sufficient for significant change are not possible.

This knowledge will also allow us to better predict which consumers will be affected by what type of instruments. For example, consumers who do not care a great deal about health issues, self-image or social identity, but who are very habitual or weigh the hedonic properties of food heavily, might be affected by food taxes, but not by other types of instruments, since the important utility components of those individuals are not directly affected by information provision. This occurs despite the habitual consumer tending to be less sensitive to price changes. Consumers who have a strong social identity, everything else equal, will be less sensitive to price changes but more sensitive to manipulations of the food environment that affect the individual's perception of the dietary norm of their relevant reference groups. Consumers that care about self-image will be affected more by information provision when this is used jointly with moral persuasion. In this instance, campaigns will be more effective if they not only inform about the GHG-emission intensity of different foods (thereby affecting the individual's ideal vector $X_{ideal}(K)$), but also activate the weight m given to self-image, by stressing individual responsibility in curbing consumption-related GHG-emissions.

Furthermore, the estimated weights and the related elements of consumers' utility need to be examined in their interplay with the income and effort constraints, since constant preoccupation with limited income and time and subjects to demands on mental effort will deplete those individuals' cognitive resources needed to guide behaviour (see, for example, Mani et al. 2013; Shah et al. 2018). This overburdening may significantly affect the initiation and success of dietary change by, among other things, affecting the reactivity to taxes. Finally, lack of practical knowledge of how to cook and choose a more climate-friendly diet constitutes a barrier to a shift towards more sustainable eating (see, for example, Graça et al. 2019; Smiglak-Krajewska and Wojciechowska-Solis 2021) thus making sticking to habitual food choices more likely. Informational campaigns that help consumers to learn how to prepare climate-friendly meals may thus increase the consumption of these meals by reducing the associated effort. Environmental and health labels can also decrease effort by reducing the search costs of finding healthy and climate-friendly foods, but the information provided should be easy to see and understand for it to be effective (see Hersey et al. 2013). There can also be secondary effects of these information tools, which are often at least as important as the primary effects of better individual choices, including impacts on social norms which will affect demand (Reisch et al. 2013).

CONCLUSIONS

Until now the focus of interventions ensuring healthy and climate-friendly food consumption has mainly been on the individual. Most approaches have aimed at encouraging individuals to change voluntarily by relying on information provision, moral persuasion and nudges. These instruments have proven not to be sufficient, and several bodies now argue that the context of consumption needs reshaping and advocate for the use of more hard-policy measures, such as food taxes and subsidies. However, as a healthy diet will not necessarily arrive as a co-benefit of taxes aimed at reducing GHG-emission, both goals need to be targeted explicitly when designing food taxes. This might lead to substantial price increases for many food products. Too little is known about the impact on utility, and thereby demand, of the factors that drive climate-friendly food consumption. To design taxes that effectively address both health and climate-friendly food consumption in the most efficient way, we need to know more. We need to estimate the weights that consumers place on hedonic properties of food, on habits, health and moral identity, as well as social identity. Furthermore, we need to understand which diets consumers perceive as to be healthy and as their moral ideal, as well as what are the food related social norms of their key reference groups, since these factors will affect how sensitive consumers are to changes in food prices.

Food taxes and subsidies, however, will seldom be sufficient as the only instrument. An important reason for this is that educational and informational efforts to change consumer behaviour might be a necessary precursor to strong interventions owing to substantial barriers to implementing hard regulatory measures. Another reason is that food taxes and information affect consumers differently and often the instruments will be interrelated. So, in order to design an efficient system of taxes and subsidies, supplemented with information provision and other soft instruments, such as nudges, we need to understand the motivations behind consumers demand for climate-friendly food consumption and how they weight difference sources of utility from food consumption. If we want to use food taxes to target a specific reference group if the group is sticky as regards behavioural change, then the model will help to explain this stickiness. Also, understanding peer pressure will give scope for interventions that are not price based in situations in which price increases sufficient for change are not possible. Making salient the moral self may affect price sensitivity, by helping to understand the interplay between food taxes and other instruments in the presence of a heterogeneous group.

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[1] Characteristics that are impossible to evaluate even after consumption are credence goods (for example, Ford et al. 1988).

[2] This model develops an earlier model presented in Lombardini and Lankoski (2011).

[3] Although we assume only positive reference groups, the model could easily be extended to include dissociative (that is, negative) reference groups, that is, groups an individual does not

want to be associated with. Note also that we assume only one reference group even though in reality individuals can identify with different groups.

[4] Note that, for simplicity in these constraints, there is no subscript for the specific individual. Please read each constraint as specific to an individual

[5] We refer to household scanner data, but data might be obtained through other channels too. The key is to combine highly detailed consumption data with nutrition and GHG-emission information, and with survey data.