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## **The Economics of Diet and Obesity: Public Policy**

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### **Summary and Keywords**

The rise in obesity and other food-related chronic diseases has prompted public-health officials of local communities, national governments, and international institutions to pay attention to the regulation of food supply and consumer behavior. A wide range of policy interventions has been proposed and tested since the early 21st century in various countries. The most prominent are food taxation, health education, nutritional labeling, behavioral interventions at point-of-decision, advertising, and regulations of food quality and trade. While the standard neoclassical approach to consumer rationality provides limited arguments in favor of public regulations, the recent development of behavioral economics research extends the scope of regulation to many marketing practices of the food industry. In addition, behavioral economics provides arguments in favor of taxation, easy-to-use front-of-pack labels, and the use of nudges for altering consumer choices. A selective but careful review of the empirical literature on taxation, labeling, and nudges suggests that a policy mixing these tools may produce some health benefits. More specifically, soft-drink taxation, front-of-pack labeling policies, regulations of marketing practices, and eating nudges based on affect or behavior manipulations are often effective methods for reducing unhealthy eating.

The economic research faces important challenges. First, the lack of a proper control group and exogenous sources of variations in policy variables make evaluation very difficult. Identification is challenging as well, with data covering short time periods over which markets are observed around slowly moving equilibrium. In addition, truly exogenous supply or demand shocks are rare events. Second, structural models of consumer choices cannot provide accurate assessment of the welfare benefits of public policies because they consider perfectly rational agents and often ignore the dynamic aspects of food decisions, especially consumer concerns over health. Being able to obtain better welfare evaluation of policies is a priority. Third, there is a lack of research on the food industry response to public policies. Some studies implement empirical industrial organization models to infer the industry strategic reactions from market data. A fruitful

avenue is to extend this approach to analyze other key dimensions of industrial strategies, especially decisions regarding the nutritional quality of food. Finally, the implementation of nutritional policies yields systemic consequences that may be underestimated. They give rise to conflicts between public health and trade objectives and alter the business models of the food sector. This may greatly limit the external validity of ex-ante empirical approaches. Future works may benefit from household-, firm-, and product-level data collected in rapidly developing economies where food markets are characterized by rapid transitions, the supply is often more volatile, and exogenous shocks occur more frequently.

Keywords: food, nutrition, obesity, public policy, consumer behavior, tax, nutritional labels, food quality, food industry, marketing, regulation, trade agreements, health economics

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## Diet-Related Diseases and Public Policies: Rationales for Interventions

Worldwide in 2016, more than 1.9 billion adults and 340 million children and adolescents were overweight or obese (World Health Organization, 2018). The rise in obesity and other diet-related chronic diseases has prompted public-health officials of local communities, national governments, and international institutions to pay attention to the regulation of food supply and consumer behavior. There are heated debates between stakeholders (e.g., consumer associations, food companies, healthcare professionals, policymakers) on the normative rationales and the effects of food taxation or simplified front-of-pack labeling. Academic economic research can help to resolve disputes about the justification and effectiveness of such interventions by testing the validity of normative rationales for market regulations, and by providing ex-ante and ex-post empirical evaluations of policies. This article reviews scientific advances and research challenges around four policy targets: food prices (i.e., tax and subsidies), consumer information, the consumer choice environment, and the quality of food supply.

Before reviewing the research on diet and obesity policies, it is important to present the various normative rationales for public intervention. The neoclassical model of consumer choice provides a reference normative standard for judging the relevance of public policy. Neoclassical consumers have two key motivations: the maximization of immediate satisfaction from eating, at the lowest cost in terms of time and money, and eating in a way that is likely to preserve their health capital. Immediate pleasures and costs are weighted against future rewards and pain via a discount factor, so that behaviors are time-consistent.<sup>1</sup> Some individuals will prefer junk food to fruits and vegetables, up to the point where the marginal satisfaction of eating junk food is equal to the discounted marginal dissatisfaction of worse future health or larger body sizes. If individuals eat unhealthy food and their health deteriorates, the value of weight- and diet-control behavior increases, which raises the demand for exercise, functional food, and dieticians. In this setup, obesity and other diet-related diseases are private problems and, a priori, the market will be efficient at supplying health inputs, whether they be junk food or diets.

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A natural implication of neoclassical models is that nutritional policies can only be justified by market failures, like imperfect information, externalities, and moral hazard.

Yet, consumers are often misinformed and misguided about the exact nutritional content of processed food or they possess nutritional knowledge that is limited in light of the technical complexity of the food-health relationship. This situation produces a role for information policies that respect the neoclassical principle of so-called consumer sovereignty. Information policies can be sorted into three categories of action: health education,<sup>2</sup> which takes the form of public-information campaigns and nutritional education, the nutritional labeling of food products and restaurant menus, and advertising regulation.

Part of the medical care costs of obesity are supported by public health insurance, particularly in countries with well-developed welfare states.<sup>3</sup> A meta-analysis of the direct healthcare overspending related to obesity for public and private insurers in France, Italy, Japan, the United States, the United Kingdom, and Switzerland revealed that it represented at least 0.7% to 2.8% of these countries' total healthcare expenditures (Withrow & Alter, 2011).<sup>4</sup> These costs rise steadily with the increase in the prevalence of obesity, the aging of the population, and medical advances. This is likely to impose a heavy burden on the funding of health systems in developed countries and, more importantly, in emerging countries (see Wang, McPherson, Marsh, Gortmaker, & Brown, 2011, for the United States and Rtveladze et al., 2013, for Brazil).<sup>5</sup> To assess the overall volume of externalities produced by the food market, one has to weigh these healthcare costs against the benefits that "unhealthy eating" generates, in terms of jobs and profits in the food sector and fiscal revenues for governments. Corrective taxes may help internalize the economic burden of externalities.

When individuals are covered by public health insurance, an ex ante moral hazard problem arises as the consequence of the inability of public insurance to charge individuals fairly.<sup>6</sup> Taxing unhealthy food or subsidizing healthy food can be welfare-enhancing when the prepolicy welfare cost, which is only due to moral hazard on the insurance market, is higher than the postpolicy welfare cost, which is the sum of the residual costs of ex ante moral hazard and consumer losses due to prices differing from marginal costs (Arnott & Stiglitz, 1986).

The neoclassical framework is grounded on the assumption that consumers do not make systematic errors, which notably requires that their preferences are independent from changes in their environment. This assumption has been invalidated by a large literature in experimental economics, marketing, and psychology of food choices, which has evidenced several perceptual, affective, and cognitive mechanisms through which context-specific factors *systematically* affect what consumers eat and how much they eat. This literature demonstrates the impact of food marketing on consumer choices, while the most recent advances on the neurobiological and physiological consequences of nutritional intake show how biased food choices shape likes and needs (Berthoud, 2012; Chandon & Wansink, 2011; Morton, Meek, & Schwartz, 2014). If consumers are subject to

behavioral biases, then food decisions made by consumers in the present have negative effects on themselves in the future; that is, unhealthy foods generate “internalities” (Herrnstein, Loewenstein, Prelec, & Vaughan, 1993; O’Donoghue & Rabin, 2006). Taxes may directly increase consumers’ welfare by helping them to adopt behaviors that would be more consistent with their “true” preferences. In addition, governments and public health advocates have been interested in the use of behavioral biases for designing interventions, coined “nudges,” based on modifications of the choice environment that do not restrict the consumer choice set (Camerer, Issacharoff, Loewenstein, O’Donoghue, & Rabin, 2003; Thaler & Sunstein, 2003; Thaler & Sunstein, 2009).<sup>7</sup> As argued by Mancino, Guthrie, and Just (2018), nudges on point-of-purchase combined with targeted subsidy policies may specifically benefit low-income people. In contrast, tax policies have been criticized for their potential regressivity, as low-income households spend larger budget shares on unhealthy food (Muller, Lacroix, Lusk, & Ruffieux, 2017).

This general normative framework provides rationales for tax-based policies and a variety of nonprice interventions targeting consumers. With this in mind, the next section reviews the research on food taxation.<sup>8</sup> It discusses the optimal design of taxes and the available empirical evidence and highlights some important challenges for modeling and identification of policy effects. This discussion is followed by an examination of the research on health education, nutritional labeling, behavioral interventions, and advertising restrictions. Interestingly, most studies are experimental, and there is a clear need for “real-world” studies with credible identification strategies. The last section aims at opening a new research agenda for health economists and others. The earlier sections discuss the potential responses of firms to public policies, but section “THE NUTRITIONAL QUALITY OF FOOD SUPPLY” focuses directly on firms’ strategic choice of food quality. It examines the potential interactions with governments’ interventions on quality standards and with trade policies. Although the theoretical and empirical literature is limited, changing food supplies may perhaps hold greater promise than interventions that target consumer behavior. The conclusion summarizes the main research challenges that have been identified and emphasizes that the rapid transitions of food systems in emerging and developing countries provide great opportunities for research.

## Food Taxation

Junk food taxation was popularized in a *New York Times* op-ed in 1994, when writer Kelly Brownell proposed that the tax revenues be earmarked for subsidizing healthier foods and nutrition-education programs.<sup>9</sup> Since then, the public-health sector has seen taxes and subsidies on nutrients or foods as an effective tool to address the rise of diet-related chronic diseases. More recently, several countries and jurisdictions have introduced excise taxes motivated by nutritional objectives. For instance, between 2009 and 2014, Denmark had an excise tax on sugar-sweetened beverages (SSB) and juices with sugar content higher than 0.5g/100 ml. In 2012 France implemented a uniform unit excise tax

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on SSBs, which was modified in 2018 to make it progressively increasing with the sugar content of beverages. Chile has an excise tax on SSBs with more than 6.25 grams of sugar per 100 ml. Mexico has had an excise tax on nonalcoholic beverages with added sugar since January 1, 2014, as well as taxes on calorie-dense unhealthy food. Hungary has nutritional excise taxes targeting a wide range of beverage and food products with high fat, sugar, or salt content. The U.S. cities of Berkeley, California, and Philadelphia, Pennsylvania, have implemented specific taxes on SSBs.

### Design and Implementation of Nutritional Taxes

From a standard neoclassical perspective, corrective taxes can be used to reduce the burden of externalities generated by the consumption of unhealthy food. Optimal taxation theory then suggests that taxation should vary from one product to another, as an increasing function of the marginal externality generated by each product (Sandmo, 1975). This raises two practical issues. First, governments often lack scientific evidence about the health externalities produced by the consumption of specific foods. This may explain why it has been easier to target sugar-sweetened beverages or specific nutrients such as salt or trans fats, for which the scientific research has high-level evidence. Second, it is easier for practical reasons to target broad food categories, but some are heterogeneous in terms of nutritional quality (e.g., the ready meals). In this case, the optimal tax rate must increase with the average marginal externalities of the products in the category. It should be higher if the consumers with higher marginal externalities are more price-sensitive (Diamond, 1973).

The second rationale for nutritional taxes is the correction of rationality biases. A small theoretical literature has investigated the question of optimal taxation when consumers do not follow neoclassical rationality. The theory of optimal taxation is similar to that for externalities (Haavio & Kotakorpi, 2011). However, the main difficulty lies in the measurement of the marginal internalities generated by food products or nutrients; that is, the welfare losses generated by rationality biases. Griffith, O'Connell, and Smith (2017A) discussed the articulation of efficiency and equity concerns, as food taxes are likely to disproportionately affect low-income households. We may imagine that individuals with high consumption of unhealthy food face strong adjustment costs in food habits (addiction) or are less attentive to price changes. They thus have larger marginal internalities and are less price-responsive. In that case, the optimal tax rate should be smaller in order to avoid harming their welfare, but this also reduces the effectiveness of the tax. However, the tax revenues may be earmarked for policies targeting specifically these consumers—for instance, subsidizing healthy school lunches in disadvantaged areas. Such a policy has the potential to limit the regressivity of a tax while increasing its long-term benefits for the population at risk.

The practical design and implementation of nutritional taxes raises interrelated empirical and legal issues. Designing a nutritional tax requires that the range of products to which it applies, as well as its magnitude, be appropriately defined as a function of its intended effect. In most jurisdictions, a tax would have to be motivated either by public finance

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rationales or by public health rationales. The jurisdiction would often face legal challenges regarding its compliance with international trade laws and multilateral agreements, such as EU internal market laws for EU country members, or World Trade Organization Laws. A tax can be framed as a behavioral measure of consumer protection and public health promotion if it respects a proportionality principle. The proportionality test applied by the Court of Justice of the EU examined (1) whether the public health goal is legitimate and the measure is appropriate and necessary or (2) whether there is no better alternative in terms of cost-effectiveness, where the computation of the cost should include consumer welfare losses. In addition, the design of the tax has to be origin-neutral; that is, the tax must not lead to protecting domestic products that are similar to foreign taxed products in terms of nutritional characteristics (Alemanno & Garde, 2013, 2015). Given these legal constraints, the design of tax policies can greatly benefit from empirical economic studies identifying the relevant market for the products that are targeted, and evaluating ex-ante the potential effect of the tax on prices, consumer welfare, consumption, and health. These legal constraints also explain why most nutritional taxes have targeted SSBs. First, epidemiological analyses clearly show that high SSB consumption is associated with greater risks of obesity and diabetes, especially for children (Malik, Pan, Willett, & Hu, 2013). Second, the expected health and consumption impact of SSB taxes are clearly documented by epidemiological and economic studies. In particular, most SSBs contain little or no essential vitamins or minerals, so reducing their consumption has no negative consequences for health. Finally, the market for SSB products is clearly delineated.

### What We Know About the Effectiveness of Taxation Policies

A number of empirical ex-ante evaluation studies have provided simulation results based on estimation of price elasticities and assuming a one-to-one pass-through of the tax onto consumer prices. The induced variations in consumer choices are sometimes used as inputs in epidemiological models to provide evaluations of gains in terms of population health (e.g., the number of deaths avoided or life-years saved or the expected weight loss for average consumers (see, for instance, Mytton, Gray, Rayner, & Rutter, 2007). Good economic studies rely on estimates of complete structural demand systems, which helps account for substitution effects and better identification of unintended effects and variations in consumer welfare (Lusk & Schroeter, 2011; Miao, Beghin, & Jensen, 2013). For instance, Allais, Bertail, and Nichèle (2010) estimated a demand system in French household data, and simulated the effect of a 10% ad valorem tax on energy-dense food categories (cheese, butter, cream, sugar-fat products, and ready meals). They found that the tax would have a small effect, producing a slight reduction in body weight (-4%) and modest and regressive losses in household consumer welfare, but potential negative consequences in terms of micronutrient intakes (most vitamins and minerals). Using U.S. data, Harding and Lovenheim (2017) compared the impact of a tax on high-fat, sugar, and salt products to a tax applied directly to nutrients. Since a given food category often includes products of varying nutritional quality, they divided each food category in two or three clusters of distinct nutritional quality. Their demand system thus allowed for within-

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category consumer substitutions from lower quality products to higher quality products. Their estimation and simulation results suggest that nutrient-specific taxes have a larger impact on nutrition and are less regressive than product-specific taxes.

SSB taxes are certainly the most studied, both from an ex-ante and from an ex-post perspective. For instance, Fletcher, Frisvold, and Tefft (2010A, 2010B) have exploited variations in soft-drink taxes across states and time in the United States to identify the impact of changes in taxes on variations in soft-drink consumption and obesity. For children, soft-drink taxes have no impact on total calories from beverages because they substitute toward milk. The tax elasticity of adult body mass index is significant but very small in magnitude. However, this study does not document the effects of the tax on nutrients on sugar and fat, whose intakes are associated to different pathologies and levels of risks. Another limit of this study is that the observed tax variations are very small, so that they are unlikely to move consumers away from their body weight and consumption habit equilibrium point. Small tax changes may not even be perceived on point-of-purchases. As noted by Bhargava and Loewenstein (2015), the impact of a new tax “may depend not only on the underlying demand elasticity, but on the salience, complexity, nominal incidence, and framing” (p. 398).

Most ex-ante evaluation studies assume away any reaction on the supply side so that the tax is perfectly transmitted onto consumer prices (see, for instance, Zhen, Finkelstein, Nonnemaker, Karns, & Todd, 2013; Finkelstein et al., 2013; Sharma, Etilé, & Sinha, 2014). A few articles have challenged this assumption by using empirical industrial organization (IO) techniques. For instance, Bonnet and Réquillart (2013) estimated a mixed multinomial logit of demand for SSB varieties in the French soft-drink market. They used the estimated demand elasticities to calibrate a supply-side model of price setting that accounted for vertical relationships between retailers and producers. They were then able to simulate the impact of both an excise and an ad valorem SSB tax on the market equilibrium. Both types of taxes produced substitutions toward diet soft-drink varieties and naturally sweetened beverages. But the excise tax was more effective than the ad valorem for the same tax revenues because the pass-through varied from 110% to 130% for the excise tax against 60% to 90% for the ad valorem tax. Recent ex-post analyses of soft-drink tax incidence, however, have suggested that one should be cautious with these simulation results. Cawley and Frisvold (2017) identified the pass-through of the Berkeley, California, soda tax by comparing local trends in soft-drink prices to those observed in San Francisco at the same period. The tax was proposed in a referendum at about the same time in both cities and failed in San Francisco. A difference-in-difference strategy indicates that the pass-through is very low, around 40%. Etilé, Lecocq, and Boizot-Szantai (2018) found a similar pass-through of 40% in an ex-post evaluation study of the tax incidence of the French soda tax (0.07 Euro/L) that was implemented on the January 1, 2012. The study used Kantar homescan data, a before-after design, and a theoretically founded price index that measured the variations in consumer welfare from SSB consumption across time and local markets. They showed that local markets with high-competition between retailers had lower pass-through, while the pass-through was higher in low-income areas where the prices and thus margins were initially lower. An ex-

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post study of the Mexican SSB tax (1 peso/L) find a pass-through higher than 100% with a before-after design that carefully controlled for month and product fixed effects (Colchero et al., 2015).

A first lesson of this small literature is perhaps that the pass-through rate of nutritional taxes is likely to vary from one jurisdiction to another, depending on the market structure (relevant market, size, and competition) and the characteristics of the demand (price elasticities). A second lesson is that one has to be very cautious with ex-ante simulation results, even when they are based on structural models that take into account suppliers' strategic reactions. The key problem is that they identify the parameters of the demand and supply curves by using small exogenous variations in prices (at best) and shocks that are unrelated to the political dynamics of nutritional policies. Hence, their external validity is likely to be low because the adoption of nutritional taxes means much more than a marginal change in economic incentives. It is a shift in the regulatory landscape that leads companies to revise their long-term strategies in terms of marketing, product formulation, and brand portfolio (e.g., see the innovations in the soft-drink sector or the multinational Danone selling its portfolio of baked goods). In addition, nutritional taxes also have a signaling value regarding the quality of targeted products. They can encourage people to reassess the healthiness of products and therefore contribute to the denormalization of targeted products (Hawkes et al., 2015).

### Some Key Research Issues

Results from the empirical literature are generally based on estimates of demand equations either for quantity of broad product categories or for varieties of products within a category. The empirical specifications are often derived from well-defined utility functions, and the estimation results can therefore be used to recover consumer preferences from the data and to simulate the exact variations in consumer welfare associated to taxation or subsidy schemes. The most commonly used models of demand for quantities include the Quadratic Almost Ideal Demand System (Banks, Blundell, & Lewbel, 1997) and the Exact Affine Stone Index system (Lewbel & Pendakur, 2009). They can answer questions such as, "Will the aggregate consumption of snacks increase if the price of soft drinks increases?" (Zhen et al., 2013). Systems of demand for quantities are appropriate for studying substitutions between broad product categories. The food classification can be somewhat refined to account for the clustering of products into food categories of different nutritional quality or processing intensity (see Harding & Lovenheim, 2017). However, increasing the number of product categories to control for product heterogeneity implies that the mass of consumers not consuming certain foods will become large and cause inference problems. Models of demand for product varieties specifically focus on product heterogeneity by specifying individual choices between product varieties as a function of the relative marginal utility of product characteristics. They can answer questions such as, "Will consumers switch to light soft drinks if the price of regular soft drinks increases?" (Bonnet & Réquillart, 2013). They account for decisions not to consume a product variety in the consumer choice set by defining an outside option, which is forced to be a price substitute and defines the market

boundaries. This choice constrains the inference of quantity effects. For instance, in a study on SSBs, if naturally sweetened fruit juices are taken as the outside option then a decrease in the consumption of SSBs can only be explained by substitutions toward fruit juices, not toward alcoholic beverages or milk. Future researchers should more systematically investigate consumer choices over both food quantities and product quality. Consumer scanner data provide rich sources of information on these two dimensions of purchase decisions. A number of utility-based structural models have been proposed to extend discrete-choice models to quantity choices and purchase of several products (see, for an introduction, Chintagunta & Nair, 2011).

The empirical identification of price effects also raises important concerns. Most ex-ante evaluation studies simulate very large price increases (+20% seems to be a focal point), which seldom correspond to the observed variations that are leveraged to identify the models. More important, variations in prices across market and time depend on the demand through two channels. First, there is the classic supply-demand simultaneity. If demand increases and supply capacities are limited then prices are likely to rise, and the empirical price-quantity relationship identifies the supply curve rather than the demand curve (Stigler, 1954). Second, empirical IO studies have outlined that producers and retailers are likely to strategically set their prices as a function of consumer taste for unobserved product attributes (e.g., promotion, display, or advertising; see Akerberg, Benkard, Berry, & Pakes, 2007; Nevo, 2011). Finding good and credible instrumental variables is challenging.

Understanding the impact of prices on the entire distribution of food or nutrient intakes is also crucial for identifying the health benefits of policies, as the latter aims to reduce the consumption of unhealthy food by heavy consumers and increasing the consumption of healthy food by light consumers (e.g., having fewer individuals consuming large quantities of soft drinks rather than more individuals consuming no soft drinks). The difficulty is that utility-based demand systems are estimated by exploiting moment conditions for average consumption, such as conditional expected quantities or market shares. Various techniques can be applied to go beyond averages. Ayyagari, Deb, Fletcher, Gallo, and Sindelar (2013) applied finite mixture models to explore the heterogeneity in price responsiveness of U.S. alcohol consumers. They found that the class of heavy consumers is less price responsive as compared with light consumers. Etilé and Sharma (2015) and Sharma et al. (2016) used finite mixture modeling and quantile analyses, respectively, to analyze the purchases of soft drinks and alcohol in Australian scanner data. They showed that the price-quantity relationship varies along the distribution. Although heavy beverage consumers are relatively less elastic to prices, their purchases are more price-sensitive, so that the expected health impacts of price variations are expected to be larger. While these studies used reduced form demand models, Bertail and Caillavet (2008) estimated a finite mixture Almost Ideal Demand System to describe the fruit and vegetable demand patterns of French households. They identified a class of low-income consumers that was insensitive to price changes and therefore less likely to benefit from policies that would reduce the prices of fruits and vegetables. More empirical studies are definitely required to identify the price

responsiveness of populations that are economically disadvantaged or incurs higher nutritional risks.

Finally, various mechanisms sustain habit formation in food consumption: brand commitment, purchase routines, metabolic constraints on calorie intake, and neurological constraints on preferences for sugar and fat. Habit formation implies that the short-term effect of tax will amplify over time, which has important consequences for cost-benefit evaluation. A means of accounting for habit formation is to reformulate the prices and budget constraints so that they reflect the implicit constraints produced by past decisions. Increasing past consumption lowers the marginal utility of current consumption, which is equivalent to a rise in full price (Muellbauer & Pashardes, 1992; Pashardes, 1986; Spinnewyn, 1981). Zhen, Wohlgenant, Karns, and Kaufman (2011) applied this approach to the demand for nine nonalcoholic beverages in the United States. However, their results are questionable, as they suggest that habit persistence would be stronger for lowfat milk or diet sodas than for regular sodas. The identification of habit formation effects is actually very difficult, because the intertemporal correlation of choices can also be explained by unobserved fixed effects or by an autocorrelation in time-varying unobserved factors and misspecification errors can easily produce spurious results (Auld & Grootendorst, 2004). The literature on dynamic panel data models had developed various empirical strategies to deal with these concerns, but recent econometric work has questioned their performance (Blundell, Bond, & Windmeijer, 2001; Bun & Windmeijer, 2010). This opens large avenues for future empirical research.

## Nonprice Interventions Targeting Consumer Behavior

Nonprice interventions are essentially predicated on the observations that consumers lack information on the health quality of products and the health consequences of their choices, that their choices are context-dependent, and that their food preferences are partly shaped by marketing. Following the conceptual framework proposed by Hawkes et al. (2015), these interventions aim at providing an environment for “learning of healthy preferences” (p. 2410) and at encouraging people to “reassess existing unhealthy preferences” (p. 2410).

### Health Education

With respect to health education, economists have mainly focused their attention on public-information campaigns that aim to inform consumers about the generic health consequences of their food choices. In the neoclassical perspective, this is justified by the requirement that consumers be perfectly informed to effectively maximize their well-being, whatever the healthiness of the diet they choose. Food companies have few incentives to provide generic information to consumers, as they will have to share the potential benefits. However, business unions of specific food sectors may implement

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coordinated information strategies that can benefit public health—for example, the fruit and vegetable sectors promoting official dietary guidelines for fruits and vegetables.

The ex-post identification of the causal impact of information campaigns is notoriously difficult because the campaigns seldom target randomly chosen populations. Earlier empirical work examined the impact of cholesterol risk information on animal product consumption (Brown & Schrader, 1990; Chern, Loehman, & Yen, 1995; Chern & Ryckertsen, 2003). Information indices were constructed from counts of Medline or newspaper publications about the link between cholesterol and heart disease (one would now use “Google trends” counts). They were then introduced as covariates in the demand model. Identification relied exclusively on time variations and on untestable assumptions regarding the time trends in other unobserved factors. In addition, time-varying information indices can be correlated with consumer choices, and not only because they enhance their health knowledge. Changing consumer choices may trigger variations in information supply and, at a deeper level, variations in the informational environment are likely related to broader shifts in social norms—first in the more educated and better-off social groups, and then by contagion through the rest of society.

Subsequent works went one step further by exploiting individual data providing information on consumer knowledge and awareness (often about cholesterol). Studies found positive correlations between these variables and the propensity to diets low in cholesterol (Variyam, Blaylock, & Smallwood, 1996). The involvement of women in meal planning explains why mothers’ nutritional knowledge is also positively correlated with children’s dietary intake (Variyam, Blaylock, Lin, Ralston, & Smallwood, 1999). Kan and Tsai (2004) focused on the knowledge-BMI relationship. Their quantile regression results showed that more knowledge leads to a higher BMI for men who are neither overweight nor obese. The effect becomes significantly negative only in obese men. These results illustrate the difficulty of identifying causal information effects. Weight gains are likely to prompt individuals to become more aware of the diet-health relationship. Identification requires that the endogeneity of information, knowledge, or awareness is treated via the use of plausible identifying assumptions. It is difficult to find credible instrumental variables for these factors; that is, shocks that are uncorrelated with food choices even though while they strongly affect the search for information and the formation of knowledge (Park & Davis, 2001).<sup>10</sup> The only way to evaluate the benefits of information policies is eventually to use changes in information supply like public information campaigns. There has been very little ex-post evaluation of these campaigns. A major issue is that they are generally implemented nationwide, so there is no natural control group for identifying causal effects. Some studies have nevertheless relied on before-and-after comparisons of behavioral outcomes. For instance, Capacci and Mazzocchi (2011) found a significant increase of British household purchases of fruits and vegetables after the National Health Service’s 5-a-Day campaign. Natural or field experiments are eventually the only way to collect robust evidence on the impact of general information campaigns and health education policies. In this perspective, scientific partnerships with food retailers or school food service providers may provide opportunities for identifying the causal effect of large-scale education and messaging campaigns on consumer

behavior. Given that many people are now aware of the relative healthiness of food products, it would be worth testing whether providing information affects consumers by enhancing their knowledge on what is healthy and what is not or contribute to changing social norms of consumption.

### Nutritional Information

For the public-health sector, labels can help consumers to discriminate between products according to their nutritional quality. For firms, they are a way of fostering differentiation between products.

Ex-post policy evidence on the impact of mandatory labeling policies on natural purchase behavior is scarce. Mathios (2000) used the implementation of the U.S. Nutritional Labeling and Education Act (NLEA) to analyze the impact of back-of-package mandatory labeling on product choices in the salad dressing market. Using a simple before-and-after framework, Mathios (2000) showed that the NLEA caused a significant decline in the share of dressings with higher fat contents. Variyam (2008) exploited the NLEA's exemption of food-away-from-home (FAFH) sources from labeling requirements. He detected no difference between intake from food-at-home (FAH) and FAFH between usual label users and nonlabel users, which suggests that back-of-package labels are ineffective.

There have been important public controversies about the effectiveness of nutritional labels. Their use and understanding is affected by their design and position on the package, consumer motivations, and time constraints. Survey data show that women and households with young children, as well as those who have more time to shop, are more likely to use labels. A positive correlation is also found between health awareness and nutritional knowledge. Consumers also prefer synthetic and color-based systems (e.g., traffic lights) to exhaustive information about daily values for nutrients, even though some find simplified information to be stigmatizing (Drichoutis, Nayga, & Lazaridis, 2009; Grunert & Wills, 2007). Public health organizations support the mandatory disclosure of the nutrients content on simple, easy-to-interpret, front-of-package labels (Kanter, Vanderlee, & Vandevijvere, 2018). These would be more salient and easier to use than the back-of-package nutritional facts panel that is already mandatory in many countries. In contrast, the industry tends to lobby against front-of-package labels, as exemplified by recent actions to stop their implementation in France (Julia & Hercberg, 2016; Julia, Etilé, & Hercberg, 2018).

In a series of incentivized laboratory experiments, Crosetto, Muller, and Ruffieux (2016) compared the effectiveness of front-of-pack guideline daily amount (GDA) percentage information and the traffic lights (TL) color system under varying conditions of time pressure and nutritional goals. Subjects had to construct a daily diet for a third person, subject to one, four, or seven nutritional goals (kcal, fat, sugar, salt, fiber, vitamin C, and calcium). They were paid a fixed cash amount if they managed to reach the targets. Crosetto, Muller, and Ruffieux (2016) found that GDA performs better than TL when time

is unconstrained. When time is limited, TL outperforms GDA only when subjects have seven nutritional targets to reach. In a supermarket experiment with low-income subjects, the same research team found that a one-dimensional color system based on a nutrient profiling index (similar to the Australian Health-Star Ratings) outperformed the multidimensional GDA labels (Crosetto, Lacroix, Muller, & Ruffieux, 2017). This suggests that easy-to-use formats can specifically benefit low-income populations. In addition, while food preferences are neutralized in the diet-building tasks—the subjects build a diet for someone else—this is not the case in the supermarket purchase sessions. The interaction effects with food preferences are also revealed by two field experiments with supermarket shelf labels, which are similar in spirit to front-of-package labels. Teisl, Bockstael, and Levy (2001) used data from a randomized control trial in 25 supermarkets between 1985 and 1988. Stores were randomly assigned to a treatment or a control group, and treatment stores exhibited shelf tags augmented with nutrition information about the fat, cholesterol, sodium, and calorie content of products. Estimates show that nutritional shelf labeling has had mixed effects on the healthiness of the consumer basket. Kiesel and Villas-Boas (2013) implemented an experiment that focused specifically on the cognitive costs of processing information by using standardized and very simple shelf tags with three items of information at most: “low fat,” “low calorie,” and “no trans-fat.” Microwave popcorns in five stores were treated over four weeks, and their weekly sales were compared with sales from 27 control stores within the same pricing division of the grocery chain. Difference-in-difference and synthetic control methods show that the “no trans-fat” and “low calorie” mentions increase the sales of treated products, while the “low fat” labels reduce sales.

Overall, this literature suggests that food preferences modulate the perception of labels. One issue, then, is whether nutrition information always enhances consumer welfare. This is the case under standard rationality assumptions, which imply that individual choices under ignorance (*ex ante*) are always suboptimal when evaluated at the preferences displayed after information disclosure (see Teisl, Bockstael, & Levy, 2001). However, consumers are in conflict between the short-term pleasure of eating and the long-term goal of health preservation. Informing them of the nutritional value of the choice options is likely to increase the anticipated guilt and psychic costs associated with less-healthy products. They may prefer to remain ignorant (Wansink & Chandon, 2006). Caplin and Leahy (2001) proposed a behavioral economic model of anticipatory feeling that can be used to rationalize a preference for ignorance (see Kőszegi, 2003, for a previous application to health checkups).

Although the research on firms’ responses to labeling policies is scarce, it demonstrates that labeling is an important topic. Food companies can react to mandatory labeling by changing product prices, marketing, and nutritional quality.<sup>11</sup> Allais, Etilé, and Lecocq (2015) proposed evidence on firm price responses in an *ex-ante* evaluation of front-of-package fat labels and the yogurt market in France. They identified consumer preferences for labels and for fat by exploiting an exogenous difference in legal labelling requirements between two different types of yogurt (dessert yogurts and *fromages blancs*). Demand curves were estimated with household scanner data and combined with

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a supply-side model of oligopolistic price competition. Allais et al. (2015) found that mandatory fat labels for dessert yogurts would result in large price cuts on these products, made possible by sizable initial margins. Hence, food companies would maintain profits by offsetting the mandatory labeling policy with price cuts. Moorman, Ferraro, and Huber (2012) analyzed the variations in the quality of food supply in the United States after the implementation of the NLEA. They found heterogeneous effects in their sample of products. Overall, the nutritional quality decreased for the products regulated by NLEA as compared to the products that were only partially regulated or not regulated at all (fresh food and items also sold in FAFH). Firms competing in low-health categories, however, made more efforts to improve nutrition, as did firms with low market shares and firms introducing new brands. Such heterogeneity underlines a need for additional evidence on how different labeling formats can impact industrial and retailing strategies in the food sector.

### Behavioral Interventions on Point of Decision

Health education and nutritional labeling can be classified as cognitive interventions because they aim to help consumers better evaluate the consequences of their decisions. These interventions can be effective only if consumers are willing to make conscious cognitive efforts to alter their behavior. In contrast, studies in applied behavioral sciences have consistently shown that modifying aspects of choice architecture “alters people’s behavior in a predictable way without forbidding any option or changing economic incentives” (Thaler & Sunstein, 2009, p. 6). Field experiments have been implemented to test the ability of such modifications to “nudge” people into healthier food choices at the point of decision.<sup>12</sup>

These experiments exploit one or several of the behavioral biases that may affect food decisions. For instance, making the healthier option as the default or more convenient choice option in restaurants is widely cited as an example of successful use of the “status quo bias” and saliency effects to promote healthier choices: consumers tend to over-elect the first option on the restaurant menu or pick the most physically accessible option in the lunch line. In other words, they are influenced by small convenience costs of access to food (Hanks, Just, Smith, & Wansink, 2012; Liu, Wisdom, Roberto, Liu, & Ubel, 2014; Wisdom, Downs, & Loewenstein, 2010). Consumer valuation of product characteristics also depends on salient attributes of options in the choice set (Bordalo, Gennaioli, & Shleifer, 2013). Accordingly, adding an extra-large option in a menu shifts upward the preferences of consumers who did not choose the previously largest option (Sharpe, Staelin, & Huber, 2008). Conversely, forbidding extra-large portion sizes may reduce the portion sizes chosen by consumers who previously chose the large portions. In addition to context dependence, individuals often lack self-control or willpower, so they unexpectedly indulge on highly hedonic and palatable food. Uncontrolled exposure to palatable food cues undermines the achievement of weight control goals in dieters (Stroebe, Van Koningsbruggen, Papies, & Hart, 2013). Conversely, advance ordering of meals has been found to significantly increase intake of healthy food and reduce calorie consumption (Hanks et al., 2012; VanEpps, Downs, & Loewenstein, 2016). Individuals are also prone to

perception biases regarding the calorie content, volume, or weights of food portions. These perceptions vary with product attributes, such as the size and shape of the packaging or brand image, as well as with environmental factors. Doubling all sizes of a product package makes it appear only 50% bigger and affects consumer preferences (Chandon & Ordabayeva, 2009), while elongating a package (a change in one dimension only) changes the consumer perceptions of volume and increases consumer pleasure, even when the volume is preserved. Redesigning food packaging is presented as a win-win policy that may benefit consumers at zero cost to producers and retailers (Ordabayeva & Chandon, 2013). This conjecture will have to be tested in a real market setting where competition can undermine any attempt to coordinate strategic choices of packaging across firms.

What can be expected from nudge policies? Cadario and Chandon (2019) proposed a meta-analysis of the effectiveness of field interventions, which they categorized as (1) cognitive interventions, such as nutritional labels; (2) affective interventions aimed at increasing the perceptual attractiveness of food through hedonic cues or prompting people to eat healthily via positive injunctions or stigmatization of unhealthy eating; and (3) behavioral interventions that change the plate and portion sizes, or manipulate the food placement to reduce the “convenience cost” of access to healthy food relatively to unhealthy food. Cadario and Chandon (2019) found a significantly larger effect size of behavioral interventions and affective interventions than cognitive interventions (resp. +0.35 and +0.22 standard deviations on average vs. +0.08). Interventions are also more successful at reducing unhealthy eating than increasing healthy eating. A possible explanation is that behavioral interventions are effective because they overturn the decision biases that usually favor the consumption of unhealthy but very palatable food. Lack of palatability and tastiness may be a resistant barrier to the promotion of healthy products.

Field interventions do not, however, reveal much information about the external validity and generalizability of behavioral interventions. A first important point is that these interventions often focus on consumer decisions at point of purchase. However, choices are not intakes, and variations in food choices prompted by nudges may be offset at home or even during the same choice session by additional intake, simply because individuals are influenced by the various metabolic control loops that ensure the stability of body weight (Herman & Polivy, 2014). For instance, Wisdom, Downs, and Loewenstein (2010) implemented a convenience intervention in a fast-food restaurant. They manipulated the order of sandwiches on the menu in order to increase the “default status” of healthier options. They did not manipulate the convenience cost for the side dishes and drinks. While the participants chose significantly healthier sandwiches, they compensated on side dishes and drinks, so that total calories were left unaffected. Little is known about the long-term effects of behavioral interventions. Field interventions may have long-lasting effects by changing food habits. Loewenstein, Price, and Volpp (2016) provided results of an experiment involving 8,000 American children. Pupils in the treated group received incentives for consuming fruits and vegetables during a 3- or 5-week period. This increased their consumption, and the effect persisted for 2 months after the end of

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the experiment. However, in a similar large-scale field experiment in English primary schools, Belot, James, and Nolen (2016) found that the effect of the intervention vanished after 6 months. A meta-analysis of the literature on the use of financial incentives for health promotion found that the effects dissipate some months after the removal of incentives (Mantzari et al., 2015). Nevertheless, these negative results do not inform the potential impact of *sustained* changes in the food environment of consumers, such as a large-scale policy intervention redesigning all purchase and eating places according to some “guidelines” of applied behavioral sciences. This begs the question of the use of nudges for the design of nutritional policies at a population level. We clearly lack policy evaluation results about the welfare benefits of policies that intend to redesign the eating environment in order to solve “mindless eating,” or “the 200 daily food decisions we overlook” (Wansink, 2016; Wansink, Just, & Payne, 2009; Wansink & Sobal, 2007).

From a normative standpoint, such policies are beneficial for individuals and respectful of their autonomy and integrity only if they make them “better off, *as judged by themselves*” (Thaler & Sunstein, 2009, p. 5). This axiom leads to tension between efficiency and ethics. On the one hand, the policymaker or the “choice architect” has to collect the informed consent of consumers or subjects, but on the other hand, unveiling the nudge likely may reduce its effectiveness. An important issue here is that biased individual decisions cannot reflect individual “true” preferences, so assessing the welfare benefits of behavioral interventions raises difficult methodological issues. Various empirical approaches have been developed (Chetty, 2015). One can, for instance, test the policy through an experiment and collect subjective well-being proxy measures of experienced utility to see whether “nudged” individuals report higher well-being. In (quasi-)experimental settings, one may sometimes specify structural models to back out the individual “true” utility function. Identification relies on the comparison of the choices made by individuals in an environment conducive to biases to those made in a context known to remove biases (e.g., Chetty, Looney, & Kroft, 2009 demonstrated the impact of tax saliency on consumer choices). A third approach is to use ecological data to fit structural models incorporating behavioral features, such as quasi-hyperbolic discounting. In this way, one can recover experienced utility from the identification of decision utility. However, this approach incorporates modeler’s beliefs about the structure of true preferences *and* biases, and these assumptions are not testable.<sup>13</sup>

Although the application of behavioral economics to public health policy remains questionable, there can be general agreement that consumers never fully control their food environment and that the latter has a causal impact on their day-to-day decisions. Bhargava and Loewenstein (2015) have argued that behavioral sciences provide evidence for more aggressively protecting consumers from “behavioural exploitation by firms” (p. 398) through taxation and regulation of the choice context. For instance, the New York City Board of Health’s authority adopted a regulation in 2012 to cap the portion sizes of sugary drinks in food service establishments. It was repealed, however, by the New York State Court of Appeals, which considered that the regulation involved “a value judgment about voluntary consumer behaviour,” did not respond to a clearly identified health crisis with a “simple, well-understood and agreed-upon cause,” and failed to target

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supermarkets and stores.<sup>14</sup> As for nutritional taxation, regulations inspired by behavioral sciences can only be implemented if they respect key constitutional principles. In addition, while it is easy to motivate taxes by the existence of externalities, it is sometimes delicate to draw a clear line between marketing practices intended to manipulate or persuade consumers and those contextual factors consciously chosen by consumers. For instance, it has been shown that the sounds and lighting of the eating environment tend to increase consumption quantity (Herman & Polivy, 2005; Stroebele & De Castro, 2004). However, eating can also be construed as an experience commodity whose enjoyment depends on many factors, including pleasant music and a soft, warm light.

### Advertising Bans

Empirical evidence about the impact of advertising tends to show that it plays a minor but significant role in children's diet and obesity (Cairns, Angus, Hastings, & Caraher, 2013). Advertising would not be just informative, but also persuasive. If it shifts consumer taste, then bans may be welfare enhancing.<sup>15</sup> Some ecological studies propose evidence based on cross-sectional U.S. data matched with advertisement data. Since food companies are likely to concentrate their efforts on areas where the demand is more responsive or larger, advertising is instrumented. Spatial and time variations in the price of advertisements and the number of area households with a television were used as instruments and they found small but significant correlations between fast-food and soft-drink advertising and consumption (Andreyeva, Kelly, & Harris, 2011; Chou, Kelly, & Grossman, 2008). Ex-post empirical evidence is provided by the ban on advertising targeting children on Quebec TV stations in the 1980s. As English-speaking children living in Quebec continued to be exposed to border TV stations in English, it is possible to compare the consumption trends between French-speaking and English-speaking children. Dhar and Baylis (2011) found that the ban decreased fast-food consumption at the extensive margin (the number of purchase occasions), while Goldberg (1990) reported a decrease in cereals purchased by French-speaking households. However, it is worth emphasizing that advertising reaches consumers through a diversity of media. A U.K. study evaluating the effect of advertising restrictions on TV food advertising to children in 2007 found that children exposed to unhealthy food ads did not vary. One explanation is that children also watch adult programs, like the news or sport events (Adams, Tyrrell, Adamson, & White, 2012). The regulation of Internet advertising targeting children and teenagers is another important policy issue whose feasibility is a challenge for governments.

Dubois, Griffith, and O'Connell (2018) examined the potential price reactions of firms if advertising were banned in the U.K. market for potato chips. They first identified the causal impact of advertising on demand by matching household panel data on purchases and TV viewing with information on TV potato chip advertising. Hence, they were able to exploit variations in exposure to advertising across households with similar characteristics in the same market. Conditional on a rich set of controls, and given that TV advertising is not personalized (unlike Internet ads), the researchers could estimate

the demand for potato chips products as a function of their advertising and prices. Banning advertising would lead to a reduction of quantity sold by about 15%. After calibration of an oligopolistic supply-side model, they simulated firms' price responses and projected that producers would respond to the ban by cutting their prices and the quantity sold would be reduced by only 10%.

## The Nutritional Quality of Food Supply

The policies that we have just reviewed are primarily designed to alter consumer behavior through incentives, information, or choice framing. They are likely to have indirect consequences on the strategies of food companies, which may adjust their marketing strategies, prices, and the nutritional quality of products. The available empirical evidence suggests that these reactions are likely to reduce the expected health benefits of interventions. Instead of policing consumer behaviors, governments may design policies directly targeting the quality of food supply. Simulation studies based on epidemiological models suggest that upgrading the quality of food products to comply with the healthiest standards in their category can produce significant health benefits (Combris, Goglia, Henini, Soler, & Spiteri, 2011; Leroy, Réquillart, Soler, & Enderli, 2016). This section examines the literature on food reformulation and quality standards, and how regulations on food quality articulate with trade policies.

### Voluntary Reformulation

As consumers and policymakers have been increasingly concerned with food-related chronic diseases, the issue of nutritional quality of food products has become an important dimension of firms' strategic choices. Since the mid-1980s, firms have marketed a variety of foods as being healthy, for example, beverages low in sugar, low-fat dairy products, vegetal butters, and olive oils. These innovations are part of segmentation strategies that target health-oriented consumers who are willing to pay a premium for healthy alternatives to existing products.

Reformulating existing products is more challenging than launching new products. It generally entails research and development costs. It can be difficult to lower the amount of sugar, fat, or salt while respecting the production costs, taste, and safety constraints that primarily drive the conception of products (Soler, Réquillart, Trystram, Abécassis, & Champenois, 2013). The taste constraint is related to the expected impact of reformulation on consumer willingness-to-pay (WTP) for the product, and therefore, on market shares and profits. Consumer reactions are key to the success of voluntary reformulation and tension often exists between healthiness, taste, and naturalness. The best option is to achieve reformulations that do not change the sensory perceptions of consumers. This has been the case with the reduction of trans fatty acid (TFA) content in many processed products commercialized in developed countries. Public health concerns around TFA, followed by regulatory actions like labeling in the United States, have led companies to replace TFA with other fats, at zero impact on taste and perhaps minimal

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health benefits (Mozaffarian, Jacobson, & Greenstein, 2010). Reformulation costs were weighted against the commercial risks of keeping TFA in products. Food science research has shown that it is possible to use water and fiber filler, substitutes such as Stevia, and flavor enhancers to reduce salt, sugar, and fat content. But these alternatives may degrade the perception of products for consumers who are attached to the naturalness of products and averse to food technologies. Another key aspect of consumer reactions is that information can alter their expectations and behavior, even when sensory perceptions are objectively unaffected (Fernqvist & Ekelund, 2014). As mentioned earlier, consumers may decrease their willingness-to-pay for “indulgence” foods that are labeled as low in fat (Kiesel & Villas-Boas, 2013). “Low-fat” labels also tend to increase consumer perceptions of appropriate serving size (Wansink & Chandon, 2006). In their study of front-of-package labeling in the French fromage blanc and dessert yogurt market, Allais et al. (2015) found that more than 40% of households have negative WTP for having fat labels on the front of packaging, which is inversely related to the propensity to purchase full-fat products. Hence, advertising a product as being healthy is likely to degrade its image, especially if it was initially purchased by consumers with minimal health concerns. Firms eventually face a trade-off between advertising their efforts and potentially losing market shares on specific products, and remaining silent but foregoing positive benefits in terms of public image and social responsibility reputation.

The paucity of exhaustive data on the nutritional content of food purchases has long prevented the analysis of dynamics of food quality and product formulation. In an ex-post evaluation of the U.K. policy on salt reduction, Griffith, O’Connell, and Smith (2017B) exploited British household scanner data that contained precise nutritional information on each product variety at the barcode level. The time variation in household dietary salt purchases between 2005 and 2011 was broken down into three components: the reformulation of existing products, the net product introduction by firms (entries less exits), and the impact of consumer switching between products because, for instance, reducing salt makes food less tasty. The U.K. salt policy followed a two-pronged approach: informing consumers on the consequences of salt consumption (from 2005 on) and negotiating a partnership with food companies to set reformulation targets (signed in 2010). Griffith et al. (2017B) found that product reformulation was the main cause of decline in dietary salt purchases, while product entries and consumer substitutions were associated with a slight increase in salt purchase. Spiteri and Soler (2018) found similar results in an analysis of nutritional trends in the sectors of breakfast cereals, biscuits and cakes, potato chips, and soft drinks in France. Over the period 2008 to 2013, some companies operating in these sectors had made voluntary commitments to partner with public health agencies on food reformulation. The analysis showed that product reformulation generally improved the quality of existing products, in terms of reduction of sugar, saturated fat, or salt, but that once again, product innovation is often associated with negative nutritional effects as well as consumer substitutions.

These results, however useful, cannot be considered as evaluation of the ex-post causal impact of public policies based on voluntary commitments by food companies, because of self-selection. The latter depends on static and dynamic cost and demand factors as

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described at the beginning of this section. The partial observability of these factors by the econometrician hinders the identification of causal effects. Good identification strategies require an extensive understanding of the drivers of agents' decisions. Future works may propose theoretical analyses of firms' simultaneous strategic choices of product formulations, product portfolio, and prices. As demand response determines the expected benefits of reformulation, a substantial contribution would be made by including consumer health concerns in the modeling of demand, as well as behavioral hypotheses regarding consumer preference for information (Caplin & Leahy, 2001).

There are also interesting questions regarding the use of voluntary agreements by firms to preempt public regulations or to avoid actions by consumer groups or nongovernmental organizations. A rich literature also exists on voluntary environmental agreements and corporate social responsibility (Egorov & Harstad, 2017; Segerson, 2013). Finally, it would be useful to know whether and how food companies exploit the opportunity of voluntary agreements to gain market share, ensure dominant positions, or set implicit barriers to entry.

### Mandatory Food Standards

Minimum quality standards (MQS) on the nutritional composition of food products have gained popularity among public health specialists and is seen as an effective means to improve quality (Downs, Thow, & Leeder, 2013).<sup>16</sup> In theory, implementing MQS on food may increase the average quality of products and benefit to consumers. However, this result holds only when the market is highly concentrated, as price competition may prompt high-quality firms to downgrade product quality (Ronnen, 1991; Scarpa, 1998). The analysis is further complicated by the ambiguous effects of unhealthy nutrients. Fat, sugar, and salt are attributes of vertical differentiation for health, but horizontal differentiation for taste: many consumers desire not only to be in good health, but also to eat fat-, sugar-, and salt-rich food. In this situation, and for a simple duopoly market, an MQS policy can raise consumer welfare if consumers value their health more than they value fatty, sugary, or salty sensations. When this is not the case, the MQS could only be justified by the paternalist argument that consumers misperceive the consequences of their choices (Réquillart, Soler, & Zang, 2016). Réquillart and Soler (2014) suggested that MQS can be better used as a tool for conditioning other policies such as taxation or mandatory front-of-package labeling. The firms that would not comply or make significant efforts to comply to the standards would be penalized. MQS would then provide reference points for coordinating the efforts of the food sector. In the case of MQS-conditioned taxation, Duvaleix-Tréguer et al. (2012) has suggested that when a large segment of consumers favor taste over health, the MQS should not be too stringent. This avoids deterring innovations and harming consumer welfare, as otherwise firms would prefer to pay the tax than to enhance product quality. Réquillart and Soler (2014) conjectured that a policy mix of labeling, taxation, and information conditioned on an MQS increasing over time may progressively switch the quality of food supply and modify consumer habits without increasing nutritional inequalities. Testing these conjectures is challenging, as there are no policy experiments to date. One possible avenue for studying interactions

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between policy tools and quality effects would be to develop structural econometric analysis based on empirical industrial organization models that endogenize firms' quality choices.

### Globalization and Trade Laws

The globalization of food systems and trade laws are a major bottleneck for the design of national nutritional policies targeting food supply. Global trade has been liberalized through negotiations at the World Trade Organization (WTO) and tariffs have been considerably reduced. But recently, negotiations have slowed down, giving rise to regional trade and investment agreements (RTAs). Between 1990 and 2016, the number of RTAs increased from 22 to 270 (Barlow et al., 2017).

Trade agreements can impact national food markets and population health through several channels that are not well covered by economic and econometric studies. They affect the level and distribution of household incomes and impact the public resources available for social and health services, including nutritional education campaigns. Trade agreements alter the local food supply by intensifying price competition and marketing investments, increasing food diversity and availability and introducing new products (in general ultraprocessed foods).<sup>17</sup> Existing studies generally indicate that trade agreements are correlated with increased import and consumption of edible oils, meats, processed foods, and soft drinks in high-, middle-, and low-income countries (see, e.g., Lopez, Loopstra, McKee, & Stuckler, 2017; Thow & Hawkes, 2009). RTAs and trade policies are also associated with higher body mass index and cardiovascular disease incidence. However, the overall quality of empirical evidence is weak or moderate, as it does not control for trends in unobserved factors and reverse causalities from changes in consumer preferences to trade policies (Barlow, McKee, Basu, & Stuckler, 2017).

Beyond their impact on national food systems, trade agreements also constrain the nutritional policies that governments can implement. The key objective of trade agreements is to ensure that domestic regulatory policies are not discriminatory and do not create unnecessary obstacles to trade. They specifically aim to reduce nontariff barriers to trade by harmonizing quality standards and procedures. The Sanitary and Phytosanitary (SPS) agreement and Technical Barriers to Trade (TBT) agreement are two important WTO agreements with respect to nontariff barriers. The SPS agreement sets out rules for food safety, animal health, and plant health. The TBT agreement covers a wider variety of product standard and regulations adopted by governments in order to achieve certain public policy objectives, such as protecting human health or the environment, informing customers, and ensuring product quality. Following the principle of proportionality, if a government wants to set an MQS restricting imports of products that may be harmful for public health, it has to convincingly argue that the applied measures do not harm trade more than necessary to protect citizens' health. Even food labeling policies have been challenged at the EU or WTO levels by countries arguing that labeling policies could be unnecessary obstacles to international trade because they are ineffective at reducing obesity and may stigmatize specific products (Julia et al., 2018;

Thow, Jones, Hawkes, Ali, & Labonté, 2017). The normative imbalance between free trade and public health is also due to an incomplete perception of the welfare gains of trade (for a brief critical analysis, see Stiglitz, 2017). The published research on consumer gains from trade is generally based on standard rationality assumptions, which ignores the dynamic effect of trade on food preferences and health and the pervasiveness of behavioral biases (see the article “The Economics of Diet and Obesity: Understanding the Global Trends”). Studies tend to give too much weight to the benefits of trade agreements, in terms of enhanced food accessibility, as compared to the downside in terms of health. An important research priority is to develop new methods to better assess the gains of trade policies in terms of consumer welfare *and* health impacts.

## Concluding Remarks

The literature on diet and obesity policies has provided some encouraging evidence on the impact of price policies, simplified front-of-package labeling, and change in choice architecture. However, we clearly lack empirical ex-post evaluation analyses. Although an increasing number of countries implement comprehensive sets of regulatory measures, evaluation is made difficult by the lack of proper control groups. Identifying the causal impact of relevant policy variables is also made difficult because data covers short time periods over which markets are observed around slowly moving equilibrium. In addition, exogenous supply or demand shocks are rare events. Future research would benefit from household-level, firm-level, and product-level data collected in rapidly developing economies where food markets are characterized by rapid transitions and the supply is often subject to more exogenous shocks. While most published research focuses on developed countries, it is urgent to accumulate ex-ante evaluation studies for other countries. The impact of food policies is likely to vary across countries with different food cultures and industrial organization of supply.

Another limit of current research is that studies generally focus on a single tool, while multicomponent interventions appear to be promising in randomized controlled trials (List & Samek, 2015; Nathan et al., 2016). Field experiments implemented over longer time periods may help obtain substantial evidence about the optimal combination of nudges, information, and taxes that could induce sustainable change in consumer behaviors. Beyond the average treatment effects, investigating the heterogeneity of policy impacts across socioeconomic segments and populations with different diet habits and risks is another important priority. This would help to better assess not only the health benefits of policies, but also their potential impacts on health inequalities. Running field experiments does not alleviate the need to better understand the strategic interactions between consumers, food companies, and governments. The empirical research definitely needs high-quality data to track changes, both in the nutritional quality of food supply at the level of product varieties and in the variations in firms’ marketing strategies. Understanding firms’ responses to public policies is a key step for designing effective policy mix. While ex-ante empirical IO studies can provide useful insights on firm strategies when regulation changes slowly, ex-post studies are better for

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appraising their reactions to disruptive changes. Finally, there are emerging and crucial research questions about the articulation of food nutritional policies and environmental policies. The optimal design of tax policies may vary with the relative weights placed on health versus environment. If environment is the priority, then soft drinks have “good” calories, as they have a very low carbon footprint. The proliferation of food labels for signaling environmental, fair-trade, or gluten-free attributes is likely to interfere with any optimally designed front-of-package nutritional labels. Undoubtedly, the economics of diet and obesity raises research questions at the crossroads of health, agricultural, environmental, and IO and public economics.

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### Notes:

(1.) In intertemporal decision problems, individuals are time-consistent when, in the absence of shocks, they carry out at time  $t$  the action they decided on at time  $t-1$  for period  $t$ . When the intertemporal utility function is separable, time-consistency requires exponential discounting.

(2.) According to the American 2000 Joint Committee on Health Education and Promotion Terminology (2001), Health Education is “any combination of planned learning experiences based on sound theories that provide individuals, groups, and communities the opportunity to acquire information and the skills needed to make quality health decisions” (p. 99).

(3.) For a detailed discussion of the healthcare costs of obesity where private health insurance is important, see Cawley (2015).

(4.) This is an average, and some studies provide more alarming results.

(5.) It is worth noting that these estimates are obtained by simple comparisons between the healthcare expenditures of obese vs. normal-weight populations. As individuals partly self-select into obesity based on characteristics that may also induce an underuse of

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healthcare, the estimated costs are likely to be downward biased. Cawley and Meyerhoefer (2012) exploit the weight of biological relatives as an instrument for obesity to obtain estimates of the causal impact of obesity on medical care costs of obesity in the U.S. They find that obesity raises annual expenditures by 2,741 US\$ (in 2005 dollars) as compared to 656 US\$ if one does not account for selection biases. While the IV method has the drawback of identifying only local effects, i.e. causal effects for the small group of individuals that are obese because of specific genes, it has also the advantage of correcting for systematic measurement errors in self-reported BMI (e.g., under-reporting).

(6.) Taxpayers may also have social preferences that favor the public coverage of health risks. This is a priori the case in European countries, and less in the U.S., as the preference for redistribution is higher in Europe (Alesina & Giuliano, 2011). Cawley (2008) finds, however, that Americans would be willing to pay 47\$ for a 50% reduction in childhood obesity.

(7.) For examples of incorporation of behavioral sciences into policy making, see the Behavioural Insights Team in the UK [since 2010], the Social and Behavioral Science Team in the U.S. [2014–2016], or reports on neurosciences and public health policies by the French Centre d'Analyse Stratégique [2009].

(8.) We ignore by space constraints the few papers on subsidies to fruits and vegetable consumption.

(9.) For a recent review of obesity policies in the U.S., see Cawley (2015).

(10.) Following Hirshleifer and Riley (1979), a rational consumer chooses to search for information if the search costs are smaller than the expected benefits in terms of the utility derived from consumption. Hence, the determinants of consumption and information demand are similar.

(11.) Identifying the impact of voluntary labelling policies raises empirical issues of self-selection: companies choose to enroll into voluntary labelling as a function of expected benefits. A recent study on UK data by Fichera and Von Hinke Kessler Scholder (2018) exploits the differential timing of introduction of Front-of-Pack labels by retailers following recommendations by the UK Food Standard Agency in 2006. Retailers only introduced the labels for their own-brand products. This resulted in a significant improvement of their nutritional quality as compared to quality of national brands. Prices and promotions were not significantly affected by the policy. The nutritional composition of household food basket did not change overall.

(12.) There is also an empirical literature that examines the impact of financial incentives for weight-loss programs, where incentives are designed to lever on biases such as loss-aversion, e.g. contributing money to an account at the beginning of the program with the perspective of interest returns if the weight-loss objective is achieved (Volpp et al., 2008).

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(13.) By contrast, the use of (quasi-) experimental data somehow alleviates the critique made by Robert Sugden that it is generally impossible to identify a person's "true" preferences, because preferences would be context-dependent by essence (Infante, Lecouteux, & Sugden, 2016; Sugden, 2017).

(14.) See the online report of the New York State Law Reporting Bureau.

(15.) Becker and Murphy (1993) argue that advertising is information complementary to food in the production of utility. It does not change consumer tastes and, assuming perfect market competition, the equilibrium provision of advertising by firms maximizes social welfare. An alternative view is that advertising is used by firms to shift tastes and, as a consequence, the equilibrium level of advertising may be socially excessive (Dixit & Norman, 1978).

(16.) The World Health Organization has recently suggested that Eastern Mediterranean governments eliminate trans-fats and reduce saturated fats by banning the sale, production, and importation of products containing "artificially produced TFA," therefore establishing a legal threshold for the maximum content of TFA and SFA in foods and favoring imports of low-SFA over high-SFA food varieties. See <http://www.emro.who.int/nutrition/strategy/policy-statement-2013.html>

(17.) The ORE article "The Economics of Diet and Obesity: Understanding the Global Trends" presents the research on these topics.

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