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Is the reduction of chronic diseases related to food consumption in the hands of the food industry?

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Abstract

Up to now, most nutritional policies have been set up to inform consumers about the health benefits induced by more balanced diets. Reviews of the impacts of these policies show that the effects are often modest. This has led governments to implement, in more recent times, policies focused on the market environment, especially on the characteristics of the food supply. The goal of this paper is to review theoretical and empirical studies focusing on changes in the food supply induced by alternative policies, and to attempt to draw from them policy guidelines and conjectures to test in future research.

Keywords: nutrition, food industry, food quality, regulation, voluntary commitments

JEL classification: Q18, I38, L66

1. Introduction

Whereas infectious diseases have dramatically decreased and life-expectancy increased in many countries in recent decades, chronic diseases, often related to lifestyle determinants, have sharply risen and are now responsible for ~60 per cent of deaths in the world (World Health Organisation, 2010). Obesity and overweight prevalence, which is symptomatic of this evolution, now affects, on average, over 50 per cent of the populations of the OECD countries.

The growth in chronic diseases among ageing European populations leads to substantial increases in health expenditures. In the United Kingdom, according to McCormick and Stone (2007), the total medical cost of obesity represented 3.7 per cent of the National Health Service's expenditures. In France, according to Emery *et al.* (2007), the total cost of obesity and overweight to the public

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health insurance system represented 7 per cent of annual health expenditures and could reach 13 per cent in 2020. Widely induced by lifestyle evolution, up to 80 per cent of the incidences of heart diseases, strokes and type 2 diabetes, and over one-third of cancers could be prevented by eliminating shared risk factors (WHO, 2010). Among these factors, food consumption behaviours play an important role, and many governments and health agencies are implementing nutritional policies to slow the increase in these chronic diseases.

Following Mazzochi, Traill and Shogren (2009), it is convenient to classify such policies into two groups: policies supporting more informed consumer choices (such as labelling policies) and policies designed to change the market environment (such as taxation/subsidies or nutrition-related standards). These two groups of policy interventions are predicated on beliefs regarding the presence of distinct forms of market failure. Regarding the first set of policies, market failure is believed to emanate from a lack of information on the part of the consumer. In other words, an individual may not have all of the information necessary to make optimal consumption choices. Providing information is perceived as the solution to this market failure. Market failure might also be due to the difficulty consumers experience in processing information that is supplied, and in that case, governmental policies might focus on education. This is particularly important in the case of food consumption, for which the 'rational' consumer has to weigh the short-term benefits of consumption against the possible long-term adverse effects on health. For the second set of policies, the justification for intervention is related to beliefs regarding the negative externalities of unhealthy diets. Thus, it is observed that obesity and other food-related chronic diseases generate healthcare costs, which are borne collectively. However, debate persists concerning the size or even the existence of such negative externalities, as it has yet to have been proved that obese persons incur lower lifetime healthcare costs (Faulkner *et al.*, 2011). A second argument notes that there are long-term negative impacts of excessive consumption on individuals' own health. In this context of delayed impact, O'Donoghue and Rabin (2006) demonstrated that, in an economy with heterogeneous agents and in which certain individuals have time-inconsistent preferences, a tax policy is welfare enhancing.[1]

At present, most nutritional policies have focused on the consumer side to better inform consumers of the health benefits induced by more balanced diets (Traill *et al.*, 2013). In practice, most policies have been in the form of national or targeted information campaigns (Capacci and Mazzocchi, 2011) and nutritional labelling (Drichoutis, Lazaridis and Nayga, 2005; Grunert and Wills, 2007). Reviews of these policies have tended to indicate that their impacts on consumers' diets are modest. Moreover, obesity prevalence has not even begun to decrease in most countries despite such interventions, the best result to date having been a slight trend towards stabilisation in some countries (Traill, 2012).

1 For a more complete discussion, refer, for example, to Griffith and O'Connell (2010).

Several reasons can be adduced to explain these small changes: (i) obesity and lifestyle-related diseases are multifactorial and determined by numerous factors (e.g. poverty, social norms etc.), which are difficult to reverse, at least in the short term; (ii) the assumptions upon which the informational policies are based are not always relevant: they assume a rational consumer, whereas behavioural research highlights rationality biases and limits of information-based policies in changing behaviours; and (iii) modifying food consumption behaviours is difficult because market forces do not provide a healthy environment (e.g. food deserts, low nutritional quality of foods).

Consistent with this third option, Dubois, Griffith and Nevo (2014) analysed the extent to which the market environment, in this case the prices and nutritional characteristics of products, explain cross-country differences in food purchases. Even if the market environment alone does not explain all cross-country differences in food purchases, those authors demonstrate that it plays a significant role. Thus, according to their simulation results, compared with the United Kingdom and the United States, the market environment in France seems to be 'healthier' in the sense that it might encourage healthier purchasing habits.

This statement has led governments to implement, in more recent times, policies focused on the market environment. A key issue in recent years has been changes in the food supply to facilitate healthier choices by consumers. In this respect, some governments are implementing partnerships with the food industry and the retail sector to generate changes on the supply side. In some cases, governments employ more coercive policies, such as bans on certain ingredients, the implementation of quality standards or advertising regulations.

Are these policies focused on the market environment more promising than policies focused on consumers? Might passive prevention (health benefits are obtained without needing conscious changes in consumers' behaviours) allow for better results than active prevention (consumers are assumed to voluntarily change their diets to comply with nutritional guidelines)? The goal of this paper is to review relevant theoretical and empirical studies focusing on changes in food supply characteristics induced by alternative policies and attempt to draw policy guidelines and conjectures from them to test in future research.

In Section 1, we evaluate the potential contribution of changes in food characteristics to the reduction of chronic diseases and compare them with interventions focused on the consumer side. In Section 2, we analyse what we can expect from voluntary self-regulation in the food industry. In Section 3, we review firms' reactions to nutritional policies. In Section 4, we discuss the design of more effective nutritional policies targeting changes in the food supply. To do so, we propose certain conjectures to be tested. Finally, in Section 5, we discuss some of the areas in which further research is needed.

2. To what extent may changes in the nutritional quality of foods contribute to health benefits?

The issue of the nutritional quality of food products is a quite recent challenge for the food industry. Food processing and product formulation had long been optimised by primarily considering production costs, taste and safety dimensions, with the nutritional quality of food products being only a consequence of the optimisation of the other parameters (Soler, Réquillart and Trystram, 2013). However, recent changes have occurred as some firms now explicitly integrate the nutritional dimension in the definition of their products (Golan and Unnevehr, 2008).

2.1. Significant improvements for some nutrients but an overall moderate improvement in the nutritional quality of food

The most notable development in product reformulation has been the significant reduction in trans-fatty acids (TFAs). Health concerns surrounding TFAs have led health agencies to implement different types of actions such as mandatory food labelling in the United States, ingredient bans in Denmark and New York City, and voluntary self-regulation in some countries (L'Abbe, Stender and Skeaff, 2009).

Many recent studies have reported significant changes in the use of TFAs and demonstrated that the food industry has made real progress in reducing the TFA content in a variety of products (Downs, Thow and Leeder, 2013). Although some additional progress is needed, studies have confirmed that the industry has reformulated a large part of packaged foods and found substitutes in such a way that TFAs are disappearing from many products (Unnevehr and Jagmanaite, 2008).

Significant efforts intended to reduce the salt content of food are also underway. A remarkable case is the United Kingdom, which has been developing a strategy to progressively reduce population salt intake (He, Brinsden and MacGregor, 2013). In 2005, the UK Food Standards Agency (FSA) established target levels of salt for each food category. The aim was to reduce the salt added to foods by small amounts and repeat the reduction at 1- to 2-year intervals. Several reports have shown that the salt content of foods had been significantly decreased as a result of the FSA's actions (Shankar *et al.*, 2013). The final outcomes, however, remain above the initial target (Webster, Dunford and Neal, 2010); the average salt intake has only fallen from 9.5 to 8.6 g in the United Kingdom, still above the 6 g/day target. In France, reductions in the salt content of foods have been observed in many food categories since 2003. The decrease in salt content ranged only between 4 per cent and 10 per cent, whereas a 20 per cent reduction in salt consumption had been proposed as a target for the food industry (Anses, 2012).

In relation to other important nutrients, such as total fat, added sugars and fibre, only a few studies have been conducted worldwide, as brand-level nutrient databases are not available in many countries (Ng and Popkin, 2012). In France, significant developments have been observed in some food categories. For instance, in the processed potatoes sector, the mean content of saturated fats has decreased from 15.8 g/100 g in 2009 to 2.9 g/100 g in 2011 (Oqali, 2013). On the whole, however, while there are significant improvements in the nutritional quality of some products, the overall impact on consumers' intakes is still modest, as most products have yet to be reformulated.

2.2. Tremendous variability in nutritional quality within food categories

The nutrient content of food products currently available on the market is often highly variable, even between comparable products within specific food families (Dunford *et al.*, 2012a, 2012b). This considerable variation in the nutrient content of comparable products suggests that a certain range of nutritional characteristics is already accessible to manufacturers using current technologies.

In France, Combris *et al.* (2011) have shown that changes in the nutrient content of food products to adjust, in each food category, all products in the first quartile of the healthiest products, could lead to an average variation in the nutrient amounts delivered to the market of between 15 per cent and 25 per cent. Similarly, studies have investigated the potential impacts on the quality of consumers' diets if all food products were to comply with the 'Choices' standard – an open access standard developed in the Netherlands to promote food reformulation.[2] This standard, which is moderately demanding, is already in effect in certain countries; for example, between 15 and 25 per cent of the food items available on the Dutch market comply with this standard (Roodenburg, Popkin and Seidell, 2011). According to simulations, the impact of the 'Choices' standard on the average nutrient intake of the population could be substantial (Temme *et al.*, 2011; Vyth *et al.*, 2011).

2.3. An assessment of the potential health impacts of food reformulation

As shown above, actual improvements in the nutritional quality of food are extremely variable and depend on product categories and nutrients. In what follows, we compare, in the French case, the impacts on health of a food reformulation scenario[3] with those of nutritional recommendations scenarios and a 'fat tax' scenario.[4] The reformulation scenario assumes that all participants in the food industry adopt the 'Choices' standard (detailed assumptions and computations are described in Leroy, Réquillart and Soler, 2014) and is based on the assumption that consumers do not change their diets. As we do not consider the cost and price effects of such changes, the result can be regarded as the maximum potential effect of a moderate food reformulation process. The evaluation of the impacts of the adoption of different types of recommendations on consumers' diets is based on the model developed by Irz *et al.* (2014). It models how a representative consumer would adjust his or her diet if he or

2 This quality standard relies on maximum or minimum contents in various nutrients. When a product complies with these characteristics, the producer can place the 'Choice' logo on the package.

3 In this paper, we refer to reformulation when the nutritional quality of an existing product is improved and to innovation when a new product is introduced.

4 Fat taxes are used in an extensive manner. A fat tax refers to taxes, irrespective of whether they focus on fat products (e.g. taxes on soft drinks).

she adopted a given recommendation. Finally, the impact of a fat tax scenario on consumers' diets is taken directly from Allais, Bertail and Nichèle (2010), who estimated a complete food demand system and evaluated the changes in diet induced by taxing a set of products.

Using a table of the nutrient contents of food products, we compute the change in the nutrient intake of a representative consumer under three alternative scenarios. In the reformulation case, the variation in nutrient intake comes from the change in the nutrient content of products given a constant diet, whereas in the other two scenarios, the variation comes from a change in the diet of a consumer given a constant nutrient content. Finally, to determine the health effects of these changes, we used the health assessment DIETRON model, which allows us to calculate the number of deaths avoided (DA) induced by variations in food and nutrient intakes (Scarborough *et al.*, 2012).

Reformulation in line with the 'Choices' standard generates an average reduction in 'deleterious' nutrient intakes (saturated fat, salt and added sugar) that when considered together would lead to a situation in which ∼10,000 deaths per year would be avoided, of which more than 50 per cent are explained by the reduction in saturated fat intake (Table 1). Such a decrease corresponds to a 6 per cent decrease in the total deaths per year related to the chronic diseases considered in the DIETRON health model. Nutritional recommendations on fruit and vegetable (F&V) consumption, salt intake and saturated fat intake also have significant potential impacts. The food-based recommendation with respect to sugar-fat products consumption leads to smaller health impacts, primarily because it targets a food category that is a small contributor to a consumer's overall diet. Finally, the fat tax has a significant impact of the same order of magnitude as that induced by changes in the nutritional composition of foods.

While these results must be considered with caution, given the uncertainties regarding food composition and health assessment impacts, they indicate that, at least in the short- and medium-term, realistic changes in the food supply could create significant health benefits, even with passive consumers. This does not mean that consumer-oriented interventions are not relevant, but rather that supply-oriented policies must be more seriously considered.

3. What can we expect from self-regulation and voluntary agreements?

3.1. Voluntary commitments: extents and limits

An initial response of the food industry to the health and nutrition challenge is to launch new products based on nutrition and health claims and innovative foods, such as functional foods, targeting health-conscious consumers. Market incentives exist for such a strategy and depend on the number of health-conscious consumers (which is influenced by public information campaigns) and their willingness-to-pay (WTP) for healthier, innovative foods. In France, for instance, the market share of these types of products represents ∼20 per cent of the food supply.

Table 1. Comparison of DA for alternative policy scenarios

	Intervention on the supply side					Interventions on the demand side				
	Product reformulation scenario based on the 'Choices' standard adoption[a]					Nutrient and food-based recommendations[b]				10 per cent fat tax[c]
	Saturated fat	Salt	Added sugar	Fibre	Total	Fruit and vegetables (+5 per cent)	Sugar-fat products consumption (−5 per cent)	Salt intake (−5 per cent)	Saturated fat intake (−5 per cent)	Cheese and milky products, prepared meals and sugar-fat products
Deaths avoided (DA)										
CHD-stroke	4265	1629	1099	750	7743	3762	267	4000	3645	4226
Cancer	1113	392	657	0	2162	2191	69	2500	1664	2128
Total	5378	2021	1756	750	9905	5953	336	6500	5309	6354
DA/total deaths[d]	3.34 per cent	1.28 per cent	1.12 per cent	0.47 per cent	6.3 per cent	3.8 per cent	0.21 per cent	4.15 per cent	3.39 per cent	4.06 per cent

[a]See Leroy *et al.* (2014) for details on the reformulation scenario and the adaptation of the 'Choices' standard to the French foods.
[b]From Irz *et al.* (2014), the assessment of consumption changes due to the adoption of these recommendations takes into account the substitutions between food categories. The effects of several recommendations are not additive as each one induces specific product substitutions.
[c]Own computation using results from Allais *et al.* (2010) who calculated the impacts of a 10 per cent tax on nutrient and energy intakes of French consumers. The taxed food categories are: cheese/butter/cream, sugar-fat products, prepared meals.
[d]'Total deaths' correspond to the annual deaths in France related to the chronic diseases considered in the DIETRON model (Scarborough *et al.*, 2012), that is to say: coronary heart disease (CHD), stroke and cancers (mouth/larynx/pharynx, oesophagus, lung, stomach, pancreas, colorectum, breast, endometrial, kidney, gallbladder).

A second strategy is intended to improve the nutritional quality of the current supply (the remaining 80 per cent). Individual and collective private initiatives have been pursued to improve the nutritional quality of existing products. As an example, the Healthy Weight Commitment Foundation (HWCF), voluntarily pledged to collectively remove 1 trillion calories from their products by 2012 (against a 2007 baseline) and 1.5 trillion calories by 2015 (Slining, Ng and Popkin, 2013). Other voluntary approaches rely on bilateral agreements between regulatory agencies and firms. In the United Kingdom, the partnership between the food industry and the government for salt reduction was based on negotiated reformulation targets signed by 75 organisations in 2010 (Wyness, Butriss and Stanner, 2011). In France, in the framework of the National Program for Health and Nutrition implemented by the government, 35 firms or groups of firms signed such commitments between 2008 and 2013 (Sébillotte, 2013).

The theoretical literature on voluntary approaches suggests that their impacts depend on several factors (e.g. Segerson and Miceli, 1998; Segerson, 2013). Although voluntary approaches could offer potential cost savings for both regulators and firms, their impacts may be small in the absence of credible threats. The success of voluntary approaches also depends on the availability of the monitoring tools necessary to quantify and control their implementation.

There are few empirical analyses evaluating the impact of voluntary agreements on food consumers' intakes. The results of available studies indicate rather weak impacts. Slining, Ng and Popkin (2013) demonstrated that the 1.5 trillion calorie pledge made by the HWCF only accounted for 0.8 per cent of the calories sold across all consumer packaged goods food and beverage brands (~14 calories/day/capita). The overall effect of the commitments made by French firms since 2008 on consumers' caloric intakes is, however, modest and estimated at only ~10 kcal/day (Oqali, 2012). In summary, voluntary commitments by firms are often significant in what they pledge, but the final impacts are small because the number of committed firms remains limited (Eyles *et al.*, 2013).

Self-regulation and voluntary agreements also concern marketing activities. For example, 10 food and beverage companies in the United States are involved in the Children's Food and Beverage Advertising Initiative to encourage healthier dietary choices and healthy lifestyles. In Europe, 19 food and beverage companies announced a common commitment to change the way they advertise to children. Overall, the literature suggests that the impact of such initiatives on purchases of less healthy products is at best very small and does not sufficiently reduce the advertising of foods that undermine healthy diets (Berning and McCullough, 2013; Galbraith-Emami and Lobstein, 2013; Huang and Yang, 2013).

3.2. Major bottlenecks in the evolution of the nutritional quality of foods

A first explanation for the rather small impact of voluntary agreements concerns the associated costs of reformulation. For example, in processed meat products, increasing salt concentration, combined with other water-binding chemicals, increases the amount of water that can be bound into the products, and hence the product weight can be increased by up to 20 per cent with water (He and McGregor, 2009). Moreover, the investments required to reformulate can be substantial.

Beyond the cost issue, another challenge relates to the interaction between the healthiness and taste of a product, the so-called 'unhealthy = tasty' intuition. Sensory analysts have investigated the extent to which consumers may perceive a decrease in salt, fat, or sugar. Many of these works converge and have shown that significant changes in nutritional content of foods may be implemented without negative consequences on consumers' sensory attributes and taste perceptions. In the processed meat sector, for instance, it has been found that a gradual reduction of salt, beginning with a reduction of between 10 per cent and 25 per cent, repeated periodically, seems to be barely detectable by the human palate (Desmond, 2006; He and McGregor, 2009). The use of substitutes and flavour enhancers may allow for reductions in the salt, sugar and fat content of many processed foods (see, for instance, Busch, Yong and Goh, 2013). In the same vein, Wansink and Huckabee (2005) suggested that there should be a reformulation of high-energy-density foods to lower their energy density by replacing some of the fat with water and fibre filler, as research suggests that up to 20 per cent of the fat in a high-energy-density food product can be replaced with low-density items without consumers noticing a difference in taste.

Even if in blind tests, however, individuals do not perceive sensory differences between a more or less fatty (or sweet) product, in a real consumption setting, expectations associated with labels, brands, and informational cues can affect not only the perception but also the liking of a product. Indeed, expectations play an important role in food choice and consumption, as they may improve or degrade the perception of a product, even before it is tasted, with consumer satisfaction being strongly related to the degree of disparity between expectations and actual product performance (Deliza and MacFie, 1996; Bowen *et al.*, 2003; Wansink, van Ittersum and Painter, 2004; Mustonen *et al.*, 2007; Finkelstein and Fishbach, 2010; Wilcox, Roggeven and Grewal, 2011; Vadiveloo, Morwitz and Chandon, 2013; Fernqvist and Ekelund, 2014). In an experiment, Raghunathan, Naylor and Hoyer (2006) found that when information pertaining to the assessment of the healthiness of food items is provided, the less healthy the item is portrayed to be, the better is its inferred taste, and the more it is enjoyed during actual consumption. An experiment conducted by Kiesel and Villas-Boas (2013) in stores in the United States confirmed that consumers make trade-offs between taste and nutritional content, as they demonstrated that low-fat labels have led to a decrease in the sales of healthier products. The consequence is that, in certain markets, as shown by Allais, Etilé and Lecocq (2012) in the *fromage blanc* and dessert yogurts sector in France, some consumers may have a negative WTP for nutritional labelling.

This literature suggesting that food descriptions affect both taste and healthfulness perceptions among consumers is important to consider, as it suggests that informing consumers may have unintended effects. This issue plays an important role in firms' responses to nutritional policies, as the reformulation issue is strongly related to the perceived link between health and taste characteristics. In the absence of negative links between the two, improving nutritional characteristics is possible. The successful reduction of TFAs in foods illustrates this point, as, even if it led to additional costs, consumers did not perceive it as a taste issue. On the contrary, reductions in salt, total fat or sugar seem more difficult to implement, as they may be negatively perceived by many consumers when they are signalled on labels and food packages. This means that changes may occur when they are implicit and not signalled to consumers. In this case, however, firms do not have strong incentives to reformulate their products.

In such a context, firms might segment demand by targeting specific products for health-conscious consumers who have a sufficiently high WTP for healthier, innovative products (e.g. functional foods, health and nutritional claims). However, for other consumers, there are no strong incentives to improve the nutritional quality of foods as long as the 'unhealthy=tasty' intuition holds. The consequence is that in markets that are not explicitly targeted towards health-conscious consumers, a single firm has no interest in deviating from the equilibrium by enhancing (through reformulation) the healthiness of its products. As long as the other firms do not modify the characteristics of their products, it is very hazardous for a firm to unilaterally modify the characteristics of its products, as is the case in a Prisoner's dilemma.

4. Firms' reactions to nutritional policies

When reformulation towards healthier products is likely to affect consumers' perceptions of the hedonic characteristics of the good, market forces may not be sufficient to generate a significant increase in the nutritional quality of foods. A public intervention may be justified by targeting changes in the food supply, through policies supporting more informed choices or those intended to change the market environment.

4.1. Policies supporting more informed choices

4.1.1. Labelling

The motivation for product labelling is to reduce consumers' information costs with the aim that better information will help consumers make better choices. From the vast literature on consumer responses to labelling, it appears that the overall impact of descriptive labelling remains modest. In particular, it depends on the socio-economic status of individuals, with less-educated individuals responding less to the information (for recent surveys, refer to Grunert and Wills (2007) and Drichoutis, Nayga and Lazaridis (2011)).

By increasing market transparency regarding nutritional attributes, however, a labelling policy can also affect the price and quality of firms' decisions and contribute to product reformulation and innovation (Caswell, 1998; Caswell *et al.*, 2003). Even if not all consumers respond to food labels, making certain nutritional characteristics of the good more salient may lead firms to react strategically to the potential change in demand.

4.1.1.1. Firms' responses in quality. Moorman, Ferraro and Huber (2012) investigated how firms responded to standardised nutrition labels on food products required by the US Nutrition Labeling and Education Act (NLEA). They found that the NLEA had (i) a negative effect on brand nutrition levels relative to control brands not required to have a nutrition label; (ii) a positive effect on brand nutrition for new brands compared with existing brands in the category and (iii) a positive effect on brand nutrition for brands in lower-health categories compared with brands in higher-health categories. The rationale behind those results is found in the correlation between taste and nutrition attributes and consumer arbitrage between taste and nutrition. If consumers believe that nutrition is negatively correlated with taste and the taste characteristic is more important than the nutrition characteristic in consumers' choices, then the strategic response of firms to the NLEA is to decrease nutritional quality to avoid discouraging consumption. This response is reinforced by the fact that price is also a key variable for consumers, whereas more nutritious products are likely to be more costly. The issue for new brands is different, as it is a way to segment demand and attract new consumers.

The specific case of TFAs is interesting, as it illustrates a case in which the negative link between taste and nutritional characteristics is weak. Thus, the mandatory disclosure of information led to a significant reduction in the TFA content of processed food in the United States (Rahkovsky, Martinez and Kuchler, 2012). Unnevehr and Jagmanaite (2008) demonstrated that, in addition to mandatory labelling, liability suits and a ban on this ingredient in New York restaurants created strong incentives for product reformulation.

Another option for labelling is the voluntary disclosure of information through Front-of-Pack (FOP) labelling. For instance, Vyth *et al.* (2010) studied the characteristics of foods marketed with the 'Choices' logo in the Netherlands. The results indicate that the 'Choices' logo has motivated food manufacturers to reformulate existing products and develop new products with a healthier product composition, especially where sodium and dietary fibre are concerned. Young and Swinburn (2002) demonstrated that the impact of 'Pick the Tick' logo on the salt content of food was relatively small, as only a limited number of firms joined the programme. Van Camp, de Souza Monteiro and Hooker (2012) analysed the introduction of new products. They found that the use of FOP labels is most frequent for private label products, suggesting that an FOP label is a tool for retailers to further differentiate private label products from national brands. They also found that the nutrient composition of food was not associated with the use of FOP logos.

4.1.1.2. Firms' response in prices. The price impact of labelling policies has been less analysed than the product quality impact of labelling regulations.

This price reaction might come from a direct cost impact, changes in the structure of the industry or firms' strategic price reactions.

Moorman, Du and Mela (2005) found no significant impact of the NLEA on prices. They did, however, show that the NLEA has had an impact on firms' survival, favouring large firms to the detriment of small firms. Sumanac, Mendelson and Tarasuk (2012), studying the Canadian bread market, observed a price impact of a reference to whole grains on the FOP. The mean price did not differ in the presence of a whole-grain reference, but breads with whole-grain labelling were less likely to be low in price. Thus, voluntary nutrition labelling may be targeting a market of health-conscious consumers who are willing to pay premium prices for more healthy options.

Allais, Etilé and Lecocq (2012) evaluated the strategic price reactions of firms to an FOP policy. They studied the French market for *fromage blanc* and dessert yogurts. Their results suggested that ignoring firms' price reactions can lead to erroneous conclusions. They found that when firms' strategic pricing was ignored, imposing an FOP label on dessert yogurts (signalling the fat content of the product) reduced households' average annual fat purchases by ~12 per cent. On the contrary, when firms were free to adjust their prices, overall fat consumption increased by ~5 per cent.

4.1.2. Advertising regulation

From a public health perspective, concerns have emerged regarding food advertising (WHO, 2012), as many reports worldwide show that (i) a major part of advertising time on television and other media is dedicated to food and beverages, especially during children's programmes; (ii) advertised food and beverages have low nutritional quality and (iii) advertising has a causal, albeit modest, impact on children's food choices and food intake (Cairns *et al.*, 2013; Mills, Tanner and Adams, 2013).

Advertising is a key strategic variable in the competitive game. The theoretical and empirical economic literature has extensively studied its effects on market equilibria, depending on its informative versus persuasive role (see Bagwell, 2007). As demonstrated by Motta (2013), two effects play a role in determining the impact of advertising restrictions on the total consumption of a given good. One effect is the extent to which an advertising ban lessens consumers' demand at any given prices. The other effect concerns the price variation induced by the advertising restriction. When advertising decreases prices (i.e. when more advertising entails more intense competition), both effects have the same sign. Then, a ban on advertising decreases aggregate consumption. When advertising raises prices (i.e. when more advertising increases consumers' loyalty), the net effect on consumption is *a priori* ambiguous and depends on the relative magnitude of the two effects.

Moreover, in imperfectly competitive markets, government constraints such as banning advertising on a strategic variable can facilitate coordination among firms and may improve efficiency if it enables firms to produce the same level of sales with less advertising spending. Iwasaki and Tremblay (2009) showed that, in the case of the cigarette industry in the United States, producers have benefitted from advertising restrictions thanks to this coordination effect.

4.1.2.1. The impact of advertising bans. Few articles empirically assess food advertising restrictions. Dhar and Baylis (2011) studied the effect of a ban on fast-food advertising in Quebec. They showed that the ban decreased the probability of fast food consumption (by 13 per cent); however, for those consumers who continued to consume fast food, the amount spent was not affected. Kent, Dubois and Wanless (2011) examined the nutritional quality of foods advertised to children in Ontario, where advertising is self-regulated by the industry, and in Quebec, where a child-directed advertising ban exists. The results suggested that advertised foods in Quebec are marginally healthier than those in Ontario.

The United Kingdom also introduced restrictions on advertising foods high in fats, salt and sugar (HFSS) to children. According to Adams *et al.* (2012), the restrictions did not change children's relative exposure to HFSS advertising. The authors suggested that stronger restrictions targeting a wider range of products are required. Dubois, Griffith and O'Connell (2013) conducted an *ex ante* evaluation of the impacts of an advertising ban on crisp consumption in the United Kingdom. In the absence of a price reaction by firms, their model predicted that an advertising ban on crisp consumption would lead to a decrease in crisp consumption. They also found that the strategic reaction of firms would be a price reduction that would more than offset the impact of the advertising ban.

Those results suggest that advertising bans might have positive effects if they are well designed, that is, if they encompass a sufficiently large range of products and affect a sufficiently large range of programmes. However, price adjustments are likely to limit the impact and in some cases might fully eliminate the impact.

4.2. Policies intended to change the market environment

Among the instruments used to modify the market environment, some, such as minimum quality standards (MQS), directly target food characteristics, whereas others, such as taxes and subsidies, target prices but might have indirect impacts on food characteristics.

4.2.1. Minimum quality standards

Based on the view that voluntary changes remain overly limited, health agencies have envisaged MQS as instruments to increase the nutritional quality of the food supply.

The theoretical literature on MQS has primarily explored the impact of establishing MQS when products are differentiated along one dimension. In a duopoly framework in which firms adjust prices and qualities, Ronnen (1991) and Crampes and Hollander (1995) demonstrated that implementing an MQS induces an increase in both qualities. Moreover, in most cases, the quality gap between the firms' two products narrows and consumers gain from the introduction of an MQS. Because health and taste characteristics might play a role in consumer choice, allowing products to be differentiated according to more than one dimension may be more relevant for the analysis. The literature on MQS in a context of multiple product differentiation yields ambiguous results. Deltas, Harrington and Khanna (2013), considering an MQS in a double differentiation setting, demonstrated that, while it appears that the market underprovides product quality, an attempt to increase it through an MQS could be counterproductive. An MQS may not only decrease welfare but also average quality. In their model, the increase in the quality of the low-quality firm induces a decrease in the quality of the high-quality firm. The authors concluded that when consumer heterogeneity is primarily in the form of WTP for product quality, an MQS increases quality and is socially desirable. On the contrary, when consumer heterogeneity is primarily in the form of horizontal attributes, firm qualities are strategic substitutes and an MQS may be socially undesirable.

The TFA-related initiatives illustrate the case in which the nutrient has a weak impact on consumer taste perceptions. Combined with mandatory labelling, an MQS seems to have been successful in generating reductions in TFA content in Denmark and New York, without major inconvenience mentioned by the descriptive studies. Note that, as highlighted by Unnevehr and Jagmanaite (2008), MQS have generally been implemented smoothly, once a large part of the food industry has already adapted the food processes, as their implementation is the final step in generalising the evolution of a food process. For other nutrients such as fat or sugar that are more involved in the 'unhealthy = tasty' intuition, the implementation of an MQS may not be efficient, as the theoretical literature is inconclusive in this case.

4.2.2. Taxation

In Europe, some countries have recently introduced or raised taxes on unhealthy foods. In 2011, Hungary introduced taxes on manufactured goods that contain sugar. In Finland, the excise tax on soft drinks was raised from €0.045 to €0.075/l in 2011. In 2011, Denmark introduced a tax on saturated fat and increased the tax on sugar products, soft drinks and alcohol. The tax rate is 16 DKK/kg (€2.15) of saturated fat for selected product categories and only applies if the saturated fat content exceeds 2.3 g/100 g (Smed, 2012; Jensen and Smed, 2013). The impacts of the tax were considered controversial, and as a result, the tax was abandoned in 2013. Finally, in France, a €0.0716/l tax on soft drinks, whether they are sugar-based or diet, was introduced in January 2012.

As there are few examples of implemented fat taxes, most studies on the impact of a fat tax on consumption and health rely on simulations. Reviews of the impact of taxes on consumption exist (Irz and Niemi, 2011; Eyles *et al.*, 2012; Mytton, Clarke and Rayner, 2012). When taxation applies to food categories, most studies conclude with a statement regarding the difficulty of defining policies leading to an improvement in the intake of all nutrients. Recent works suggest that (i) focusing on intra-category taxation might be a better strategy, as the elasticity of demand within a category is larger than that across categories (e.g. Griffith, Nesheim and O'Connell, 2010; Bonnet and Réquillart, 2013b) and (ii) it is more efficient to define a nutrient-based tax/subsidy rather than a food-based tax/subsidy (Miao, Beghin and Jensen, 2012; Harding and Lovenheim, 2014).

4.2.2.1. Integrating firms' response in prices. An important issue in appraising taxes is their transmission to consumer prices. The theoretical literature indicates that an *ad valorem* tax is less likely to be overshifted than an excise tax (Delipalla and Keen, 1992; Anderson, de Palma and Kreider, 2001).[5]

Three recent papers have addressed the issue of firms' price responses to a tax policy in the context of nutritional policies. Griffith, Nesheim and O'Connell (2010) studied the United Kingdom market for butter and margarine. They studied manufacturers' responses to a tax proportional to the saturated fat content of the companies' products. Their results showed that the tax induced substitution away from high-fat towards low-fat products. They also found that an excise tax was overshifted (the average pass-through rate was 1.45), whereas an *ad valorem* tax was undershifted (the average pass-through rate was 0.81). Allais, Etilé and Lecocq (2012) studied the French market for *fromages blancs* and dessert yogurts. They studied manufacturers' responses to an *ad valorem* tax, related to the fat content of the manufacturers' products. They found that the pass-through rates of the different products were lower than one. Bonnet and Réquillart (2013a) studied the market for soft drinks. Their analysis accounted for the strategic relationships between manufacturers and retailers. They found that an excise tax was overshifted (the average pass-through rate was 1.3) and an *ad valorem* tax was undershifted (the average pass-through rate was 0.8). Their results were partly supported by an *ex post* analysis of the impact on prices of the 'soda' excise tax introduced in France in January 2012. Thus, Berardi *et al.* (2012) demonstrated that for products that experienced a price increase (86 per cent of all products), the average pass-through rate was 1.24.

An important conclusion is that, due to strategic pricing, an excise tax has a larger impact on consumption than an *ad valorem* tax.

4.2.2.2. Integrating firms' responses in quality. Firms not only react in prices, but may also react by changing food characteristics through product reformulation. This issue is partially considered in theoretical analyses, but at present no empirical study has been conducted on this topic in the nutrition field. The crucial issue is to determine the conditions under which a tax policy improves the nutritional content of products. For example, Cremer and Thisse (1994) demonstrated that in a vertical differentiation model, a uniform *ad valorem* tax reduced both qualities. This result is at odds with the objective of nutritional taxation. However, Lambertini and Mosca (1999) showed that there is a taxation/subsidisation scheme that induces firms to produce socially optimal qualities.

Duvaleix-Tréguer *et al.*. (2012) developed a duopoly model with double differentiation assuming that consumers have heterogeneous preferences with

5 Overshifting of a tax means that the increase in the consumer price is larger than the amount of the tax. Otherwise, we refer to the undershifting of a tax. Note that in a context of perfect competition, a tax is never overshifted.

respect to product variety (the taste attribute). In addition, products also differ by a vertically differentiated attribute (healthiness). The incumbent firm produces the low-quality product and cannot modify its characteristics. On the contrary, the entrant strategically selects the characteristics of its good, anticipating the price competition. The authors showed that an increase in consumers' WTP for healthiness provoked an increase in the quality of the entrant product and its price. This induced a reduction in the price of the less healthy product. Depending on the strength of these effects, it might be the case that the market share of the unhealthy product increases. This mechanism is central, as it demonstrates that a firm producing an unhealthy product might have incentives to reduce its price to maintain some market share.

Using this model, they studied the impact of a tax that applies to products that do not comply with a minimum quality threshold. They showed that if the threshold is not excessively high, the quality of the entrant product increases, as the firm prefers to comply with the threshold and thus escape the tax. In this case, the overall health impact is positive, but a decrease in the health of less health-conscious consumers is possible, as some of them shift from the healthier product to the 'deleterious' one due to changes in the prices and characteristics of the products. Finally, with respect to welfare, the authors showed that a tax associated with a relatively low quality threshold was likely to increase welfare.

5. Discussion

As noted by Traill *et al.* (2013), making evidence-based policy decisions is not easy in the field of food-consumption-related diseases. There are many reasons that may explain these difficulties. Lifestyle-related diseases are determined by multiple factors that are not easy to disentangle; each one likely has small effects. The data necessary for robust empirical analyses are often missing. Moreover, linking datasets on health and datasets on food consumption is usually not trivial. In addition, datasets describing food characteristics at the brand level are insufficient to measure the changes in the nutritional quality of foods, although some attempts are in progress (Ménard *et al.*, 2011; Dunford *et al.*, 2012a, 2012b). Thus, an evidence-based evaluation of the effects of alternative policies is not fully available.

Policies supporting more informed consumer choices have been more commonly considered than policies designed to change the market environment. Moreover, studies have frequently focused on the consumer response to the policy, whereas the research reported in this article indicate that firms react to nutritional policies and, depending on the case, amplify or lessen the health impacts of these policies. Assessing the effects of nutritional policies at the market equilibrium, by simultaneously accounting for firms' and consumers' responses, is clearly a research priority.

Research conducted in the EATWELL project (Brambila-Macias *et al.*, 2011; Traill *et al.*, 2013) led the authors to conclude that (i) public information campaigns have been successful in raising awareness of unhealthy eating but have failed to translate the message into action; (ii) policy interventions designed to reduce or ban unhealthy food advertisements have generally had a weak positive effect on improving diets and (iii) interventions targeting the market environment, such as fiscal measures and nutrient, food and diet standards, are generally more effective, albeit more intrusive. In line with this diagnosis, the research surveyed in this paper, primarily focused on the supply side, leads us to suggest a set of additional plausible conjectures, which will have to be tested in further research.

Conjecture 1. *The food industry, through changes in the nutritional quality of foods, may be able to make a significant contribution to the reduction of food-related chronic diseases. When the 'unhealthy = tasty' intuition holds, public regulation may be justified, as market incentives are not sufficient to lead to product reformulation.*

Consumers value food characteristics according to (at least) two dimensions: taste and health. The first refers to a variety (horizontal) differentiation, whereas the second refers to a quality (vertical) differentiation. These two attributes are frequently not independent in the sense that increasing the quality (healthier product) may be interpreted, once it is signalled to the consumers, as modifying the taste attribute. The link between the two depends on nutrients, product categories and technology. The case of TFAs illustrates an extreme case in which the two attributes seem to be independent. Conversely, another extreme case, which might be illustrated by fat content, is when the products only differ in a single characteristic, whereas consumers infer two dimensions: following the 'unhealthy = tasty intuition', a decrease in fat is accompanied by degradation in the taste characteristic.

In the latter case, informing consumers may not necessarily intensify competition by stimulating the demand for nutritional attributes. If that were the case, as noted by Unnevehr and Jagmanaite (2008), manufacturers and producers would reformulate as early as possible to capture first-mover profits. All consumers would experience a change in diet composition, irrespective of whether they were specifically seeking change.

Once health and taste attributes are negatively linked, a firm has limited incentives to reformulate its products, as consumers do not necessarily have higher WTP for healthier products. In an oligopoly situation, unilaterally modifying product composition might generate losses for the firm if consumers switch to the competing brand (product reformulation might increase costs or negatively affect taste). However, if both firms reformulate to a healthier product, this might generate additional profits for both firms. In this case, public intervention may then be justified to solve the Prisoner's dilemma firms are confronted with.[6]

6 In some cases (a large cost increase and a negative impact on demand), it is possible that if both firms reformulate, profits will decrease. This situation is no longer described by a Prisoner's dilemma.

Conjecture 2. *Designing policies targeting substitutions within a food category rather than between food categories allows for (i) easier substitutions by consumers and (ii) greater incentives for food reformulation on the supply side. Although these changes may lead to smaller health benefits for some consumers (those who easily switch from one category to another), they induce greater benefits at the population level.*

Food-based recommendations are intended to promote substitutions between food categories. Decreasing the consumption of soft drinks, processed meats and junk food are common messages addressed to consumers. Similarly, the taxation of food categories is intended to obtain health gains from substitutions between food categories. For consumers complying with these recommendations, the health benefits may be large. However, for most consumers, the welfare costs associated with a change in diet may also be large, preventing many of them from modifying their diets. The price elasticity of a food-product category is frequently lower than one, confirming the strong rigidity of diets when considering food categories (Green *et al.*, 2013). In addition, firms producing in food categories in which consumption must be decreased lack incentives to improve the health quality of their products. On the contrary, they may respond strategically to limit the loss of market shares by decreasing price, decreasing nutritional quality when health and taste characteristics are negatively related, or increasing food advertising.

On the contrary, promoting substitutions within food categories may prove more effective. On the consumer side, whereas the individual health benefit may be smaller, the associated costs of changing may also be smaller, allowing more consumers to adapt their diets. On the supply side, firms may have greater incentives to improve the health quality of their products to benefit from the consumers' changes.

From a public health perspective, the trade-off is between a policy allowing substantial changes in diet for few consumers versus small changes in diet for many consumers. The above discussion suggests that under the first strategy, consumers' and firms' reactions may work in opposite directions, whereas they may be synergetic in the second.

Conjecture 3. *'Quality conditioned' policy instruments, targeting as a priority product reformulation, may contribute to greater health benefits than instruments prioritising changes in consumers' diets.*

To favour massive substitutions within food categories, compatible with consumers' preferences and firms' incentives, public intervention must employ 'quality conditioned' instruments.

A direct approach to favouring product reformulation is based on quality standards through voluntary commitments or mandatory standards. Voluntary agreements have been somewhat successful in reducing the salt content in foods. To be effective, voluntary agreements should be based on industry commitments rather than individual firms' commitments. However, coordination costs are often high, and voluntary agreements on collective standards might be difficult to implement, particularly in fragmented industries. MQS are also an option, as exemplified by the TFA case. MQS have generally been implemented smoothly, once a large part of the food industry has already adapted food processes, their implementation being the last step in generalising the food process evolution. However, the overall effects of an MQS on prices and welfare have yet to be empirically assessed. The theoretical literature suggests that when product differentiation encompasses multiple dimensions, an MQS defined on a given dimension may generate unexpected effects such as a decrease in the average quality of products sold on the market. For some specific nutrients (e.g. salt in bread, added sugars in soft drinks), establishing an MQS might be efficient. However, establishing an MQS might be difficult in practice, especially when it involves numerous nutrients.

Indirect approaches may be considered to reward (penalise) nutritional quality improvements (downgrading). Different tools are available, such as taxation, labelling or advertising regulations.

Regarding tax policies, the literature suggests that to have the maximal impact on consumer demand, an excise tax should be preferred to *ad valorem* taxes, as the former is likely to be transmitted into final consumer prices to a greater extent than the latter. Taxing the 'bad' products within a food category is sensible, as products within a category are highly substitutable. This militates for taxes that are based on the content of the bad nutrient. There are different ways to do so, but employing non-linear schemes might be attractive. In particular, defining a quality threshold should be favoured to allow substitution within the product category between taxed and untaxed products. In the example of soft drinks in France, which employs a per gram of sugar form of taxation, the main substitutions are between sugar-based (taxed) and diet products (untaxed) rather than between the sugar-based products (Bonnet and Réquillart, 2013b). Moreover, firms may also react to taxes by adjusting the contents of their products. The results from Duvaleix *et al.* (2012) suggest that if the quality threshold is not excessively high, firms have incentives to improve the quality of their products to escape the tax. Finally, the impact on other food categories might be lower, thus avoiding or limiting perverse effects.[7]

Labelling regulations may also be designed to favour food reformulation. The literature suggests that 'prescriptive' labelling, based on coloured logos (traffic lights), might be more powerful than descriptive labelling (nutrient fact panels) in inducing changes in the consumer demand for healthier products. As suggested by Muller and Ruffieux (2012), under prescriptive labelling, logos rating a product within its category induce a larger number of intra-category

7 Finkelstein *et al.* (2013) analysed the impact of a tax on sugar-sweetened beverages, while accounting for intra- and inter-category substitution. Half of the decrease in energy consumption induced by the tax is due to impacts within the product category and half comes from substitution or complementarity with other food products.

substitutions than logos providing an overall assessment of the product. This result is consistent with the understanding that modifying one's entire diet is costly for consumers, whereas modifying the choice of products within a category is less costly. With logos designed at the category level, in response to the change in demand, firms might have strong incentives to reformulate their products in the right direction. However, firms producing the less healthy products might also react by cutting their margins to maintain their market shares.

Regarding food advertising, the available literature suggests that advertising bans might have positive effects if they are well designed, that is, if they encompass a sufficiently wide range of products and affect a sufficiently wide range of programmes. A first goal is to weaken the 'unhealthy = tasty' inference, which is one of the main bottlenecks for food quality improvement.

The Office of Communications experience in the United Kingdom is interesting in this respect. A nutrient profiling system has been used to classify more or less healthy products. On this basis, advertising 'unhealthy' products is prohibited during programmes for which children form a large proportion of the audience (Ofcom, 2007). Then, firms may decide to participate in a voluntary advertising restriction agreement, which means that they reformulate their 'unhealthy' products or stop advertising. According to Zhu, Huang and Cohen (2012), leading firms should choose participation and reformulation as long as prospective product reformulation costs do not exceed the marginal profitability of reformulation. However, Traill *et al.* (2012) did not find any impact of the Ofcom initiative on consumption, perhaps because restrictions were overly strict.

Conjecture 4. *To generate substantial effects on a consumer's overall diet, a 'quality conditioned' policy mix of prescriptive labelling, price incentives and advertising regulation should be designed.*

Thus far, nutritional policies based on descriptive labelling, advertising regulation, information campaigns, voluntary commitments and, in some cases, fiscal policies have been considered independently. Their goal is to promote diet changes through substitutions between food categories. Individual impacts are often weak because food habits are difficult to modify. In addition, product formulation has not changed substantially, and in some cases firms have developed strategic actions to limit the impact of policies.

To be more successful, a nutritional policy should primarily target product substitution within food categories rather than between food categories, as demand at the product level is much more elastic than at the category level. The policy should also provide incentives to the food industry to amplify changes in the desired direction rather than to oppose them. In particular, product reformulation should be favoured, as it potentially affects all consumers.

To create the proper incentives for firms, demand for healthier products should be favoured, whereas demand for the most deleterious products should be discouraged. To do so, quality thresholds should be determined at the product category level. Then, a combination of instruments including prescriptive labelling, a tax/subsidy policy, and advertising regulations could be applied. The threshold could change over time. Compared to a policy based on an MQS, such a policy mix could be smoother, allowing for the gradual adaptation of products and reducing the costs of adapting to the policy.

The available research does not provide numerous results regarding the policy mix to select. Berning (2011) suggested jointly considering advertising regulation and tax policy, as persuasive advertising may reduce the price elasticity of unhealthy products and thus lessen the potential impacts of price policies. Roosen and Marette (2011) demonstrated that when certain consumers are not well informed by the label, an optimal policy consists in combining the use of a label and a subsidy (as they analysed a product for which consumption is recommended). Duvaleix-Tréguer *et al.* (2012) studied the combination of a quality standard and a taxation policy and concluded that if the quality threshold is not excessively 'high', such a system provides strong incentives for product reformulation. Additional research is clearly needed in this domain.

Conjecture 5. *A 'quality conditioned' policy mix may decrease health inequalities.*

Obesity rates are not evenly distributed among the population. Low-income consumers experience higher obesity rates than high-income consumers. Moreover, unhealthy dietary habits are substantially more frequent among low-income consumers.

The public health literature suggests that informational campaigns or, more generally, policies targeting more informed choices tend to increase health inequalities. Approaches targeting changes in the market environment have more controversial impacts on health inequalities. This is the case for fiscal policies. A tax policy on food is generally regressive, as low-income consumers devote a larger share of their expenditures to food consumption than high-income consumers. Moreover, according to Tiffin and Salois (2012), the regressivity of a tax policy is particularly large when the tax is focused on products with high saturated fat contents. A policy that combines a fat tax with a subsidy on F&V is actually more regressive, as high-income consumers tend to consume more F&V than low-income consumers. For these reasons, measures that apply to the entire population may not reduce health inequalities. Conversely, approaches that target vulnerable populations that have a shared propensity to adopt unhealthy behaviours are more appropriate (e.g. Dallongeville *et al.,* 2011).

Whereas many authors agree on the regressive impact of food taxes, there is no consensus on the impact of taxes on health inequalities. Thus, some studies have shown that the impact on consumption might be progressive (Smed, Jensen and Denver, 2007). As a consequence, the likely impact on health might also be progressive, thus reducing health inequalities. It has also been shown that, while heavy-consumption consumers may be less responsive to price changes, the impact of a tax on consumption is larger for heavy-consumption consumers, meaning that the health benefits could be higher for these consumers (Gustavsen and Rickersten, 2011).

The impact of product reformulation on health inequalities is difficult to assess, as it depends on the origin of the unhealthy dietary habits of low-income consumers. If the poorer diet quality is primarily explained by the selection of products within food categories, then reformulation is likely to reduce health inequalities, as reformulation should primarily target the most harmful products in each category. If it is primarily the result of the relative weight of the different product categories, then product reformulation might only reduce inequalities if it concerns the most harmful product categories.

6. Conclusion

In this paper, we argue that interventions intended to modify the market environment faced by consumers are necessary to combat the rise of food-related chronic diseases. Firms have incentives to create new products for health-conscious consumers who have a sufficiently high WTP for healthier products. However, for a large share of the food market, firms have no incentive to enhance the healthiness of food products. This is in large part explained by the 'unhealthy = tasty' intuition, which creates a situation in which a single firm has no interest in deviating from the equilibrium by enhancing (through reformulation) the healthiness of its products. As long as the other firms do not modify the characteristics of their products, it is very hazardous for a firm to unilaterally modify the characteristics of its products. We thus argue that policy intervention is needed to provide incentives for all firms to reformulate their products. We argue that, rather than establishing MQS, a more optimal policy would be to define a consistent mix of actions integrating price policy, prescriptive labelling and advertising restrictions for products that do not comply with a given threshold. Such a policy is intended to provide incentives for firms to reformulate their products while avoiding banning certain products. Moreover, rather than targeting inter-category changes in consumer diets, which has proved costly for the consumer, such a policy, designed at the level of product categories, is designed to favour substitution within product categories.

However, the available research does not allow these conjectures to be confirmed through evidence-based analyses. To achieve this goal, new investigations are required. First, a conceptual framework that allows for a discussion of the impacts of various policy instruments is lacking. Such a framework, integrating the linkages between products' health and taste characteristics, would be useful for analysing firms' strategic reactions to policies and thus for deriving a set of optimal policies. Second, empirical analyses of policies should better account for the heterogeneity of situations, particularly those that are income related. Those evaluations should also integrate firms' strategic reactions to the policies wherever they concern prices or product characteristics. To do so, it is necessary to develop a database on product characteristics that would make it possible to characterise the heterogeneity of content among products and how product characteristics change over time (Roodenburg and Leennen, 2007; Goglia *et al.*, 2010; Neal *et al.*, 2013). Third, to be able to evaluate the health impact of policies, it is necessary to develop integrated models linking economic models predicting the impact of various policies on consumption with health models predicting how a change in consumption impacts health. This is absolutely critical if one wishes to compare the cost-effectiveness of various policies.

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