The indirect economic dimension of impact evaluation
(PEN Deliverable 3.2.2)

Professor Daniele Moro
Dr Giulia Tiboldo
Dr Elena Castellari
On behalf of the PEN consortium

Università Cattolica del Sacro Cuore
Alta Scuola di Management ed Economia agroalimentare (SMEA)
Via Milano 24
26100 Milano, Italy
https://dipartimenti.unicatt.it/economia-agroalimentare-home

Moro D, Tiboldo G, Castellari E. The Indirect Economic Dimension of Impact Evaluation - Deliverable 3.2.2. Bremen, Germany: JPI HDHL Policy Evaluation Network (PEN), 2022:1–40

The indirect economic dimension of impact evaluation

1. Introduction

The number of obese and overweight people has been increasing in recent years in several European countries. According to the World Health Organization (WHO), in 2014 Europe had the second highest proportion of overweight and obese people after the Americas, and today more than 50% of the adult population is overweight or obese in most Member States (WHO, 2019; Eurostat, 2020). As poor nutrition and obesity increase the susceptibility to diseases, such as cardiovascular diseases, diabetes and cancers (also referred to as "non-communicable diseases" (NCDs)), effective public policies are needed to prevent and tackle unhealthy lifestyles (Eurostat, 2020). This is why, the European Commission launched in May 2007 the "Strategy for Europe on nutrition, overweight and obesity related health issues", with the goal of reducing ill-health due to imbalanced diets and limited physical activities (EC, 2007). Among the others, the School Fruit and Vegetables and Milk (FVM) Scheme is one of the actions that was taken to help children to develop healthy eating habits (EC).

Despite recognizing the essential role that direct public policies can play in tackling unhealthy diets, such as taxes on unhealthy foods and nutrients (e.g. the Danish saturated fats tax and the French soda tax in 2012, the Catalonia sugar-sweetened beverages tax in 2017 and the UK sugar tax in 2018) or the aforementioned FVM scheme, it is also important to acknowledge that other policies with different objectives, such as agricultural and trade policies, may contribute to or hinder the success of these interventions by indirectly affecting the so called "food environment" (i.e. what foods are available, where and for what price) (Clark et al. 2012). This is why, understanding the key mechanisms through which these policies may indirectly affect food consumption and dietary quality is essential to design effective strategies for achieving healthier lifestyles.

The main objective of this subtask is therefore to identify the potential mechanisms through which existing policies with different objectives, such as agricultural and trade policies, may indirectly affect nutritional and health outcomes and to assess the extent of these impacts. Similarly to Traill et al. (2014), we first analyze the key influencing factors of food choices (i.e. prices, income and preferences) (section 2). Then, we review the existing body of literature evaluating how different policies may indirectly affect food consumption and health through their impact on these influencing factors, first focusing on agricultural and trade policies (section 3 and 4 respectively) and then, on other policies (section 5). The distribution of the policy impact with respect to the economic welfare distribution of different socio-economic groups is also analyzed. Differently from Traill et al. (2014), this analysis focuses only on indirect policies, as direct policies effects are already part of sub-task 3.2.1 evaluation.

Moreover, as prices are pointed out by several authors as the most important influencing factor in determining food consumption in high-income countries, such as Europe and the US (e.g., Alston, Sumner, and Vosti 2006), we carry out a structured literature review on price transmission along the agri-food chains to review and refine methods that are currently used to analyze the indirect health economic dimension of policy impacts through food prices (section 6). The findings from this review are then employed to develop a theoretical framework of price transmission along the food chain that enables to estimate the potential effect of policies affecting the cost of agricultural raw commodities on foods prices and consumption. This framework is then employed in our empirical application assessing the effects of changes in the cost of raw sugar on the sugar-sweetened beverages market in Italy (section 7).

2. Key influencing factors of food choices

The quantity demanded of food mainly depends on prices and food availability, income and consumers' preferences. Therefore, any policy or intervention that directly or indirectly affects one or more of these influencing factors may have significant impact on the amount and type of foods consumed in a country (Alston, Sumner, and Vosti 2006; Traill et al. 2014). Even though income and food availability significantly affect quantities demanded of foods, prices are often pointed out as the most important influencing factor in determining food consumption in high-income countries, such as the U.S. and Europe (Alston, Sumner, and Vosti 2006). Moreover, while the impact of consumers' preferences on the healthiness of the diet cannot be easily generalized given their multifactorial origins (Beckerman et al. 2017), some key insights about the role of prices and income in determining food choices and diet quality can be given.

Focusing on prices, the law of demand applies to food as to all other goods. This means that all the policies that cause lower prices may encourage food consumption, and so, they are blamed for exacerbating the obesity problem (Alston, Sumner, and Vosti 2008). As price elasticities for all foods are usually higher in low-income countries and, within countries, in low-income groups, changes in food prices are expected to have a greater impact on lower income countries and on poorer households rather than on more affluent ones, leading to a higher risk of obesity and/or undernutrition problems among the most vulnerable groups of the population (Green et al. 2013; Traill et al. 2014). In this regard, it is important to acknowledge that while in the past overweight and obesity were mainly affecting high income countries, nowadays they have become a global problem, as the prevalence of obese and overweight people is also increasing at an alarming rate in low and middle-income countries (EC, 2007; Boseley, 2019).

As all the policies that directly or indirectly affect food prices are blamed for being regressive, different approaches are found especially in the literature about food taxation to evaluate the potential distributional effects of these policies, such as indices that compare the income and tax distribution (i.e., the Reynolds-Smolensky and the Kakwani -García-Muros et al. 2017) or the comparison of changes in traditional measures of consumer surplus (i.e., compensating or equivalent variations) across different socio-demographic groups to draw conclusions about the distribution of the policy impacts (see for example Caillavet, Fadhuile, and Nichèle 2016; Dogbe and Gil 2018).

As for prices, income elasticities are higher in low-income countries and groups than in relatively richer ones. Moreover, for all socio-demographic groups, income elasticities for animal products, processed and ready-to-eat foods, as well as for food-away from home (FAFH), are higher than those of all other foods (Traill et al. 2014). This is why the economic growth of a country is usually associated with the so-called “nutrition transition”, that is, a dietary shift from traditional staple foods towards less healthy diets which are richer in animal fats, sugars, and ultra-processed foods. According to several authors, this “nutrition transition” has been significantly contributing to the rise in obesity rates and NCDs in less-developed countries (Baker, Kay, and Walls 2014; Giuntella, Rieger, and Rotunno 2018). This means that any policy that indirectly affects income can have a significant impact on dietary quality, and so, on consumers’ health, particularly for the most vulnerable socio-economic groups.

3. Agricultural policies

Agricultural policies, such as subsidies and price support measures, as well as quotas, may indirectly affect food consumption because of their impact on food prices through their effect on agricultural commodities costs (Alston, Sumner, and Vosti 2006). According to the conventional economic wisdom, agricultural subsidies may lead to over-production and lower prices to consumers, and so, to higher food consumption, with potential negative impacts on health (Miller and Coble 2007; Alston, Sumner, and Vosti 2008; Alston, Okrent, and Rickard 2013). However, real world subsidy programs often differ significantly from this text-book simplistic representation (Alston, Sumner, and Vosti 2008; Alston, Okrent, and Rickard 2013). For example, the US farm policy has been often referred to as a “cheap food policy” and it has been blamed for increasing the availability of fattening foods at relatively low prices, and so, for contributing to the obesity epidemic in the country. This is because subsidy payments, like the ones included in the US commodity programs, may lead farmers to increase their production, thanks to higher returns (i.e., price plus subsidy). In order to clear the market from this surplus production, the price of agricultural commodities should then fall, leading, in turns, to less expensive food products at the retail level, and so, to higher consumption (Miller and Coble 2007). Nevertheless, it is important to acknowledge that the effects of these subsidies have been also limited by the presence of additional policies, (e.g., acreage set-asides) that reduced the production acreage, and so, the price-depressing and consumption-enhancing effects of these measures. As a consequence, the overall impact of the US subsidy policy has been smaller than the text-book subsidy model would suggest (Ralston 1999; Alston, Sumner, and Vosti 2008; Alston, Okrent, and Rickard 2013; Franck, Grandi, and Eisenberg 2013). Furthermore, U.S. farm commodity programs made only some agricultural commodities cheaper (e.g. grains and oilseeds), while the price of other commodities increased, because of the presence of additional policies, such as import restrictions and trade barriers (Alston, Sumner, and Vosti 2006; 2008). For instance, import barriers were applied to sugar, dairy products, orange juice and beef, therefore increasing domestic prices and discouraging consumption of all the foods that use these raw commodities as ingredients (Alston, Okrent, and Rickard 2013; Ralston 1999). This is why, according to some authors, the net effect of the U.S. agricultural policy was to raise agricultural and food prices rather than decreasing them (Alston, Sumner, and Vosti 2008). For example, Alston, Sumner, and Vosti (2008) review some of the studies that evaluate the impact of the removal of the U.S. agricultural policy. Among the others, the analysis carried out by the Australian Bureau of Agricultural and Resource Economics (ABARE) finds out that the elimination of farm subsidies would result in higher prices for grains only (e.g., corn and wheat), while the prices of many other commodities should fall. As a consequence, the consumption of many foods, such as those containing sugar, meat and dairy products, as well as, that of fruits and vegetables should increase. However, the authors also point out that the overall nutritional and health consequences of the subsidies phase out are difficult to predict and might not be desirable. For example, higher sugar and meat intake might have a negative effect on consumers' health, while the opposite is true for fruits and vegetables, even though an increase in potato consumption might not be desirable. Rickard, Okrent, and Alston (2013) use a detailed multi-market model to simulate the effects of the US agricultural commodity program on prices and consumption of several commodities. Similar to the ABARE study, their results indicate that the removal of all agricultural policies, including trade barriers, would cause a rise in the consumption of several foods thanks to lower prices, leading to a higher caloric intake for consumers. As stated by Alston, Sumner, and Vosti (2008), these studies confirm that the U.S. agricultural policy together with trade restriction measures have not made food commodities cheaper, therefore contradicting the "cheap food policy" theory.

As for the U.S., agricultural policies in many other OECD countries have led to higher prices for agricultural commodities through market price support measures introduced to ensure farmers' profitability (Traill et al. 2014). For example, the European Union (EU) Common Agricultural Policy (CAP) had the effect of a tax on consumers, because of high internal price support and foreign protection, therefore discouraging food consumption. For example, the price of sugar was two or three times higher than the equilibrium level in the absence of the policy (Schmidhuber and Shetty 2010). This is why the recent reform of the EU CAP, which has involved a shift from market price support to direct payments which are mainly delinked from production, has lowered consumers prices, therefore encouraging higher food consumption (Traill et al. 2014). In this regard, Bonnet and Requillart (2011) investigate the impact of the EU CAP sugar policy reform on retail prices and purchases of sugar-sweetened beverages (SSBs), and so, on added sugars intake for French consumers. Their results indicate that the 36% decrease in the sugar cost due to the reform enactment will result in a 3% fall in SSBs prices. Moreover, regular products with the highest sugar content will benefit the most and will obtain the highest gain in market share. This means that consumption of added sugars will increase, particularly among households including obese and over-weight individuals, with potential negative consequences on health.

Overall, it seems that the EU CAP before the reform has mainly taxed consumers rather than subsidized them, by setting floor prices for several commodities and ensuring foreign protection. According to Schmidhuber and Shetty (2010), the EU agricultural policy particularly taxed those commodities (i.e. sugar, dairy product and meat), and so, nutrients (i.e. cholesterol, saturated fats and added sugars) that are generally associated with significant adverse effects on health (i.e. development of NCDs). However, the CAP has also indirectly encouraged the consumption of some of these unhealthy nutrients by subsidizing some foods to the nonprofit sector and to the food industry to dispose of the surplus production induced by the price support measures (Birt, 2007). For example, subsidies were provided to promote milk consumption in schools through the FVM scheme, which has been often criticized as the milk was full-fat, and so, it supplied too many calories and saturated fats to children, therefore potentially contributing to the incidence of NCDs, and also, for the sale at cheap prices of butter to hospitals (Birt, 2007; Schmidhuber and Shetty 2010). The distribution of the over-production resulting from the agricultural support program had a significant impact on the dietary choices of some population groups also in the US. For example, the donation of the cheese surplus to low-income households under the Emergency Food Assistance Program (TEFA) almost doubled the its consumption within this group. A similar example is given by peanut butter (Ralston 1999). Moreover, as subsidies were also provided to allow the sale at cheap prices of raw agricultural commodities to the food industry, such as dairy products and beef, the EU agricultural policy indirectly affected the nutritional quality of food products available to consumers by encouraging the use of relatively cheap dairy fats and beef in food manufacturing, and so, the content of some unhealthy micronutrients in processed foods (i.e., saturated fats) (Birt, 2007). According to the analysis carried out by Lloyd-Williams et al. (2008), per-capita saturated fats consumption and cholesterol level would have been lower (-1% and -0.06mmol/L) without the CAP subsidies leading to more than 20,000 fewer deaths related to chronic health diseases and strokes.

Finally, subsidies were also provided in the form of export subsidies to allow the sale of excess production at world market prices outside the EU, therefore potentially shifting the health burden to other countries (Birt, 2007; Schmidhuber and Shetty 2010). This is because, by depressing world prices (large country assumption), the EU CAP indirectly encouraged excess food consumption in food-importing countries, with potential detrimental consequences on health (i.e. excess saturated fats consumption deriving from the availability of relatively cheap beef and dairy products) (Birt, 2007; Schmidhuber and Shetty 2010; Traill et al. 2014). This was particularly true for developing countries, where the CAP price-depressing effect on final consumption was more significant given the low value of margins along the food chain (Schmidhuber and Shetty 2010). It is also important to acknowledge that the EU CAP might have had some unintended consequences not only on food consumption but also on food production in developing countries. Generally, low international prices of agricultural commodities reduce the economic value of agricultural products, therefore depressing farmers' income (Clark et al. 2012). Moreover, the large-scale cattle rearing which was highly subsidized by the EU CAP required large quantities of feed that were mainly supplied by developing countries. So, the large demand of feed from the EU may have led, in some cases, to the diversion of land from human to animal food production in those countries. Overall, all these factors may have affected the availability of food, and so, public health in developing countries, resulting in depressed production and, in turn, food consumption (Birt, 2007; Clark et al. 2012). This is an example of how domestic agricultural policies can also have indirect global health implications (Traill et al. 2014).

Production quotas were also used under the EU CAP in order to stabilize the production of some agricultural commodities, such as milk and sugar, and so, to keep internal prices high (EUROSTAT). This means that production quotas may also indirectly affect food consumption through their effect on prices. Bouamra-Mechemache, Jongeneel, and Réquillart (2008) simulate different scenarios of a gradual increase in milk quotas in the EU using a partial equilibrium model. Their results show that, in the absence of the quotas, milk production would increase leading to a large fall in raw milk price. For example, a 1% increase in production would result in a 3% fall in milk prices. Moreover, as a significant share of the EU milk production is exported, this would consequently lead to lower prices for dairy products also on international markets. Similar results are also found by Soregaroli, Sckokai, and Moro (2011) and Philippidis and Waschik (2019). Bouamra-Mechemache, Jongeneel, and Réquillart (2008) also find that the rise in milk supply may have a greater impact on the implicit price of fats rather than on that of proteins. This is because, while the increase in the availability of milk protein can be sold on the world market (mainly as skimmed-milk powder), the same is not true for milk fat, as the EU is not competitive for butter at the international level. This means that the milk fat surplus should be incorporated into other food products in order to be sold on the domestic market. In this way, the milk quotas abolition may indirectly affect consumers' health by inducing changes in the composition and in the nutritional quality of the food products available to consumers.

Several authors also claim that agricultural policies may indirectly affect diets and public health not only through prices, but also through their effect on food products availability (Traill et al. 2014). By dictating which crops will be subsidized, the government indirectly incentivize producers to supply some agricultural commodities over others, and so, it determines which foods will be the most readily available to consumers (Hawkes et al. 2012; Franck, Grandi, and Eisenberg 2013; Traill et al. 2014). For example, both the EU and US agricultural policies provided only little financial support to fruits and vegetables production, while many subsidies were assigned to other agricultural commodities, such as dairy products, meat and sugar. As a consequence, these policies made more profitable for farmers to substitute the crops receiving payments on at least some of the agricultural land previously devoted to fruits and vegetables, therefore reducing fruit and vegetable supply and availability. Moreover, subsidies on cereals indirectly favored the rise in meat supply by incentivizing grains production that could be used as cheap cattle food (the so called "double-subsidy" effect for meat producers) (Miller and Coble 2007; Birt, 2007). These examples show how agricultural policies may indirectly shape diets by affecting the mix of commodities produced and made available on the market (Traill et al. 2014).

As food choices are mainly determined by prices and availability, and this is particularly true for households on low-income, the EU CAP may have widened health inequalities across different socio-economic groups, and also, contributed to “food poverty” (i.e., the inability to have access or to be able to afford foods for a healthy diet) (Birt, 2007). As explained by Birt (2007), the widespread availability of cheap dairy, meat, and sugary products (e.g., snacks and drinks) thanks to the CAP subsidies, made foods with high saturated fat and sugar content more affordable to low-income consumers. On the other hand, the relatively high prices paid for vegetables and fruits led to lower their consumption among people living on a tighter budget. As high intakes of fatty and sugary foods and low fruit and vegetable consumption are known to be associated with the incidence of several NCDs, the inequality in diets also translated into an inequality in diet-related diseases, with these diseases being more prevalent among poorer socio-economic groups.

Some authors empirically test the existence of a significant association between the prevalence of obesity issues in a country and agricultural policies through food prices. For example, Cutler, Glaeser, and Shapiro (2003) analyze the relationship between the percentage of obese people and the level of producer protection in a country through linear regression, using the Producer Support Estimate (PSE)[1] data provided by the OECD to account for the level of tariff and non-tariff barriers on agricultural commodities. Their results show that a one standard deviation increase in the PSE significantly lowers the incidence of obesity by 4.5%. Differently from Cutler, Glaeser, and Shapiro (2003), Loureiro and Nayga (2005) and Alston, Sumner, and Vosti (2008) employ the Consumer Support Estimate (CSE), a measure of consumers support to the agricultural sector, instead of the PSE (Alston, Sumner, and Vosti 2008) as explanatory variable to measure the agricultural subsidies effect on obesity rates. Consistently with Cutler, Glaeser, and Shapiro (2003), their results show that countries that require larger contributions from consumers to support the agricultural sector through high agricultural prices are more successful in limiting the incidence of obesity-related problems. Nevertheless, some questions remained unanswered. For example, Alston, Sumner, and Vosti (2008) point out that obesity rates differ significantly across EU countries, even though they share the same agricultural policy (CAP). Moreover, it would be important to establish whether the correlation between high agricultural prices and low obesity rates also translates into a causal effect (Schmidhuber and Shetty 2010).

In conclusion, it is conceptually possible that agricultural policies may significantly affect diets and the prevalence of overweight and obesity in a country through their effect on prices and availability of agricultural products. However, the size of this effect depends on several factors, such as the extent of price transmission along the food chain, that is, the rate at which changes in the agricultural raw commodities costs are transmitted to retail prices. Moreover, consumers’ responsiveness to food price changes and substitution patterns are relevant too (Alston, Sumner, and Vosti 2008; Alston, Okrent, and Rickard 2013). According to several authors, agricultural policy has only had a modest impact on final retail prices and food

[1] The Producer Support Estimate (PSE) is computed as the ratio of domestic agricultural prices over worldwide prices (Cutler, Glaeser, and Shapiro, 2003).

choices, and so, on nutritional outcomes (Alston, Sumner, and Vosti 2008; Golan and Unnevehr 2008). This is mainly because agricultural commodities costs represent only a small fraction of the final prices paid by consumers for food products, and this share has also significantly been shrinking over time (Alston, Sumner, and Vosti 2006; Alston, Okrent, and Rickard 2013; Traill et al. 2014). During the last decades, the farm-retail spread has been dramatically increasing, partly because of the rise in the costs of other inputs (e.g., labor cost), and also because of the changes in food characteristics (e.g., added-value components such as convenience, packaging and distribution). The higher the margins between first and final consumption (e.g. processing, marketing and distribution margins), the lower the extent of farm-retail vertical price transmission (Schmidhuber and Shetty 2010). For this reason, the influence of farm commodity prices on final retail prices is even lower in the case of ultra-processed and ready-to-eat foods, and also, for food-away-from-home and sugar-sweetened beverages, that is, for several food categories that are often implicated in the rising incidence of obesity (Golan and Unnevehr 2008; Rickard, Okrent, and Alston 2013; Traill et al. 2014). For example, the farm value share in sweetened foods is less than 5% (Beghin and Jensen 2008).

Moreover, it is also important to acknowledge that consumer responsiveness to price changes for most foods is low (Ralston 1999; Schmidhuber and Shetty 2010; Franck, Grandi, and Eisenberg 2013; Traill et al. 2014). Furthermore, the recent transition towards alternative support measures which are mainly decoupled from current production (i.e. area-based incentives and decoupled payments) in several OECD countries contribute to re-align domestic and international prices, and so, to reduce the incentives to over-production (Alston, Sumner, and Vosti 2008; Alston, Okrent, and Rickard 2013; Cawley 2010; Traill et al. 2014). Therefore, the ability of agricultural policies to affect caloric intake in developed countries, like the EU and US, is quite modest and has been falling over time. However, in less developed countries, this impact might be more significant, as the extent of price transmission between farm and food products prices is higher, given the low level of processing and value addition along the food chain (Traill et al. 2014).

Even though the direct impact of agricultural policies on retail prices and consumers might be modest, these policies may also indirectly affect the quality of the diet by influencing food manufacturers choices (Alston, Sumner, and Vosti 2006). This is because, farm policies modify agricultural inputs relative prices, therefore creating opportunities for the food industry to substitute for lower priced ingredients. In this way, they also influence the nutritional quality of the food products available in the marketplace, as well as food prices and consumption, as the food processors cost savings may be passed on to consumers (Alston, Sumner, and Vosti 2006; Hawkes et al. 2012; Franck, Grandi, and Eisenberg 2013). For example, the corn and sugar policies in the US have distorted the relative prices of sugar and high-fructose corn syrup (HFCS), therefore encouraging the replacement of sugar with the relatively less expensive HFCS as a caloric sweetener (Alston, Sumner, and Vosti 2008; Beghin and Jensen 2008). However, there is some evidence that HFCS consumption may facilitate the rise in the energy intake, as well as the risk of food-related diseases (Beghin and Jensen 2008; Cawley 2010; Franck, Grandi, and Eisenberg 2013). According to several authors, overall agricultural subsidies have skewed agricultural markets towards the over-production of commodities (e.g. HFCS and hydrogenated soybean oil) that are basic ingredients of ultra-processed, energy dense foods, therefore allowing food manufacturers to increase calorie density at a negligible cost, and also, to launch novel foods rich in cheap sugars and fats (Clark et al. 2012; Hawkes et al. 2012; Franck, Grandi, and Eisenberg 2013) Agricultural subsidies can therefore influence food composition and public health without first influencing consumers preferences, and consumers might not be even aware of the reformulation process, particularly if the taste remain unchanged (Golan and Unnevehr 2008).

4. Trade-related policies

As for agricultural policies, trade-related policies may indirectly affect the quality of the diet and public health by influencing the "food environment"(Clark et al. 2012). In general, all trade policies that restrict food imports (i.e. import tariffs, quotas and barriers), raise foods prices, therefore discouraging consumption (Ralston 1999; Alston, Sumner, and Vosti 2008; Alston, Okrent, and Rickard 2013). This was for example the case for sugar under the EU and US sugar regime, thanks to the presence of import tariffs and restrictions (Schmidhuber and Shetty 2010; Alston, Okrent, and Rickard 2013). This is why, according to the analysis carried out by Rickard, Okrent, and Alston (2013), the removal of all US farm support policies, including trade barriers, would cause higher consumption of several food products, such as sugar and dairy products, therefore raising caloric intake among consumers. In the same way, according to Bonnet and Requillart (2011), the reform of the EU sugar policy regime might indirectly encourage added sugars consumption among French households by decreasing the cost of sugar for food manufacturers, such as soft-drinks producers, by 36%.

Even though trade liberalization may lead to lower domestic prices for foods in some countries, such as the US and EU, thanks to the reduction of non-tariff barriers, this might not be the case for world food prices. For example, the trade reform induced by the Uruguay Round Agreement on Agriculture (URAA) caused an overall rise in world food prices by eliminating the incentives to over-produce in developed countries, such as the US and EU (also thanks to the concurrent domestic agricultural policy reform) (Traill et al. 2014). On the other hand, trade liberalization may also lead to lower global foods prices, thanks to the rising level of international competition and the possibility of exploiting economies of scale for producers (Thow and Hawkes 2009). In any case, it is important to acknowledge that given the low value of transmission of world food prices changes to domestic prices (less than 50%), trade reforms are expected to have a very modest impact on final food prices and diets. This is particularly true if we consider that international food prices would change by few percentage points even in the case of full trade liberalization (about 5% for agricultural commodities and 1.3% for processed foods) (Traill et al. 2014).

Even though the price effect of the trade reform on agricultural and food commodities prices might have been limited, this might not be the case for food availability (Traill et al. 2014). Reductions in trade barriers can lead to greater amounts and types of foods that are imported and consumed into a country which, in turns, can alter the nutritional quality of the diet, and so, the prevalence of diet-related diseases (Sharon Friel et al. 2013; Traill et al. 2014). On the one hand, the growth in international trade may indirectly affect health by favoring the access to nutritious foods in all countries (Baker, Kay, and Walls 2014). However, on the other hand, it can also be an important driver of NCDs, by displacing traditional staple foods and favoring the global diffusion of the so-called “risk-commodities”, such as alcohol and ultra-processed foods (Baker, Kay, and Walls 2014; Traill et al. 2014; Giuntella, Rieger, and Rotunno 2018). Some studies show that the trade liberalization process that took place during the last decades has resulted in a dramatic increase in imports of refined foods that are rich in calories but nutrient poor in several developing countries, therefore contributing to the spread of the obesity pandemic (Sharon Friel et al. 2013; Barlow, McKee, and Stuckler 2018). This was for example the case for Mexico after the North America Free Trade Agreement (NAFTA), where the increase in trade flows of foreign products after the tariff elimination, particularly from the US, raises directly and indirectly the availability of several food products, such as soft-drinks, snack foods, dairy products and meat, that are associated with the “nutrition transition”, that is, the dietary shift away from traditional staples toward energy-dense processed foods (i.e. confectionary, savory snacks, processed meat products as well as soft-drinks). As these foods tend to be higher in added sugars, fats and salt than relatively less processed foods, the nutrition transition is also associated with rising rates of obesity and NCDs (Thow and Hawkes 2009; Clark et al. 2012; Sharon Friel et al. 2013; Baker, Kay, and Walls 2014; Giuntella, Rieger, and Rotunno 2018). A similar process took place in the Pacific Islands after trade liberalization (Thow and Hawkes 2009; Sharon Friel et al. 2013).

Besides this direct effect, trade policies, such as regional and bilateral trade agreements, can also indirectly influence food supply within a country in several ways. For example, NAFTA also indirectly contributed to higher availability and lower relative prices for animal products in Mexico (both meats and dairy products) by favoring domestic production, thanks to the rise in US export flows of cheap feed grains into the country, such as oilseed and related products (Thow and Hawkes 2009; Clark et al. 2012; Sharon Friel et al. 2013). This partly explains why chicken consumption in Mexico increased by 50% after NAFTA enactment (Clark et al. 2012). However, it is also important to underline that the expansion of the livestock sector in Mexico has mainly taken place under the aegis of US-lead firms which were able to take advantage of the more liberal investment regime ensured by NAFTA (Clark et al. 2012). More in general, as for other free trade agreements, NAFTA also indirectly raised the availability of processed foods and beverages in Mexico through the liberalization of foreign-direct investments (FDI), that is, by allowing transnational food companies to expand their production and marketing activities in the domestic market (Thow and Hawkes 2009; Baker, Kay, and Walls 2014). For instance, in Mexico US-based companies have been dominating the market of soft-drinks, which are considered as one of the major contributors of the rising added-sugar intake among Mexican households (Clark et al. 2012). In the same way, the rising availability of highly processed foods (e.g. processed cheese, whey, French fries, snacks) in Central America has mainly been driven by FDIs rather than by the rise in US exports (Thow and Hawkes 2009). It has also been proven that FDI liberalization through trade agreements has led to a significant surge in soft-drink consumption in several low and middle-income countries, and so, to a higher incidence of NCDs (Sharon Friel et al. 2013; Baker, Kay, and Walls 2014).

More in general, provisions about FDI liberalization, which are often a part of trade-related agreements and policies, enable a greater penetration of multinational food corporations at all the stages of the food chain, including food retailing, in many developing countries (Clark et al. 2012; Traill et al. 2014). In this regard, it is important to acknowledge that global retailers (e.g. Walmart, Carrefour and Tesco) may significantly affect the population eating habits through the variety of products they choose to sell, for example, by offering products which were previously unavailable, and also, in terms of prices and promotion (Sharon Friel et al. 2013; Traill et al. 2014). As global fast-food and supermarket chains act as an important vector of ultra-processed foods distribution, the rising market penetration of global food retailers has often been blamed for favoring the development of unhealthy eating habits in developing countries (Clark et al. 2012; Sharon Friel et al. 2013; Baker, Kay, and Walls 2014).

For all the reasons mentioned in the discussion above, many authors claim that NAFTA had a deleterious effect on nutrition and public health in Mexico (Baker, Kay, and Walls 2014). On the other hand, this agreement may have had some positive effects on diet quality for US households, as the imports of fruits and vegetables were much higher than they would have been in the absence of this (Ralston 1999). This example shows how the impact of free trade agreements on public health is likely to vary according to the partner country. For example, countries with a preferential trade agreement with the US generally have a much higher level of per capita soft-drink consumption (+63%) than countries with no such agreement which, in turn, may lead to a higher risk of NCDs (Baker, Kay, and Walls 2014). More in general, free trade agreements with the US are often associated with higher caloric intake in import countries, probably because of the highly competitive processed foods and beverages sector in the US (Barlow, McKee, and Stuckler 2018). In addition, imported US foods may be more obesity-prone than domestic ones because of their nutrients profile (Giuntella, Rieger, and Rotunno 2018). Therefore, the overall impact on diet and health of trade policies is quite difficult to predict, as it depends on the relative changes in prices and availability of healthy foods relatively to unhealthy ones (Giuntella, Rieger, and Rotunno 2018).

Trade policies can also affect diet and health through other indirect pathways, such as, by influencing income distribution and consumers' preferences (Sharon Friel et al. 2013). For example, trade liberalization can stimulate economic growth and employment in developing countries by favoring exports, increasing low-cost import opportunities, and also, by attracting FDIs (S. Friel et al. 2013; Baker, Kay, and Walls 2014). As mentioned by Traill et al. (2014), free trade agreements allow the production of agricultural and food commodities in those regions that have a comparative advantage, which mostly are developing countries, therefore raising domestic average income and potentially improving living standards. However, on the other hand, by favoring economic growth, trade policies may also indirectly contribute to the rise in NCDs as rising prosperity is often associated with a dietary shift from traditional staples towards less healthy diets (i.e. nutrition transition) (Clark et al. 2012; Baker, Kay, and Walls 2014; Giuntella, Rieger, and Rotunno 2018). Focusing on consumers' preferences, all policies that favor trade and investment liberalization also facilitate the transnational growth and reach of global food advertising, and so, they can have long-term nutritional implications on the population by shaping consumer preferences (Friel et al. 2013; Traill et al. 2014; Giuntella, Rieger, and Rotunno 2018).

Finally, according to several authors, free trade agreements may indirectly affect consumers' health by constricting the domestic "policy space", that is, the freedom to develop policies and regulations to promote and protect public health (Sharon Friel et al. 2013; Baker, Kay, and Walls 2014). For example, by strengthening intellectual property rights and enhancing trademarks protection, they might constrain the ability of the government to develop regulations about food labeling and composition criteria, as well as food advertising, as these may be deemed to be trade-related (Sharon Friel et al. 2013; Baker, Kay, and Walls 2014). This was for example the case of Thailand, whose front of pack traffic light labeling system on food products was blamed for contravening the Agreement on Technical Barriers to Trade (Sharon Friel et al. 2013). In this regard, it is also important to underline that all technical barriers to trade, such as technical and quality standards as well as sanitary and phytosanitary measures, may potentially have the same impact on food prices and availability as tariff barriers. This is why the Agreement on Technical Barriers to Trade, by ensuring that countries do not adopt technical regulations that generate unnecessary barriers to trade, may have contributed to rising caloric intake by increasing the availability and affordability of food products traded and consumed across countries (Baker, Kay, and Walls 2014; Traill et al. 2014; Barlow, McKee, and Stuckler 2018).

Some authors empirically evaluate the impact of trade-related policies on diet and health using different approaches. Baker et al. (2016) use a natural experiment to evaluate the effect of the US-Peru Free Trade Agreement (FTA) on soft-drinks market and consumption in Peru. To do so, they employ a difference-in-difference (DID) approach using Bolivia as a control country. Their results show that the FTA have significantly encouraged FDIs and soft-drink production in the country, as well as the diversification of sugar-sweetened beverages supply. However, the overall impact on health is difficult to determine. For example, the increase in bottled water sales may have a positive impact on health, while rising juices, sport and energy drinks consumption may have detrimental effects on health given their high added sugar content. Barlow, McKee, and Stuckler (2018) employ a fixed effects regression model to assess how the 1989 Canada-US FTA affect calorie availability in Canada, which is measured as the total quantity of food and beverages available to consumers. Their results show that this agreement increased calorie availability in Canada by 170 calories per capita per day, with potential negative impacts on health. Giuntella, Rieger, and Rotunno (2018) evaluate the impact of NAFTA on obesity prevalence in Mexico, using the share of unhealthy food imports coming from the US as the main explanatory variable and an instrumental variable approach to control for the potential endogeneity of this variable. Their results show a positive and robust causal effect of unhealthy food imports on obesity across Mexican state, and also, a significant negative relationship between education and exposure to unhealthy foods. This means that the pro-obesity role of unhealthy food imports is more significant for less educated people, and so, that health disparities may have widened after the FTA. However, it is also important to acknowledge that FTAs are often implemented in combination with other policies to achieve specific goals, such as promoting economic development. As a consequence, it might be challenging to isolate the actual effect of FTAs alone, also considering that demand-side factors, such as rising prosperity, may also significantly affect the nutrition transition (Barlow, McKee, and Stuckler 2018).

5. Other policies

Besides agricultural and trade policies, many other policies may indirectly affect nutrition and health through their impact on the food environment. Among the others, value-added tax (VAT) regulations may influence food choices by making food commodities relatively cheaper or more expensive, also depending on the degree of pass-through to consumer prices (Viren 2009). For example, ODonoghue et al. (2018) find that the reduction in the VAT rate on foods in Hungary would increase food consumption by 9%, with this impact being the largest among households in the lowest income decile. On the other hand, monetary policies can significantly affect agricultural commodities prices not only domestically, but also on international markets if the country is large enough (i.e., “large country “assumption) (Abbot et al., 2008). In this regard, several authors claim that the US dollar depreciation policy between 2002 and 2008 was partly responsible for the 2007-2008 global food price crisis (Abbot et al., 2008; Mitchell, 2008; Gilbert 2010; Borychowski and Czyżewski 2015). As almost all commodities are traded in terms of US dollars, when the dollar depreciates, agricultural commodities become relatively cheaper in other currencies, and so, their demand increases. However, as agricultural supply is inelastic in the short run, this may in turn lead to a general rise in food prices (Abbot et al., 2008; Gilbert 2010; Borychowski and Czyżewski 2015). In particular, it has been shown that the elasticity of commodity prices with respect to dollar depreciation ranges between 0.5 and 1 and this explains why the 35% depreciation of the US dollar against the euro between 2002 and 2008 may have had a significant impact on international food prices in that period (Mitchell, 2008).

Focusing again on policies related to the agricultural sector, according to several authors farm commodities have become more abundant and cheaper during the last fifty years thanks to public investments in agricultural research and development (R&D) rather than because of farm subsidies. Agricultural R&D contributes to lower unit cost of farm commodities by increasing total factor productivity, and this change in production costs can significantly impact food prices (Alston, Sumner, and Vosti 2006; 2008; Miller and Coble 2007; Beghin and Jensen 2008; Rickard, Okrent, and Alston 2013). In addition, technological innovations deriving from R&D investments make agricultural products more abundant that they would have been otherwise (Alston, Sumner, and Vosti 2006; Rickard, Okrent, and Alston 2013).

More in general, all the policies that affect farm commodities production costs, such as energy costs, may indirectly influence food prices and availability, and so, nutrition and health. For example, higher energy prices due to fuel taxation can significantly raise the production costs of agricultural raw materials, also because some key inputs, such as fertilizers and other chemicals, which are heavy-users of energy in their production processes, become more expensive (Mitchell, 2008; Borychowski and Czyżewski 2015). Moreover, transport costs also increase in this scenario (Gilbert 2010). This rise in food production costs ultimately gets reflected into higher food prices and lower availability (Mitchell, 2008; Gilbert 2010; Borychowski and Czyżewski 2015). Renewable energy policies, such as the EU Renewable Energy Directive, may also have unintended consequences on food markets and consumers. For instance, the dramatic growth of biofuel production in the EU and US has been mainly driven by government subsidies and mandates (e.g., mandatory minimum blending requirements). However, biofuels production may lower agricultural commodities availability and raise food prices in two ways. First, demand for agricultural commodities increases as they are partly converted to fuel. As agricultural supply is non-elastic in the short-run, this in turns leads to higher prices (Rajagopal and Zilberman 2007; Borychowski and Czyżewski 2015). Then, agricultural land is partly reallocated from food to biofuel production, therefore reducing food supply ("food vs fuel" trade-off) (Rajagopal and Zilberman 2007; Gilbert 2010; Zilberman et al. 2013; Borychowski and Czyżewski 2015). This is why many authors claim that the diversion of foods crops as biofuels has been an important determinant of the 2007 food price crisis (Mitchell, 2008; Gilbert 2010). Actually, the extent of the effect of biofuel production on food prices highly depends on the producing-country resource availability (mainly land and water) (Rajagopal and Zilberman 2007; Zilberman et al. 2013). Focusing on the example provided by Zilberman et al. (2013), the expansion of corn ethanol production in the U.S., where farmers face significant land constraints, is expected to have a much higher impact on agricultural commodities prices and supply than expanding sugar ethanol in Brazil, where only a small fraction of arable land has been already used intensively. It is also important to acknowledge that second-generation biofuels are expected to put less pressure on foods markets than first-generation ones, as they use less land, and so, they should generate lower land diversion (Zilberman et al. 2013). This is particularly true if we consider that several by-products from biofuel can be also used as animal feed (e.g., dried distiller grains with soluble, oilcakes and so on) (Al Riffai et al., 2010).

Compliance with mandatory or voluntary regulations concerning for example food safety, animal welfare and pollution control implies additional costs for farmers, such as operational and investment costs, as well as transaction costs related to the required administrative procedures (Ralston 1999; Menghi et al., 2008). For example, investments in technology to meet higher standards of food safety or pollution control may significantly affect production costs of farm products, and so, the prices of some foods, therefore discouraging final consumption. In a similar way, operational costs may increase when a pesticide is banned, as producers have to turn to alternative products which might be less effective or more expensive than the one that was previously employed. This may lead, in turns, to lower yields, and so, to higher prices for some agricultural products, such as fruits and vegetables. Even though higher food prices may reduce consumption, the implied assurance of food safety deriving from the regulation may positively affect consumers' demand for these products, therefore contrasting the consumption depressing effect generated by higher food prices (Ralston, 1999; Menghi et al., 2008). As for food safety, ensuring higher standards of animal welfare implies higher costs for farmers, such as investment costs in new equipment or the operational costs for farm management adaptation, and also, lower productivity rates due for example, to the reduction in livestock density (Ralston, 1999; Nocella, Hubbard, and Scarpa 2010). Even though higher farm costs may reflect into higher prices for animal products, and so, lower consumption, several studies show that consumers are willing to pay considerable price premiums for products obtained using animal-friendly production systems (Baltzer 2004; Dransfield et al. 2005; Dickinson and Bailey 2005; Heng, Peterson, and Li 2013; Lusk 2019). As a consequence, in all the cases mentioned above, the net effect on food consumption is uncertain, as the change in consumers' preferences may counterbalance the consumption-depressing effect of higher food prices due to the improvement of food safety and animal welfare, as well as, to the reduction of the environmental impact of food production (Opara and Mazaud 2001; Menghi, 2008).

However, it is also important to acknowledge that food safety regulations by allowing or restricting the use of some inputs can also indirectly influence nutrition and health through their impact on food products composition. This is for example the case of some animal drugs affecting the fat content of meat, and also, of food additives, as they play an important role in determining the appearance, palatability and shelf-life of many processed foods (Ralston, 1999). In a similar way, besides their direct effect on consumers' tastes and behavior, information regulations, such as labeling requirements or advertising restrictions, can also indirectly affect nutrition and health through their impact on the composition of foods available to consumers. This is because information policies, by rising public awareness about some food attributes, also incentivize manufacturers to reformulate their products in order to capture first-mover profits, and this reformulation process may take place even if consumers are not concerned or even aware about the health attribute in question (Golan and Unnevehr 2008). For example, the 2005 release of the USDA Dietary Guidelines for Americans, which included recommendations for whole grains consumption, determined a sharp increase in whole grains products supply, with many manufacturers changing their product formulation and launching new whole-grain lines. This reformulation process had a significant impact on whole-grain consumption even if many US consumers were not even aware of the USDA recommendations (Mancino, Kuchler, and Leibtag 2008). Similarly, a significant product reformulation process took place after the enactment of the 2003 Federal nutrition label regulation that imposed the mandatory disclosure of trans-fat content on packaged foods (Unnevehr and Jagmanaite 2008). However, it is important to underline that these reformulated products are not necessary more healthful that the products they substitute for. For example, Mancino, Kuchler, and Leibtag (2008) point out that producers may raise sugar, salt and fat content to increase the palatability of whole grains products, therefore negatively affecting consumers' health. Similarly, as noticed by Unnevehr and Jagmanaite (2008), trans-fats were replaced only in some cases by healthier oil substitutes, while in several product categories less healthful substitutes were introduced.

Policies affecting the food system development may also play a significant role in shaping the local food environment, and so, on overweight and obesity rates in a country (K. B. Morland

and Evenson 2009). On the one hand, several authors claim that market deregulation may worsen the obesity pandemic by favoring the spread of fast-food restaurants and convenience stores (Maddock 2004; De Vogli, Kouvonen, and Gimeno 2014; Traill et al. 2014). For example, De Vogli, Kouvonen, and Gimeno (2014) find that countries adopting more liberal market policies often experience a faster increase in fast-food consumption and average population body mass index (BMI) than other countries. Moreover, as the per capita number of food stores and restaurants increases, the full price of food (i.e., the money price plus travel and waiting time) decreases, therefore encouraging food consumption (Chou, Grossman, and Saffer 2004). However, on the other hand, policies favoring the food system development may have beneficial effects on nutrition and health for people living in "food deserts" (i.e. areas where few or no food sources are available) by improving food access, that is, by increasing the number and variety of food stores (Hendrickson, Smith, and Eikenberry 2006; Alviola, Nayga, and Thomsen 2013). This is because people residing in these areas are likely to pay high food prices and usually face few options in terms of healthy foods as supermarkets are often limited in number and far in distance, and this may negatively affect their health status. This is particularly for more disadvantaged socio-economic groups (Inagami et al. 2006; Alviola, Nayga, and Thomsen 2013). As a consequence, policies favoring the food system development may improve the nutritional status of the communities residing in those areas. For example, many studies find that higher availability of supermarket chains is associated with lower prevalence of overweight and obesity, also across young people (Morland, Diez Roux, and Wing 2006; Liu et al. 2007; Morland and Evenson 2009; Powell 2009). However, the opposite is true for convenience stores, especially for children (Morland, Diez Roux, and Wing 2006; Powell et al. 2007; Grafova 2008; Morland and Evenson 2009; Grafova 2008; Galvez et al. 2009). So, the overall impact of stores availability on nutrition and health is quite controversial, also because demand side factors may partly explain the food system development ("reverse causality issue") (Baker, Kay, and Walls 2014; Traill et al. 2014).

Among the other others, policies affecting income and women employment may play a significant role on nutrition and health. Besides encouraging the nutrition transition in developing countries (see section 4), rising real income, also thanks to higher rates of women labor force participation, may also enable consumers to substitute healthier and more expensive food products for cheaper energy-dense ones, therefore preventing overweight and obesity issues (Cawley 2010). However, on the other hand, as the opportunity cost of time increases with income, people demand for convenience foods (i.e. ready-to-eat products, food-away-from home) may rise too, and these food products are often nutritionally less adequate than the ones prepared at home (Chou, Grossman, and Saffer 2004; Alston, Sumner, and Vosti 2006; Cawley 2010). This is why according to some authors childhood obesity is positively associated with maternal employment (Cawley 2010).

6. Understanding price transmission in agri-food chains

Even though incomes and food availability significantly affect food demand, prices are pointed out as the most important influencing factors in determining food consumption in high-income countries, such as Europe and the U.S. (Alston, Sumner, and Vosti 2006) (see Section 2). Therefore, understanding the determinants and dynamics of price transmission along agri-food chains is essential to model and predict the potential indirect impacts of policies affecting agricultural raw commodities costs on nutritional and health outcomes through food prices. In this section we summarize the main findings from the structured literature review we carried out to analyze how vertical price transmission in agri-food chains has been modeled and empirically analyzed in previous studies, focusing in particular on the sugar market.

Many factors may affect the extent of pass-through along food-chains. From the theoretical standpoint, Gardner (1975) is the first one to formally investigate the determinants of price transmission in the farm-retail supply chain. One of the key findings of Gardner's model is that the elasticity of pass-through (from farm to retail level) and the elasticity of pass-back (from retail to farm level) are not equal to each other. This means that the elasticity of price transmission is not independent on the source of the shock and the pass-through is usually smaller than the pass-back (Meyer and Cramon-Taubadel 2004; Lloyd 2017). McCorriston, Morgan, and Rayner (1998, 2001) extend Gardner's (1975) framework and prove that the presence of market power, particularly in the intermediate sector (i.e., food manufacturers), as well as the cost structure may significantly affect the extent of price transmission. On the other hand, the results from Weldegebriel (2004) shows that the existence of market power along the food chain (both oligopoly and oligopsony power) does not necessarily always lead to imperfect price transmission, as much depends, for example, on the assumed functional forms of the retail demand and farm supply. Furthermore, other potential causes of incomplete or asymmetric pass-through of prices are identified in the literature, such as adjustment or menu costs, inventory management strategies and government intervention (Meyer and Cramon-Taubadel 2004; Vavra and Goodwin 2005). Overall, these studies show that the assumption of full price transmission between farm and retail prices is often implausible and too restrictive because of the complexity and number of factors involved and, above all, given the existence of market power at different levels of modern food supply chains.

The issue of price transmission and market power in vertical chains, is usually analyzed following two main approaches: (1) time-series models; (2) New Industrial Organization (NEIO) models.

Time-series models analyze the movements of prices in vertically-related markets, for example, by estimating the correlation coefficient at different stages of the market or testing the causality in price transmission (Digal and Ahmadi–Esfahani 2002; Lloyd 2017). Among the others, price-asymmetry and cointegration models are the most widely used time-series techniques in the agricultural economics literature (Digal and Ahmadi–Esfahani 2002; Kharin 2015). Time-series techniques have been extensively used in empirical analysis as they are relatively easier to implement than NEIO methods to evaluate the price dynamics of the whole supply chain, partly because of fewer data requirement (mainly farm and retail price movements) (Digal and Ahmadi–Esfahani 2002; Lloyd 2017; Cavicchioli 2018). However, these models are also often criticized as they lack a microeconomic foundation (Digal and Ahmadi–Esfahani 2002; Lloyd 2017; Cavicchioli 2018).

On the other hand, the main focus of NEIO methods is modelling and testing imperfect competition (Lloyd 2017; Bonanno, Russo, and Menapace 2018). For example, firms' conduct or price-cost margins are not assumed a priori, but derived from microeconomic models of supply and demand of the industry and empirically tested (Aragrande et al. 2017). In this regard, Appelbaum's (1982) conjectural variations approach has been used widely to directly estimate the intensity of oligopoly or oligopsony power in homogeneous products agricultural markets using industry-level data (Sheldon 2017; Bonanno, Russo, and Menapace 2018) while, discrete choice demand models, such as the random coefficients model developed by Berry, Levinsohn, and Pakes (1995) (BLP herein), are commonly used for the analysis of demand and market power issues in differentiated products market, as they allow to overcome the so-called "dimensionality issue". As for time-series techniques, NEIO models also provide measures of price transmission, but their findings are more conclusive and reliable as they are rooted in economic theory (Digal and Ahmadi–Esfahani 2002; Lloyd 2017; Cavicchioli 2018). However, it is also important to acknowledge that these models may be difficult to estimate due to the data requirements, and also, because of the required econometric efforts that increase with the model complexity and the number of stages of the marketing chains being analyzed (Digal and Ahmadi–Esfahani 2002; Cavicchioli 2018).

The main differences between the time-series and NEIO approaches and the results that one can get by applying these methods can be further illustrated focusing on some studies that analyze the impact of the 2006 EU CAP reform of the sugar market. The first study by Aragrande et al. (2017) uses a times-series approach (Vector Autoregression and Vector Error Correction models) to assess the effect of the EU reform of the sugar regime on price transmission in the sugar sector, by using data on ex-work and retail sugar prices in some European countries. Their results show that vertical price transmission asymmetries toward price increases exist from ex-work to retail price, and also, the other way around. This means that the reduction in the cost of sugar after the reform was not fully transmitted to retail prices, and so, the distance between ex-work and retail prices of sugar in the EU has been increasing over time.

On the other hand, Bonnet and Requillart (2013) employ the NEIO approach to investigate the potential indirect impact of the EU sugar policy reform on the sugar-sweetened beverages (SSBs) market in France. They develop a structural econometric model that allows to assess the extent of price transmission of a cost change (i.e., change in the cost of raw sugar) taking into account the vertical and horizontal interactions between manufacturers and retailers. To do so, they first estimate consumer demand for SSBs using the BLP model of demand and food purchases data from a representative survey of French households. The estimated demand parameters are then used to recover the marginal costs of production for each product in the market which, in turn, are employed to select the best model of vertical contract between retailers and manufacturers using non-nested tests. In this way, the authors are then able to simulate the decrease in the cost of raw sugar due to the EU reform of the sugar regime using the estimated demand parameters and the selected model of supply. Their results challenge the belief that firms do not pass on the full extent of a cost change as the estimated average pass-through rate is above 1. In other words, because of the industry strategic pricing, the raw sugar cost decrease is over-shifted to SSBs prices, therefore encouraging SSBs consumption, particularly of those with higher sugar content, with potential negative effects on consumers' health.

The study by Bonnet e Requillart (2013) is an example of how NEIO models enable not only to measure the extent of price transmission but also to explain its determinants, thanks to their microeconomic foundation, and also, to carry out counterfactual simulations using the estimated parameters. However, as mentioned before, the required econometric effort and data (e.g., food purchases data including both prices and quantity both, product characteristics, input costs data, etc…) for the model estimation are more significant than those required for commonly used time-series methods. The findings from this paper also confirms the significant role that price transmission along agri-food chains plays in determining the actual impact of policies affecting agricultural raw commodities costs on consumers' nutritional and health outcomes. We also adopt a similar framework in our study on price transmission along the SSBs chain in Italy which is outlined in the next section.

7. Agricultural and trade policies, price transmission and consumers' health: a case study on sugar and the sugar-sweetened beverages market in Italy

7.1 Introduction

Following Bonnet and Requillart (2011; 2013), we develop an empirical framework to evaluate the indirect effects of policies affecting the costs of raw agricultural commodities on health outcomes through food prices. This framework is then employed to assess the potential effects of agricultural and/or trade policies reform affecting the cost of raw sugar on prices and consumption of sugar-sweetened beverages (SSBs). We choose the sugar-SSBs supply chain as sugar is an important ingredient of SSBs, and so, changes in the price of sugar might have a significant impact on SSBs prices and consumption, and so, on consumers' health (Bonnet and Requillart 2011). Moreover, the consumption of sugar-sweetened beverages is considered as one of the most important contributors to the spread of obesity and over-weight, particularly among children and adolescents (Keller and Bucher Della Torre 2015).

Our empirical framework consists of three steps. First, we estimate consumers' demand for SSBs applying the random coefficient logit demand model (Berry, Levinsohn, and Pakes, 1995) to SSBs purchases data in Italy. Second, for the supply side, we use the demand estimates to recover marginal costs for each product in the market, assuming the existence of a Nash-Bertrand price equilibrium, fixed retailer markups and constant marginal costs. Then, the estimated demand parameters and marginal costs are used to conduct a counterfactual simulation to derive the new SSBs market equilibria after a change in the cost of sugar, which may potentially derive from a change in the EU agricultural or trade policies. In this way, we are able to assess the extent of price transmission of a cost shock (i.e., change in the cost of raw sugar) along the sugar-SSBs chain, as well as the potential indirect effects of economic policies reforms on SSBs consumption. Moreover, as our demand model allows for different price sensitivities based on income level, we are also able to evaluate the heterogeneous impact of these policy changes across different socio-economic groups, and so, to derive the distributional implications from a health perspective.

Even though several papers investigate the potential impact of direct policies targeting SSBs on health (Andreyeva, Long, and Brownell 2010; Céline Bonnet and Réquillart 2013; Y. Liu, Lopez, and Zhu 2014; Berardi et al. 2016; Capacci et al. 2019), to the best of our knowledge, only few studies exist that have analysed the role of indirect policies affecting agricultural commodities prices on the SSBs market, and so, on sugar consumption, and none of them have focused on Italy. An analysis of this type is needed considering that a large body of literature (Alston, Okrent, and Rickard 2013; Alston, Sumner, and Vosti 2006; Alston, Okrent, and Rickard 2013; Aguirre, Mytton, and Monsivais 2015; Bonnet and Requillart 2011) has proven the key role that these policies can play in affecting food consumption and consumers' health, and also, the upcoming Italian sugar tax in 2023.

The remainder of this section is organized as follows: models and methods are outlined in section 7.2, while section 7.3 describes the data and estimation approach. The results are discussed in section 7.4, while section 7.5 concludes.

7.2 Model and methods

7.2.1 Demand model

The demand for SSBs is modelled according to the random coefficients logit demand model developed by Berry, Levinsohn, and Pakes (1995) (herein BLP). This model solves the dimensionality issue of differentiated markets by projecting the products into the characteristics space and represents consumer preference as a function of product attributes and consumer characteristics (Nevo 2000; Kim 2004). Moreover, it allows to obtain more flexible substitution patterns with respect to the standard multinomial logit (Bonnet and Requillart 2011; Bonnet and Requillart 2013; Villas-Boas 2007). The indirect utility that each consumer *i* gets from the consumption of product *j* in market *m* is a function of its price (p_{jm}), the observed and unobserved (by the econometrician) product characteristics (X_{jm}, ξ_{jm}), and the unknown parameters of the model, (α_i, β, ϒ):

$$U_{ijm}= \alpha_i p_{jm} + \beta X_{jm}+ \xi_{jm} + \varepsilon_{ijm},$$

(1)

where ε_{ijm} is a mean zero stochastic term that is assumed to be independently and identically distributed (i.i.d) with an extreme value type I distribution (Berry, Levinsohn, and Pakes, 1995; Nevo, 2000; Kim 2004).

The random parameter α_i represents the marginal utility of income and accounts for the potential heterogeneity of individual preferences for price (Kim, 2004). Following Nevo (2000), the distribution of consumers' taste parameter for price is modeled as follows:

$$\alpha_i= \alpha + \sigma v_{i,} + \pi D_i \quad v_i \sim P_v(v), \; D_i \sim \widehat{P_D^*}$$

(2)

where α represents the mean preference for price and is common to all consumers, v_i is a vector of unobserved (to the econometrician) demographic characteristics that follows a known parametric distribution $P_v(v)$, while D_i are observable demographic characteristics and P_D^* might be a non-parametric distribution known from other sources, or a parametric distribution with the parameters estimated somewhere else. For simplicity, we assume $P_v(v)$ has a standard normal distribution.

Therefore, the utility that consumer *i* can get from product *j*, as in (2), can be divided into two parts: a mean utility component, δ_j, which is product-specific and common to all households, and a mean-zero heteroskedastic deviation from the mean, $u_{ijm}+\varepsilon_{ijm,}$ which captures the effect of the random coefficients:

$$U_{ijm}= \delta_{jm} + u_{ijm} + \varepsilon_{ijm}$$

(3)

where:

$$\delta_{jm} = \alpha p_{jm} + \beta X_{jm} + \xi_{jm}$$

(4)

$$u_{ijm} = \sigma v_i p_{jm} + \pi D_i p_{jm}$$

(5)

We complete the consumer choice model by allowing for an outside good to account for the possibility that consumers do not buy any of the products included in the choice set. For the outside good, we normalize the mean utility (δ_0) to zero. Without the outside good, a homogenous price increase of all the products would result in no changes in quantities purchased (Nevo 2000; Kim 2004).

The model further assumes that each consumer buys only one unit of the good that provides him/her with the highest utility and that ties do not occur. As ε_{ijm} is assumed to be i.i.d type I extreme value, the probability that consumer *i* purchases product *j* in market *m*, $Prob_{ijm}$, is computed as follows (Xiao, 2008; Zheng and Huang, 2014) :

$$Prob_{ijm} = \frac{\exp\left(\delta_{jm} + u_{ijm}(v,\ D)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}(v, D)\right)} \ .$$

(6)

Aggregating (6) over all consumers in the market, one obtains the market demand expressed as the market shares of each product *j* as:

$$s_{jm} = \int Prob_{ijm}\, \mathrm{d}Pv(v)\ \mathrm{d}PD(D), = \int \frac{\exp\left(\delta_{jm} + u_{ijm}(v\ ,\ D)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}(v)\right)}\, \mathrm{d}P_v(v)\ \mathrm{d}P_D(D).$$

(7)

As the integral in (7) does not have an analytic closed form, it can be approximated through a simulation estimator that replaces the population density with the empirical distribution obtained from *n's* random draws (Berry, Levinsohn, and Pakes, 1995):

$$s_{jm} = \frac{1}{ns}\sum_{i=1}^{ns} Prob_{ijm} \qquad = \qquad \frac{1}{ns}\sum_{i=1}^{ns} \frac{\exp\left(\delta_{jm} + u_{ijm}(v\ ,D)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}(v\ ,D)\right)}$$

(8)

The estimated parameters from equation (7) can then be used to estimate own- and cross-price elasticities of demand for each product:

$$\eta_{jkm} = \frac{\partial s_{jm}}{\partial p_{km}}\frac{p_{km}}{s_{jm}} \begin{cases} \frac{p_{jm}}{s_{jm}} \int \alpha_i\, s_{ijm}\left(1 - s_{ijm}\right) \mathrm{d}Pv(v)\mathrm{d}P_D Pv(D) & \text{if } j = k, \\ -\frac{p_{km}}{s_{jm}} \int \alpha_i\, s_{ijm}\, s_{ikm}\, \mathrm{d}Pv(v)\ \mathrm{d}P_D(D) & \text{if } j \neq k\ . \end{cases}$$

(9)

Where each individual *i* has a different price sensitivity for every product in the choice set.

7.2.2 Supply and market equilibrium

Following Berry, Levinsohn and Pakes (1995) and Nevo (2001), we assume that the profit of each multiproduct firm *f* that produces a subset J_f of the *J* products in the market is defined as:

$$\Pi_f = \Sigma_{j\epsilon Jf}(p_j - mc_j)\, Ms_j(p, X, \xi; \vartheta) - C_f \ ,$$

(10)

where p_j and mc_j are the price and marginal cost of product *j*, respectively; *M* is the market size; s_j is the market share of brand *j*; ϑ includes the estimated demand parameters; and C_f are the fixed costs of production.

Under the assumption of a pure-strategy Nash-Bertrand equilibrium, firms simultaneously choose prices to maximize profits from all the J_f products, yielding the following first order conditions:

$$\frac{\partial \Pi_f}{\partial p_j} = s_j(\bullet) + \Sigma_{r\epsilon Jf}(p_r - mc_r)\frac{\partial s_r(\bullet)}{\partial p_j} = 0, \quad \text{for all } j\epsilon J_f \ ,$$

(11)

which can be re-written in matrix form:

$$s(\bullet) - \Omega(p)\, \Lambda(p\text{-}mc) = 0 \ ,$$

(12)

where $\Omega(p)$ is the matrix of partial derivatives of the market shares with respect to prices, while Λ is the market structure matrix whose elements are defined as follows (Berry, Levinsohn and Pakes, 1995):

$$\Omega_{rj}(p) = -\frac{\partial s_r(\bullet)}{\partial p_j}, \quad \text{for each j, r } \epsilon J_f$$

(13)

$$\Lambda_{jr} = \begin{cases} 1 & \text{if } r, j \in Jf \\ 0 & \text{otherwise} \end{cases}$$

(14)

The price-cost margin and marginal cost for each brand j can be recovered by solving the system of equations in (12):

$$(p\text{-}mc) = (\Omega(p)\, \Lambda)^{-1}\, s(\bullet)$$

(15)

$$mc = p - (\Omega(p)\, \Lambda)^{-1}\, s(\bullet)$$

(16)

As data about wholesale prices are not available, we assume a constant mark-up rule for the retailer. Hausman and Leonard (2002) show that retail prices and demand elasticities can be used to approximate manufacturers' first order condition under this assumption.

As explained in previous works on vertical relationship in the supply chain, such as Chidmi (2013) and Villas-Boas (2007), the price-cost margin derived in equation (15) following Berry, Levinsohn, and Pakes (1995) and Nevo (2001) are similar to the ones obtained in the case of a two-part tariff agreement between the retailer and the manufacturer in which the retail-price cost margin are set equal to zero. In this situation, the retail prices are given by the sum of manufacturers' wholesale prices and the retail marginal cost, while the retailers set the franchise fee F to extract part of the manufacturers' profits. The marginal cost computed in equation (16) can be interpreted as the total marginal cost (i.e., marginal cost of production and distribution).

7.2.3 Counterfactual simulations

To evaluate the impact of a change in the cost of raw sugar on SSBs purchases, we need first to determine the consequent change in SSBs prices. After computing the value of SSBs marginal costs incorporating the new cost of sugar (mc'), the new equilibrium prices for SSBs (p_j*) can be derived by solving the following equation:

$$\min_{\{p_j^*\}_{j=1,\dots,J}} \; || p_j^* - \Lambda(p_j^*) - mc_j' || \qquad (17)$$

where ||.|| is the Euclidean norm in R_J while Λ corresponds to the manufacturers' margin. The cost pass-through rate can then be computed as the proportion of the change in the marginal cost that is transferred to final prices (Kim and Cotterill 2008; Bonnet and Requillart 2013), while the new equilibrium market share vector can be derived using equation (8). In this way, we are able to predict the new market equilibrium, and so, the potential impact of policies affecting the SSBs market through prices cost on consumers' behavior and health.

7.3 Data and estimation

7.3.1 Data

In our empirical application we use Nielsen Household Panel data on SSBs purchases in Italy for the period January 2019- December 2020. These data provide information on beverages purchases (e.g., quantity, price, channel), product characteristics (e.g., brand and vendor name, flavour, packaging, energy and sugar content etc…), as well as household characteristics (e.g., income level, household size, presence of children etc…) for over 9,000 Italian households. Products are defined based on: vendor name, segment (i.e., ice tea, cola, other carbonated soft-drinks, fruit drinks) and sugar content (i.e., regular vs diet). A market is defined as a region-quarter combination. Therefore, the market share for each product is computed as the ratio of the sum of purchases of that brand for all the households in the selected market divided by the total value of beverages purchases in the relevant market. After dropping all the products with a market share lower than 0.4%, our sample consists of 25 products which account for almost one third (32.2%) of total SSBs purchase. Therefore, the outside option consists of all the other SSBs with a market share strictly lower than 0.4%, fruit juices and nectars, and bottled water. Average prices are then derived as the ratio of the total sales value divided by the total volume sold (euro/l). The summary statistics for the selected products are reported in Table 1.

Table 1. Summary statistics.

Product	Vendor	Segment	Diet	Sugar (gr/L)	Share	Price (€/L)
Brand 1	Vendor 1	The	0	78.2	0.5%	0.99
Brand 2	Vendor 2	The	0	91.3	0.3%	0.71
Brand 3	Vendor 3	The	0	100.9	3.0%	1.68
Brand 4	Vendor 4	The	0	68.1	1.0%	0.63
Brand 5	PL	The	0	85.9	0.8%	0.60
Brand 6	Vendor 3	The	1	3.4	0.4%	1.58
Brand 7	Vendor 1	Cola	0	106.5	7.5%	1.09
Brand 8	Vendor 5	Cola	0	85.8	2.1%	0.71
Brand 9	PL	Cola	0	104.6	0.4%	0.39
Brand 10	Vendor 1	Cola	1	0.0	3.6%	1.11
Brand 11	Vendor 5	Cola	1	0.0	0.4%	0.73
Brand 12	Vendor 1	Other	0	115.7	1.2%	0.90
Brand 13	Vendor 1	Other	0	19.3	0.4%	0.96
Brand 14	Vendor 4	Other	0	54.1	0.7%	0.50
Brand 15	Vendor 4	Other	0	102.2	1.0%	1.16
Brand 16	Vendor 6	Other	0	100.0	0.4%	0.95
Brand 17	Vendor 6	Other	0	110.7	0.8%	0.97
Brand 18	PL	Other	0	99.6	1.0%	0.44
Brand 19	Vendor 4	Other	1	4.2	0.5%	0.78
Brand 20	Vendor 7	Fruit drink	0	123.9	1.2%	1.55
Brand 21	Vendor 8	Fruit drink	0	109.8	0.8%	1.31
Brand 22	Vendor 9	Fruit drink	0	94.7	0.7%	0.93
Brand 23	PL	Fruit drink	0	105.4	2.1%	0.90
Brand 24	Vendor 10	Fruit drink	0	112.2	0.7%	1.30
Brand 25	Vendor 10	Fruit drink	1	53.1	0.8%	1.49

Source: Authors' elaboration of Nielsen Homescan data.

7.3.2 Estimation strategy

The demand function defined in section 7.2.1 can be estimated using a Generalized Method of Moments (GMM) estimator, as described in Berry, Levinsohn and Pakes (1995) and Nevo (2000). An estimation issue in this model is the potential endogeneity of prices, as prices are likely to be correlated with the unobserved product characteristics $\xi_{j,}$ leading to biased estimates. This is because prices are a function of mark-ups which, in turns, depend on all the product characteristics, including the unobservable attributes (Berry, Levinsohn and Pakes1995; Nevo, 2000). To overcome this issue, we employ an instrumental variables' (IVs) approach using cost and supply shifters (i.e., producer price index (ISTAT), the average price of white sugar within the Community (EU), plastic (Camera di Commercio di Milano-Monza-Brianza-Lodi) and fuel price indices (Ministry of Ecological Transition), as well as the average package size as IVs. According to the test results, these instruments are both valid (Hansen's J p-val=0.9844) and relevant (First stage F-statistic = 39.7; Shea's partial R^2 = 0.16).

We include the following variables to account for the observables product characteristics (X_j): 1) Vendor dummy variables (i.e., Vendor 1 to 10 and Private Labels); segment dummy variables (i.e., ice tea, cola, other carbonated soft-drinks and fruits drinks); a dummy variable taking the value of 1 for diet products and 0 for regular SSBs. Seasonal and regional fixed effects are also added to control for potential systematic differences in SSBs purchases across time periods and geographic areas. Finally, we account for the potential effect of the COVID-19 pandemic and the consequent lockdown in Italy by creating a specific dummy variable taking the value of 1 for the Italian lockdown period (March-May 2020).

The model is estimated using 200 draws for the assumed parametric distribution of the unobserved household characteristics, v_i. On the other hand, the non-parametric distribution of consumers' observable characteristics, D_i (i.e., income level), is estimated using 200 random draws of households for each market[2]. In this way, we are able to account for differences in price sensitivity across income groups. We also add optimal instruments to enable the estimation of random coefficients and to increase estimation efficiency (Vincent 2015). The estimation is performed using STATA 17 with the BLP algorithm developed by Vincent (2015), while simulations are carried out in Matlab (R2021a).

7.4 Empirical results

7.4.1 Estimated demand and supply parameters.

Table 2 reports the estimated demand parameters for the mean utility and deviations from the mean for the random coefficient demand model described in section 2. On average, the own-price of SSBs has a negative (-7.443) and statistically significant impact on utility and the deviation from the mean (0.352) is also statistically significant, indicating that the taste parameter for price differs across Italian consumers. Moreover, we find that household affluency level positively affects the price coefficient (0.964), meaning that people with higher income are also less sensitive to price changes than people living on a tighter budget. Our results also show that Italian consumers prefer regular SBBs rather than diet products with lower or zero sugar content (-0.646).

[2]Households in Nielsen Panel data are grouped in four classes based on the affluency status: 1) low; 2) lower-middle; 3) upper-middle; 4) high.

Table 2. Random coefficient logit demand model estimation results.

Variable	Parameter estimates	Standard errors
Price	-4.443***	0.624
Price standard deviation	0.352***	0.109
Price#Affluency	0.964***	0.172
Ice tea	0.130***	0.039
Cola	1.357***	0.039
Fruit drink	2.671***	0.096
Diet	-0.646***	0.03
Vendor 1	1.795***	0.085
Vendor 2	-0.023	0.073
Vendor 3	3.044***	0.117
Vendor 4	1.223***	0.062
Vendor 5	0.112*	0.067
Vendor 6	1.075***	0.09
Vendor 7	-0.062	0.082
Vendor 8	-0.979***	0.074
Vendor 9	-1.445***	0.07
Vendor 10	-0.408***	0.069
Lockdown	-0.129***	0.035
Summer	0.005	0.03
Fall	-0.086***	0.03
Winter	-0.164***	0.031
Constant	-3.716***	0.175
Observations	11256	

Notes: *, **, and *** represent 10, 5 and 1 percent levels of statistical significance, respectively. Regional fixed effects coefficients omitted for brevity.

Table 3 shows the average, minimum and maximum value of estimated own-price elasticities, price, price-cost margin and marginal cost for the whole market, by sugar content and by vendors. The full matrix of average own-price and cross price elasticities is reported in Table A1. The average own-price elasticity ranges between -1.27 to -2.88 and is higher in absolute terms for diet (-2.49) and national brands (NBs) products (-2.44) relative to regular (-2.29) and private labels brands (-1.78). Diet SSBs and NBs products ensure higher price-cost margins (0.58 and 0.54 €/L respectively) in absolute terms to producers than regular (0.50) and PLs product (0.41). On the other hand, despite their relatively low prices (0.71€/L) compared to the average category value (1.11 €/L), PLs beverages ensure much higher percentage margins (about 60%) than branded products (46.1%), as their marginal costs (0.32€/L) are half the value for NBs (0.66€/L)

Table 3. Statistics (mean, min and max) of the own-price elasticity, market prices, absolute and percentage price-cost margin (PCM and %PCM) and marginal cost (MC) per liter. For the all market, by sugar content and by vendors.

Vendor	Elasticity	Price (€/L)	PCM (€/L)	%PCM	MC (€/L)
All	-2.33	1.11	0.52	48.3	0.60
Minimum	-1.27	0.45	0.38	35.6	0.10
Maximum	-2.88	1.86	0.89	78.2	1.06
National Brands	-2.44	1.19	0.54	46.1	0.66
Private Labels	-1.78	0.71	0.41	59.8	0.32
Regular	-2.29	1.07	0.50	48.7	0.58
Diet	-2.49	1.28	0.58	46.5	0.69

Source: Authors' calculation from estimated parameters.

7.4.2 Simulation results

To evaluate the potential impact of agricultural and trade policies affecting the cost of raw sugar on the SSBs market in Italy we carry out a counterfactual simulation in which we assume the cost of sugar changes by 9%, as this corresponds to the coefficient of variation for the price of white sugar within the Community (EU) calculated over the two-year period the SSBs purchase data were collected (2019-2020). As the main concern from a health perspective is related to those policies that might indirectly encourage the consumption of SSBs and sugar (Alston, Sumner, and Vosti 2008; Bonnet and Requillart 2011), in this section we mainly analyze the estimated effects of a decrease in the cost of sugar[3].

Table 4 reports the simulated changes in marginal cost (mc), price and market share (MS) by product, together with the estimated pass-through rate by brand. Using the added sugar content of each product[4], we find that a 9% decrease in the cost of sugar causes an average 0.3 cents fall in SSBs marginal costs, roughly corresponding to 0.8% of total marginal cost, with this impact being higher for brands with higher sugar content. On the other hand, diet brands (i.e., brands 6,10,11,19,25) are not affected by this change in marginal costs as they do not contain sugar as ingredient.

Consistent with the findings by Bonnet and Requillart (2013) for the French SSBs market, our results also show that the cost-shock is over-shifted to consumers, as the pass-through rate is higher than 1 for all brands. Overall, the price for regular SSBs decreases by 0.4%, and the percentage price change is much higher for branded products than for PLs. For example, focusing on the regular ice-tea segment (Brand 1 to 5), the percentage price change of NBs is equal to -0.3% percent on average, while the one of PLs is -0.5%. On the other hand, prices for diet products remain almost unaffected by the cost-shock, or they slightly increase.

[3] Given the symmetry of the estimated price reactions to an increase and a decrease in marginal costs, the results for an increase in the price of sugar would be equal but with opposite sign compared to the ones discussed in this section about a decrease in the sugar price.

[4] For fruit drinks, we assume the quantity of sugar deriving from fruit is proportional to the fruit content (e.g., 50%). Then, the quantity of added sugar is computed as the difference between total sugar and the amount of sugar naturally contained in fruit computed in this way.

Table 4. Impact of a 9% decrease in the cost of sugar on marginal cost, price and market share, by product.

Product	Vendor	Added sugar content (gr/L)	Change in mc (€/L)	Change in price (€/L)	Pass-through rate	Change in price (%)	Change in MS (%)
Brand 1	NB	78.2	-0.003	-0.003	1.03	-0.3%	0.1%
Brand 2	NB	91.3	-0.003	-0.004	1.11	-0.4%	0.4%
Brand 3	NB	100.9	-0.004	-0.005	1.24	-0.3%	0.3%
Brand 4	NB	68.1	-0.003	-0.003	1.08	-0.3%	0.1%
Brand 5	PL	85.9	-0.003	-0.004	1.11	-0.5%	0.4%
Brand 6	NB	-	-	0.002	-	0.1%	-0.8%
Brand 7	NB	106.5	-0.004	-0.004	1.07	-0.3%	0.4%
Brand 8	NB	85.8	-0.003	-0.004	1.12	-0.4%	0.4%
Brand 9	PL	104.6	-0.004	-0.004	1.10	-0.9%	0.6%
Brand 10	NB	-	-	0.001	-	0.0%	-0.7%
Brand 11	NB	-	-	0.000	-	0.0%	-0.6%
Brand 12	NB	101.8	-0.004	-0.004	1.07	-0.4%	0.4%
Brand 13	NB	19.3	-0.001	0.000	0.39	0.0%	-0.5%
Brand 14	NB	54.1	-0.002	-0.002	1.03	-0.4%	0.0%
Brand 15	NB	102.2	-0.004	-0.004	1.15	-0.3%	0.4%
Brand 16	NB	100.0	-0.004	-0.004	1.12	-0.4%	0.4%
Brand 17	NB	110.7	-0.004	-0.005	1.14	-0.4%	0.5%
Brand 18	PL	99.6	-0.004	-0.004	1.08	-0.8%	0.5%
Brand 19	NB	-	-	0.000	-	0.0%	-0.6%
Brand 20	NB	59.8	-0.002	-0.002	1.07	-0.1%	0.0%
Brand 21	NB	79.0	-0.003	-0.003	1.16	-0.2%	0.2%
Brand 22	NB	66.6	-0.002	-0.003	1.09	-0.3%	0.1%
Brand 23	PL	67.6	-0.003	-0.003	1.12	-0.3%	0.1%
Brand 24	NB	78.2	-0.003	-0.004	1.22	-0.3%	0.2%
Brand 25	NB	-	-	0.001	-	0.0%	-0.6%

Source:Authors' own elaboration

The market share of regular SSBs rises on average by 0.3%, also thanks to the substitution with diet products, whose market share falls by 0.6%. The only exception is brand 13, which is affected by the change in the cost of sugar as diet products given its very low sugar content (19.3 gr/L). In line with the results of Bonnet and Requillart (2011), we also find that it is the brands with the highest sugar content that experience the larger market share increase in all segments, and also, PLs benefit the most, except for the fruit drink segment.

As mentioned in the previous section, we are able to assess the differential impact of the change in SSBs prices across different socio-economic groups as our model allows for different price sensitivities based on the income level. Changes in SSBs purchases and added sugar by income group are shown in Table 5.

Table 5. Impact of a 9% decrease in the cost of sugar on SSBs and added sugar consumption by income group.

Income level	% of households	SSBs[1]	ΔSSBs[1]	Δ%SSBs	Added sugar[2]	Δ Added sugar[2]	Δ% Added sugar
Low	21.9%	11.3	0.07	0.6%	898.2	8	0.9%
Lower-middle	31.6%	11.7	0.06	0.5%	902.3	6.6	0.7%
Upper-middle	29.1%	12.6	0.05	0.4%	950.2	5.7	0.6%
High	17.4%	12.2	0.04	0.3%	877.4	4.2	0.5%

Notes: [1]Liter/person/year; [2]Grams/person/year.

Source:Authors' own elaboration.

Consistent with the results from the demand model estimation, we find that lower-income households (Low and Lower-middle) are more sensitive to price changes, and so, they experience the largest increase in SSBs purchases (0.07 liter and 0.06 liter per person per year respectively) in our simulated scenario. As a consequence, they also experience the highest increase in added sugar consumption (8 and 6.6 grams per person per year respectively). On the other hand, relatively more affluent households are less affected by the fall in SSBs prices both in terms of SSBs and sugar consumption. This means that policies affecting the price of sugar may indirectly increase health inequalities by encouraging unhealthy food choices particularly among less affluent consumers. Furthermore, our results also show that the percentage increase in added sugar (from 0.5% to 0.9%) is higher than the percentage rise in SSBs consumption (from 0.3% to 0.6%) for all income groups, meaning that consumers switch towards products with higher sugar content in our simulated scenario.

7.5 Conclusions and discussion

The consumption of sugar-sweetened beverages is considered as one of the most important contributors to the spread of obesity and over-weight, particularly among children and adolescents (Keller and Bucher Della Torre 2015). For this reason, specific direct policies have been introduced in different countries to tackle the rising consumption rate of SSBs, such as the French soda tax in 2012 and the Catalonia SSBs tax in 2017. Even though a lot of attention has been devoted to the effects of direct policies targeting SSBs consumption in the empirical literature (i.e., Andreyeva, Long, and Brownell 2010; Céline Bonnet and Réquillart 2013; Y. Liu, Lopez, and Zhu 2014; Berardi et al. 2016; Capacci et al. 2019), to the best of our knowledge, only few studies exist that evaluate the potential impacts of indirect policies affecting agricultural raw commodities prices (i.e., agricultural and trade policies) on the SSBs market, particularly, of those affecting the price of sugar. We believe an analysis of this type is needed as sugar is an important ingredient of SSBs, and so, changes in the price of sugar may have a significant impact on SSBs prices and on consumers' health (Bonnet and Requillart 2011). It is also important to acknowledge that sugar beet production has been one of the most supported and protected commodities by the EU CAP (Bureau et al. 2007), for example, through the very last agricultural quota system in place until 2017 (EC[b]). As a consequence, the ongoing restructuring of the sugar sector that started with the 2006 reform of the sugar regime and the 2013 reform of the EU CAP (EC[b]) may have significant impacts on the cost of sugar, and so, on the prices of all food products having sugar as a key ingredient.

Consistent with the findings of Bonnet and Requillart (2011) for the French soft-drink market, the results from our analysis show that the reduction in SSBs marginal costs that follows a decrease in the price of sugar is over-shifted to SSBs prices, leading to higher market share for regular SSBs, particularly, for those with higher sugar content, with potential detrimental impacts on health. This is particularly true for lower socio-economic groups, as they are the most sensitive to price changes, and so, health inequalities may widen. However, it is also important to acknowledge that the estimated impact of a sugar cost-shock on the SSBs market in this analysis is quite limited, and much lower that the one estimated for example by Bonnet and Requillart (2011, 2013). There are at least two explanations for this outcome: first, in the current analysis we assume a 9% reduction in the cost of sugar, which is equivalent to the relative dispersion of the price of sugar around the mean in the period 2019-2020 in the Community. On the other hand, Bonnet and Requillart (2011, 2013) simulate a much higher fall in the price of sugar (36%) as they were interested in analysing the effects of the 2006 EU sugar reform. Moreover, the price for white sugar within the Community has been significantly decreasing after the EU sugar reform, falling from above 630 euro/ton in 2006 to 312 euro/ton at the beginning of 2019 (EC). This also implies that the cost of sugar as a share of the total cost of producing SSBs has been significantly decreasing over time.

Overall, the results from this analysis confirm the relatively modest impact of changes in the cost of agricultural commodities on health outcomes through food prices, mainly because of the falling influence of farm commodity prices on final retail prices (Alston, Sumner, and Vosti

2008; Golan and Unnevehr 2008). However, it is also important to acknowledge that several factors may affect the overall impact of cost-shocks in agricultural markets on food consumption and health. For example, the extent of price transmission along the food chain and the price elasticity of demand can play a significant role in determining the overall impact of policies affecting agricultural commodities prices on health outcomes through food prices.

Therefore, policy makers should account for the indirect effects and interaction with broad scale agricultural and trade policies affecting agricultural raw commodities prices and for the supply-chain dynamics when evaluating the potential effects and effectiveness of policies targeting healthy food consumption patterns, such as the upcoming Italian SSBs tax in 2023. In this regard, Bonnet and Requillart (2013) find that the introduction of a 10% excise tax on all SSBs in France would only result in a 7% increase in SSBs prices given the indirect effects of the 2006 EU sugar policy reform on the French soft-drinks supply-chain (i.e., on production costs). Therefore, the results by Bonnet and Requillart (2011, 2013) show the importance of accounting for the industry strategic pricing, as well as for the interactions with other economic policies with different objectives to correctly forecast direct policies impacts.

The results from this analysis can be of help for policy-makers desiring to develop specific public policy for healthy diets by providing significant insights about price-transmission dynamics within the Italian sugar-SSBs supply chain, and also, about the potential interactions of SSBs taxes with the broader policy and economic environment. However, this study comes with some limitations. First, our estimate of price transmission along the sugar-SSBs supply chain is based on the assumption of a retailer-fixed mark-up rule, which corresponds to the case of a two-part tariff agreement between the retailer and the manufacturer in which the retail-price cost margins are set equal to zero. Future work may relax this assumption and test different models of vertical conduct along the Italian SSBs-sugar supply chain. Moreover, food-away-from-home purchases of SSBs are not included in our dataset, and so, we might underestimate the total impact of changes in SSBs prices on soft-drink consumption.

8. Concluding remarks

In this report we analyze the indirect health dimension of policies impacts, that is, the key mechanisms through which policies with different economic objectives, such as agricultural and trade policies, may indirectly affect food consumption and dietary quality. As poor nutrition and obesity increase the susceptibility to NCDs (Eurostat, 2020), understanding the potential indirect effects of economic policies on the so called “food environment” (Clark et al. 2012) is essential for policy-makers to design effective strategies for healthier lifestyles.

Through an extensive literature review we identify several ways in which different policies (i.e., agricultural, trade and policies, VAT and food safety regulations, etc…) can affect the determinants of food choices, that is, price, income and taste. However, as prices are pointed out by several authors as the most important influencing factor in determining food consumption in high-income countries, such as Europe (e.g., Alston, Sumner, and Vosti 2006), we review and refine methods that are currently used to analyze the indirect health economic dimension of policy impacts through food prices. In details, the issue of price transmission and market power in vertical chains, is usually analyzed following two main approaches: (1) time-series models; (2) New Industrial Organization (NEIO) models. Even though time-series techniques have been extensively used in empirical analysis mainly because of their ease of use and few data requirements, they are also often criticized as they lack a microeconomic foundation (Digal and Ahmadi–Esfahani 2002; Lloyd 2017; Cavicchioli 2018). On the other hand, despite being more difficult to estimate, NEIO models findings are more conclusive and reliable as they are rooted in economic theory (Digal and Ahmadi–Esfahani 2002; Lloyd 2017; Cavicchioli 2018).

As a consequence, following Bonnet and Requillart (2011; 2013) and the NEIO literature on vertical price transmission, we develop an empirical framework to evaluate the potential indirect effects of policies affecting the costs of raw agricultural commodities on health outcomes through food prices. This framework is then employed to assess the potential effects of agricultural and/or trade policies affecting the cost of raw sugar on prices and consumption of sugar-sweetened beverages (SSBs). We choose the sugar-SSBs supply chain as sugar is an important ingredient of SSBs, and so, changes in the price of sugar might have a significant impact on SSBs prices and consumption, and so, on consumers' health (Bonnet and Requillart 2011). Moreover, the consumption of sugar-sweetened beverages is considered as one of the most important contributors to the spread of obesity and over-weight, particularly among children and adolescents (Keller and Bucher Della Torre 2015).

In line with the existing literature on the potential effects of agricultural and trade policies affecting agricultural commodities cost on food consumption and health (Alston, Sumner, and Vosti 2006; Alston, Okrent, and Rickard 2013; Traill et al. 2014), the results from this analysis confirm a modest impact of changes in the cost of raw sugar on the SSBs market in Italy, and so, on health outcomes. This result can be explained by the decreasing weight of agricultural commodities costs in the total cost of producing foods, and this is the case also for sugar and SSBs. However, our results also confirm that is still conceptually possible that agricultural and trade policies indirectly affect food consumption and health through food. In details, industry strategic pricing, the extent of price transmission along the food chain and also, the price responsiveness of consumers' demand can amplify the effects of a cost-shocks in agricultural markets on food prices and consumption patterns.

Therefore, policy makers should account for the interactions with broad scale policies affecting agricultural raw commodities prices and for the industry strategic reaction to evaluate and design effective direct policies targeting healthy food consumption patterns, particularly for the most vulnerable groups of the population, as these are the most affected by changes in food prices given their high responsiveness to price changes.

References

Aguirre, Emilie K., Oliver T. Mytton, and Pablo Monsivais. 2015. "Liberalising Agricultural Policy for Sugar in Europe Risks Damaging Public Health." *BMJ* 351 (October): h5085. https://doi.org/10.1136/bmj.h5085.

Alston, Julian M., Abigail M. Okrent, and Bradley J. Rickard. 2013. "Impact of Agricultural Policies on Caloric Consumption." *Trends in Endocrinology & Metabolism* 24 (6): 269–71. https://doi.org/10.1016/j.tem.2012.12.004.

Alston, Julian M., Daniel A. Sumner, and Stephen A. Vosti. 2006. "Are Agricultural Policies Making Us Fat? Likely Links between Agricultural Policies and Human Nutrition and Obesity, and Their Policy Implications." *Applied Economic Perspectives and Policy* 28 (3): 313–22. https://doi.org/10.1111/j.1467-9353.2006.00292.x.

———. 2008. "Farm Subsidies and Obesity in the United States: National Evidence and International Comparisons." *Food Policy*, Food Product Composition, Consumer Health, and Public Policy, 33 (6): 470–79. https://doi.org/10.1016/j.foodpol.2008.05.008.

Alviola, P. A., R. M. Nayga, and M. Thomsen. 2013. "Food Deserts and Childhood Obesity." *Applied Economic Perspectives and Policy* 35 (1): 106–24. https://doi.org/10.1093/aepp/pps035.

Andreyeva, Tatiana, Michael W. Long, and Kelly D. Brownell. 2010. "The Impact of Food Prices on Consumption: A Systematic Review of Research on the Price Elasticity of Demand for Food." *American Journal of Public Health* 100 (2): 216–22. https://doi.org/10.2105/AJPH.2008.151415.

Appelbaum, Elie. 1982. "The Estimation of the Degree of Oligopoly Power." *Journal of Econometrics* 19 (2): 287–99. https://doi.org/10.1016/0304-4076(82)90006-9.

Aragrande, Maurizio, Mauro Bruni, Alberico Loi, and Roberto Esposti. 2017. "The Effect of EU 2006 Sugar Regime Reform on Vertical Price Transmission." *Agricultural and Food Economics* 5 (1): 18. https://doi.org/10.1186/s40100-017-0087-8.

Baker, Phillip, Sharon Friel, Ashley Schram, and Ron Labonte. 2016. "Trade and Investment Liberalization, Food Systems Change and Highly Processed Food Consumption: A Natural Experiment Contrasting the Soft-Drink Markets of Peru and Bolivia." *Globalization and Health* 12 (June). https://doi.org/10.1186/s12992-016-0161-0.

Baker, Phillip, Adrian Kay, and Helen Walls. 2014. "Trade and Investment Liberalization and Asia's Noncommunicable Disease Epidemic: A Synthesis of Data and Existing Literature." *Globalization and Health* 10 (1): 66. https://doi.org/10.1186/s12992-014-0066-8.

Baltzer, Kenneth. 2004. "Consumers' Willingness to Pay for Food Quality – The Case of Eggs." *Acta Agriculturae Scandinavica, Section C — Food Economics* 1 (2): 78–90. https://doi.org/10.1080/16507540410024506.

Barlow, Pepita, Martin McKee, and David Stuckler. 2018. "The Impact of U.S. Free Trade Agreements on Calorie Availability and Obesity: A Natural Experiment in Canada." *American Journal of Preventive Medicine* 54 (5): 637–43. https://doi.org/10.1016/j.amepre.2018.02.010.

Beckerman, Jacob P., Queen Alike, Erika Lovin, Martha Tamez, and Josiemer Mattei. 2017. "The Development and Public Health Implications of Food Preferences in Children." *Frontiers in Nutrition* 4 (December). https://doi.org/10.3389/fnut.2017.00066.

Beghin, John C., and Helen H. Jensen. 2008. "Farm Policies and Added Sugars in US Diets." *Food Policy*, Food Product Composition, Consumer Health, and Public Policy, 33 (6): 480–88. https://doi.org/10.1016/j.foodpol.2008.05.007.

Berardi, Nicoletta, Patrick Sevestre, Marine Tépaut, and Alexandre Vigneron. 2016. "The Impact of a 'Soda Tax' on Prices: Evidence from French Micro Data." *Applied Economics* 48 (41): 3976–94. https://doi.org/10.1080/00036846.2016.1150946.

Berry, Steven, James Levinsohn, and Ariel Pakes. 1995. "Automobile Prices in Market Equilibrium." *Econometrica (1986-1998); Evanston* 63 (4): 841–90.

Bonanno, Alessandro, Carlo Russo, and Luisa Menapace. 2018. "Market Power and Bargaining in Agrifood Markets: A Review of Emerging Topics and Tools." *Agribusiness* 34 (1): 6–23. https://doi.org/10.1002/agr.21542.

Bonnet, C., and V. Requillart. 2013. “Impact of Cost Shocks on Consumer Prices in Vertically-Related Markets: The Case of The French Soft Drink Market.” *American Journal of Agricultural Economics* 95 (5): 1088–1108. https://doi.org/10.1093/ajae/aat055.

Bonnet, Céline, and Vincent Requillart. 2011. “Does the EU Sugar Policy Reform Increase Added Sugar Consumption? An Empirical Evidence on the Soft Drink Market.” *Health Economics* 20 (9): 1012–24. https://doi.org/10.1002/hec.1721.

Bonnet, Céline, and Vincent Réquillart. 2013. “Tax Incidence with Strategic Firms in the Soft Drink Market.” *Journal of Public Economics* 106 (October): 77–88. https://doi.org/10.1016/j.jpubeco.2013.06.010.

Borychowski, Michał, and Andrzej Czyżewski. 2015. “Determinants of Prices Increase of Agricultural Commodities in a Global Context.” *Management* 19 (2): 152–67. https://doi.org/10.1515/manment-2015-0020.

Bouamra-Mechemache, Zohra, Roel Jongeneel, and Vincent Réquillart. 2008. “Impact of a Gradual Increase in Milk Quotas on the EU Dairy Sector.” *European Review of Agricultural Economics* 35 (4): 461–91. https://doi.org/10.1093/erae/jbn044.

Caillavet, France, Adélaïde Fadhuile, and Véronique Nichèle. 2016. “Taxing Animal-Based Foods for Sustainability: Environmental, Nutritional and Social Perspectives in France.” *European Review of Agricultural Economics* 43 (4): 537–60. https://doi.org/10.1093/erae/jbv041.

Capacci, Sara, Olivier Allais, Celine Bonnet, and Mario Mazzocchi. 2019. “The Impact of the French Soda Tax on Prices and Purchases. An Ex Post Evaluation.” Edited by Bhavani Shankar. *PLOS ONE* 14 (10): e0223196. https://doi.org/10.1371/journal.pone.0223196.

Cavicchioli, Daniele. 2018. “Detecting Market Power Along Food Supply Chains: Evidence and Methodological Insights from the Fluid Milk Sector in Italy.” *Agriculture* 8 (12): 191. https://doi.org/10.3390/agriculture8120191.

Cawley, John. 2010. “The Economics Of Childhood Obesity.” *Health Affairs* 29 (3): 364–71. https://doi.org/10.1377/hlthaff.2009.0721.

Chidmi, Benaissa. 2013. “‘Vertical Relationships in the Ready-to-Eat Breakfast Cereal Industry in Boston.’” *Agribusiness* 29 (4): 409–409. https://doi.org/10.1002/agr.21350.

Chou, Shin-Yi, Michael Grossman, and Henry Saffer. 2004. “An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System.” *Journal of Health Economics* 23 (3): 565–87. https://doi.org/10.1016/j.jhealeco.2003.10.003.

Clark, Sarah E., Corinna Hawkes, Sophia M. E. Murphy, Karen A. Hansen-Kuhn, and David Wallinga. 2012. “Exporting Obesity: US Farm and Trade Policy and the Transformation of the Mexican Consumer Food Environment.” *International Journal of Occupational and Environmental Health* 18 (1): 53–64. https://doi.org/10.1179/1077352512Z.0000000007.

Cutler, David M., Edward L. Glaeser, and Jesse M. Shapiro. 2003. “Why Have Americans Become More Obese?” *Journal of Economic Perspectives* 17 (3): 93–118. https://doi.org/10.1257/089533003769204371.

De Vogli, Roberto, Anne Kouvonen, and David Gimeno. 2014. “The Influence of Market Deregulation on Fast Food Consumption and Body Mass Index: A Cross-National Time Series Analysis.” *Bulletin of the World Health Organization* 92 (2): 99-107A. https://doi.org/10.2471/BLT.13.120287.

Dickinson, David L., and Dee Von Bailey. 2005. “Experimental Evidence on Willingness to Pay for Red Meat Traceability in the United States, Canada, the United Kingdom, and Japan.” *Journal of Agricultural and Applied Economics* 37 (3): 537–48. https://doi.org/10.1017/S1074070800027061.

Digal, Larry N., and Fredoun Z. Ahmadi–Esfahani. 2002. “Market Power Analysis in the Retail Food Industry: A Survey of Methods.” *Australian Journal of Agricultural and Resource Economics* 46 (4): 559–84. https://doi.org/10.1111/1467-8489.00193.

Dogbe, Wisdom, and José M. Gil. 2018. “Effectiveness of a Carbon Tax to Promote a Climate-Friendly Food Consumption.” *Food Policy* 79 (August): 235–46. https://doi.org/10.1016/j.foodpol.2018.08.003.

Dransfield, E., T. M. Ngapo, N. A. Nielsen, L. Bredahl, P. O. Sjödén, M. Magnusson, M. M. Campo, and G. R. Nute. 2005. “Consumer Choice and Suggested Price for Pork as Influenced by Its Appearance, Taste and Information Concerning Country of Origin and Organic Pig Production.” *Meat Science* 69 (1): 61–70. https://doi.org/10.1016/j.meatsci.2004.06.006.

Franck, Caroline, Sonia M. Grandi, and Mark J. Eisenberg. 2013. “Agricultural Subsidies and the American Obesity Epidemic.” *American Journal of Preventive Medicine* 45 (3): 327–33. https://doi.org/10.1016/j.amepre.2013.04.010.

Friel, S., L. Hattersley, W. Snowdon, A.-M. Thow, T. Lobstein, D. Sanders, S. Barquera, et al. 2013. “Monitoring the Impacts of Trade Agreements on Food Environments.” *Obesity Reviews* 14 (S1): 120–34. https://doi.org/10.1111/obr.12081.

Friel, Sharon, Deborah Gleeson, Anne-Marie Thow, Ronald Labonte, David Stuckler, Adrian Kay, and Wendy Snowdon. 2013. “A New Generation of Trade Policy: Potential Risks to Diet-Related Health from the Trans Pacific Partnership Agreement.” *Globalization and Health* 9 (1): 46. https://doi.org/10.1186/1744-8603-9-46.

Galvez, Maida P., Lu Hong, Elizabeth Choi, Laura Liao, James Godbold, and Barbara Brenner. 2009. “Childhood Obesity and Neighborhood Food-Store Availability in an Inner-City Community.” *Academic Pediatrics* 9 (5): 339–43. https://doi.org/10.1016/j.acap.2009.05.003.

García-Muros, Xaquin, Anil Markandya, Desiderio Romero-Jordán, and Mikel González-Eguino. 2017. “The Distributional Effects of Carbon-Based Food Taxes.” *Journal of Cleaner Production*, Towards eco-efficient agriculture and food systems: selected papers addressing the global challenges for food systems, including those presented at the Conference “LCA for Feeding the planet and energy for life” (6-8 October 2015, Stresa & Milan Expo, Italy), 140 (January): 996–1006. https://doi.org/10.1016/j.jclepro.2016.05.171.

Gardner, Bruce L. 1975. “The Farm-Retail Price Spread in a Competitive Food Industry.” *American Journal of Agricultural Economics* 57 (3): 399–409. https://doi.org/10.2307/1238402.

Gilbert, Christopher L. 2010. “How to Understand High Food Prices.” *Journal of Agricultural Economics* 61 (2): 398–425. https://doi.org/10.1111/j.1477-9552.2010.00248.x.

Giuntella, Osea, Matthias Rieger, and Lorenzo Rotunno. 2018. “Weight Gains from Trade in Foods: Evidence from Mexico.” w24942. Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w24942.

Golan, Elise, and Laurian Unnevehr. 2008. “Food Product Composition, Consumer Health, and Public Policy: Introduction and Overview of Special Section.” *Food Policy*, Food Product Composition, Consumer Health, and Public Policy, 33 (6): 465–69. https://doi.org/10.1016/j.foodpol.2008.05.004.

Grafova, Irina B. 2008. “Overweight Children: Assessing the Contribution of the Built Environment.” *Preventive Medicine* 47 (3): 304–8. https://doi.org/10.1016/j.ypmed.2008.04.012.

Green, Rosemary, Laura Cornelsen, Alan D. Dangour, Rachel Turner, Bhavani Shankar, Mario Mazzocchi, and Richard D. Smith. 2013. “The Effect of Rising Food Prices on Food Consumption: Systematic Review with Meta-Regression.” *BMJ (Clinical Research Ed.)* 346 (June): f3703. https://doi.org/10.1136/bmj.f3703.

Hausman, Jerry A, and Gregory K Leonard. 2002. “The Competitive Effects of a New Product Introduction: A Case Study.” *The Journal of Industrial Economics* 50 (3): 237–63. https://doi.org/10.1111/1467-6451.00176.

Hawkes, Corinna, Sharon Friel, Tim Lobstein, and Tim Lang. 2012. “Linking Agricultural Policies with Obesity and Noncommunicable Diseases: A New Perspective for a Globalising World.” *Food Policy* 37 (3): 343–53. https://doi.org/10.1016/j.foodpol.2012.02.011.

Hendrickson, Deja, Chery Smith, and Nicole Eikenberry. 2006. “Fruit and Vegetable Access in Four Low-Income Food Deserts Communities in Minnesota.” *Agriculture and Human Values* 23 (3): 371–83. https://doi.org/10.1007/s10460-006-9002-8.

Heng, Yan, Hikaru Hanawa Peterson, and Xianghong Li. 2013. “Consumer Attitudes toward Farm-Animal Welfare: The Case of Laying Hens.” *Journal of Agricultural and Resource Economics* 38 (3): 418–34.

Inagami, Sanae, Deborah A. Cohen, Brian Karl Finch, and Steven M. Asch. 2006. “You Are Where You Shop: Grocery Store Locations, Weight, and Neighborhoods.” *American Journal of Preventive Medicine* 31 (1): 10–17. https://doi.org/10.1016/j.amepre.2006.03.019.

Kharin, Sergei. 2015. “Vertical Price Transmission along the Diary Supply Chain in Russia.” *Studies in Agricultural Economics* 117 (2): 80–85. https://doi.org/10.7896/j.1517.

Kim, Donghun. 2004. “Estimation of the Effects of New Brands on Incumbents’ Profits and Consumer Welfare: The U.S. Processed Cheese Market Case.” *Review of Industrial Organization* 25 (3): 275–93. https://doi.org/10.1007/s11151-004-3172-6.

Kim, Donghun, and Ronald W. Cotterill. 2008. “Cost Pass-Through in Differentiated Product Markets: The Case of U.s. Processed Cheese*.” *The Journal of Industrial Economics* 56 (1): 32–48. https://doi.org/10.1111/j.1467-6451.2008.00331.x.

Liu, Gilbert C., Jeffrey S. Wilson, Rong Qi, and Jun Ying. 2007. “Green Neighborhoods, Food Retail and Childhood Overweight: Differences by Population Density.” *American Journal of Health Promotion* 21 (4_suppl): 317–25. https://doi.org/10.4278/0890-1171-21.4s.317.

Liu, Yizao, Rigoberto A. Lopez, and Chen Zhu. 2014. “The Impact of Four Alternative Policies to Decrease Soda Consumption.” *Agricultural and Resource Economics Review*. https://doi.org/10.22004/ag.econ.164593.

Lloyd, Tim. 2017. “Forty Years of Price Transmission Research in the Food Industry: Insights, Challenges and Prospects.” *Journal of Agricultural Economics* 68 (1): 3–21. https://doi.org/10.1111/1477-9552.12205.

Lloyd-Williams, Ffion, Martin O’Flaherty, Modi Mwatsama, Christopher Birt, Robin Ireland, and Simon Capewell. 2008. “Estimating the Cardiovascular Mortality Burden Attributable to the European Common Agricultural Policy on Dietary Saturated Fats.” *Bulletin of the World Health Organization* 86 (August): 535-541A. https://doi.org/10.2471/BLT.08.053728.

Loureiro, Maria L., and Rodolfo M. Nayga. 2005. “International Dimensions of Obesity and Overweight Related Problems: An Economics Perspective.” *American Journal of Agricultural Economics* 87 (5): 1147–53.

Lusk, Jayson L. 2019. “Consumer Preferences for Cage-Free Eggs and Impacts of Retailer Pledges.” *Agribusiness* 35 (2): 129–48. https://doi.org/10.1002/agr.21580.

Maddock, Jay. 2004. “The Relationship between Obesity and the Prevalence of Fast Food Restaurants: State-Level Analysis.” *American Journal of Health Promotion* 19 (2): 137–43. https://doi.org/10.4278/0890-1171-19.2.137.

Mancino, Lisa, Fred Kuchler, and Ephraim Leibtag. 2008. “Getting Consumers to Eat More Whole-Grains: The Role of Policy, Information, and Food Manufacturers.” *Food Policy*, Food Product Composition, Consumer Health, and Public Policy, 33 (6): 489–96. https://doi.org/10.1016/j.foodpol.2008.05.005.

McCorriston, S., C. W. Morgan, and A. J. Rayner. 1998. “Processing Technology, Market Power and Price Transmission.” *Journal of Agricultural Economics* 49 (2): 185–201. https://doi.org/10.1111/j.1477-9552.1998.tb01263.x.

Meyer, Jochen, and Stephan von Cramon-Taubadel. 2004. “Asymmetric Price Transmission: A Survey.” *Journal of Agricultural Economics* 55 (3): 581–611. https://doi.org/10.1111/j.1477-9552.2004.tb00116.x.

Miller, J. Corey, and Keith H. Coble. 2007. “Cheap Food Policy: Fact or Rhetoric?” *Food Policy* 32 (1): 98–111. https://doi.org/10.1016/j.foodpol.2006.03.013.

Morland, Kimberly B., and Kelly R. Evenson. 2009. “Obesity Prevalence and the Local Food Environment.” *Health & Place* 15 (2): 491–95. https://doi.org/10.1016/j.healthplace.2008.09.004.

Morland, Kimberly, Ana V. Diez Roux, and Steve Wing. 2006. “Supermarkets, Other Food Stores, and Obesity: The Atherosclerosis Risk in Communities Study.” *American Journal of Preventive Medicine* 30 (4): 333–39. https://doi.org/10.1016/j.amepre.2005.11.003.

Nevo, Aviv. 2000. “A Practitioner’s Guide to Estimation of Random-Coefficients Logit Models of Demand.” *Journal of Economics & Management Strategy* 9 (4): 513–48. https://doi.org/10.1111/j.1430-9134.2000.00513.x.

———. 2001. “Measuring Market Power in the Ready-to-Eat Cereal Industry.” *Econometrica* 69 (2): 307–42.

Nocella, Giuseppe, Lionel Hubbard, and Riccardo Scarpa. 2010. “Farm Animal Welfare, Consumer Willingness to Pay, and Trust: Results of a Cross-National Survey.” *Applied Economic Perspectives and Policy* 32 (2): 275–97. https://doi.org/10.1093/aepp/ppp009.

ODonoghue, Cathal, Jinjing Li, Ilona Cserháti, Péter Elek, Tibor Keresztély, and Tibor Takacs. 2018. “The Distributional Impact of VAT Reduction for Food in Hungary: Results from a Hungarian Microsimulation Model.” *International Journal of Microsimulation* 11 (December). https://doi.org/10.34196/ijm.00187.

Opara, Linus U., and François Mazaud. 2001. “Food Traceability from Field to Plate.” *Outlook on Agriculture* 30 (4): 239–47. https://doi.org/10.5367/000000001101293724.

Philippidis, George, and Robert Waschik. 2019. "Melitz Meets Milk: The Impact of Quota Abolition on EU Dairy Export Competitiveness." *Journal of Agricultural Economics* 70 (1): 44–61. https://doi.org/10.1111/1477-9552.12276.

Powell, Lisa M. 2009. "Fast Food Costs and Adolescent Body Mass Index: Evidence from Panel Data." *Journal of Health Economics* 28 (5): 963–70. https://doi.org/10.1016/j.jhealeco.2009.06.009.

Powell, Lisa M., M. Christopher Auld, Frank J. Chaloupka, Patrick M. O'Malley, and Lloyd D. Johnston. 2007. "Associations Between Access to Food Stores and Adolescent Body Mass Index." *American Journal of Preventive Medicine* 33 (4): S301–7. https://doi.org/10.1016/j.amepre.2007.07.007.

Rajagopal, Deepak, and David Zilberman. 2007. "Review of Environmental, Economic and Policy Aspects of Biofuels." SSRN Scholarly Paper ID 1012473. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=1012473.

Ralston, Katherine Lee. 1999. "Chapter 17 How Government Policies and Regulations Can Affect Dietary Choices." In .

Rickard, Bradley J., Abigail M. Okrent, and Julian M. Alston. 2013. "How Have Agricultural Policies Influenced Caloric Consumption in the United States?" *Health Economics* 22 (3): 316–39. https://doi.org/10.1002/hec.2799.

Schmidhuber, Josef, and PS Shetty. 2010. "The European Union's Common Agricultural Policy and the European Diet: Is There a Link?" *Trade, Food, Diet and Health: Perspectives and Policy Options*, January, 131–46.

Sheldon, Ian M. 2017. "THE COMPETITIVENESS OF AGRICULTURAL PRODUCT AND INPUT MARKETS: A REVIEW AND SYNTHESIS OF RECENT RESEARCH." *Journal of Agricultural and Applied Economics* 49 (1): 1–44. https://doi.org/10.1017/aae.2016.29.

Soregaroli, Claudio, Paolo Sckokai, and Daniele Moro. 2011. "Agricultural Policy Modelling under Imperfect Competition." *Journal of Policy Modeling* 33 (2): 195–212. https://doi.org/10.1016/j.jpolmod.2010.12.001.

Thow, Anne Marie, and Corinna Hawkes. 2009. "The Implications of Trade Liberalization for Diet and Health: A Case Study from Central America." *Globalization and Health* 5 (July): 5. https://doi.org/10.1186/1744-8603-5-5.

Traill, W. Bruce, Mario Mazzocchi, Bhavani Shankar, and David Hallam. 2014. "Importance of Government Policies and Other Influences in Transforming Global Diets." *Nutrition Reviews* 72 (9): 591–604. https://doi.org/10.1111/nure.12134.

Unnevehr, Laurian J., and Evelina Jagmanaite. 2008. "Getting Rid of Trans Fats in the US Diet: Policies, Incentives and Progress." *Food Policy* 33 (6): 497–503. https://doi.org/10.1016/j.foodpol.2008.05.006.

Vavra, Pavel, and Barry K. Goodwin. 2005. "Analysis of Price Transmission Along the Food Chain," November. https://doi.org/10.1787/752335872456.

Villas-Boas, Sofia Berto. 2007. "Vertical Relationships between Manufacturers and Retailers: Inference with Limited Data." *The Review of Economic Studies* 74 (2): 625–52.

Vincent, David W. 2015. "The Berry-Levinsohn-Pakes Estimator of the Random-Coefficients Logit Demand Model." *Stata Journal* 15 (3): 854–80.

Viren, Matti. 2009. "Does the Value-Added Tax Shift to Consumption Prices?" *AUCO Czech Economic Review*, January.

Weldegebriel, Habtu Tadesse. 2004. "Imperfect Price Transmission: Is Market Power Really to Blame?" *Journal of Agricultural Economics* 55 (1): 101–14. https://doi.org/10.1111/j.1477-9552.2004.tb00082.x.

Xiao, Wei. 2008. "The Competitive and Welfare Effects of New Product Introduction: The Case of Crystal Pepsi." 149938. Research Reports. University of Connecticut, Food Marketing Policy Center. https://ideas.repec.org/p/ags/uconnr/149938.html.

Zheng, Hualu, and Lu Huang. 2014. "The Incidence of Soda Taxes with Imperfect Information and Strategic Firm Behavior." 170201. 2014 Annual Meeting, July 27-29, 2014, Minneapolis, Minnesota. Agricultural and Applied Economics Association. https://ideas.repec.org/p/ags/aaea14/170201.html.

Zilberman, David, Gal Hochman, Deepak Rajagopal, Steve Sexton, and Govinda Timilsina. 2013. "The Impact of Biofuels on Commodity Food Prices: Assessment of Findings." *American Journal of Agricultural Economics* 95 (2): 275–81. https://doi.org/10.1093/ajae/aas037.

PEN Policy Evaluation Network

Birt, Christopher. 2007. "A CAP on Health- The Impact of the EU Common Agricultural Policy on Health". A Report by the Faculty of Public Health, https://ec.europa.eu/health/ph_overview/health_forum/docs/ev_20070601_rd05_en.pdf (accessed: 10/12/2020)

Boseley, Sarah. 2019. "Malnutrition and obesity now global problems say experts". The Guardian. https://www.theguardian.com/global-development/2019/dec/16/malnutrition-and-obesity-now-a-global-problem-say-experts (accessed: 10/09/2020).

Camera di Commercio di Milano-Monza-Brianza-Lodi. "Indici congiunturali materie plastiche per agro-alimentare, permanent link: https://www.piuprezzi.it/indici/indici-prometeia/index?incomGroupCategory=10 (accessed: 08/20/2021).

Centre for Diet and Activity Research (CEDAR). 2015. "EU Common Agricultural Policy Sugar Reforms". https://www.cedar.iph.cam.ac.uk/wp-content/uploads/2015/10/Evidence-Brief-9-CAP-and-Sugar-v.1.3-27.10.15.pdf (accesed: 08/18/2021).

European Commission (EC [a]). "School fruit, vegetables and milk scheme". https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/ market-measures/school-fruit-vegetables-and-milk-scheme_en (accessed: 10/08/2020).

European Commission (EC[b]). "EU sugar quotas system comes to an end". https://ec.europa.eu/commission/presscorner/detail/en/IP_17_3487 (accesed: 08/18/2021).

European Commission (EC). 2007. "Nutrition and physical activity - Strategy on nutrition, overweight and obesity-related health issues" https://ec.europa.eu/health/nutrition_physical_activity/ policy/strategy_en (accessed: 10/08/2020).

European Union (EU). EU sugar prices- Sugar price producers by regions, permanent link : https://data.europa.eu/data/datasets/eu-sugar-market-observatory-sugar-prices?locale=en (accessed : 01/12/2022).

Eurostat. "Archive: Milk and milk products- 30 years of quotas". https://ec.europa.eu/eurostat/statisticsexplained/index.php/Archive:Milk_and_milk_products_-_30_years_of_quotas (accessed: 10/13/2020).

Eurostat. 2020. "Overweight and obesity-BMI Statistics. Statistics explained". https://ec.europa.eu/eurostat/statistics-explained/pdfscache/12376.pdf (accessed: 10/08/2020).

Istituto Nazionale di Statistica (ISTAT). Indice generale dei prezzi alla produzione dell'industria: http://dati.istat.it/Index.aspx?DataSetCode=dcsc_prezzpind_1 (accessed, 04/29/2021)

Mazzocchi, Mario. 2017. "Ex-post evidence of the effectiveness of policies targeted at promoting healthier diets". Fodd and Agriculture Organization of the United Nations (FAO) Trade Policy Technical Notes, Trade and Food Security, N.19, November 2017.

Menghi, Alberto, Kees de Roest, Andrea Porcelluzzi, Claus Deblitz, Zazie von Davier, Barbara Wildegger, Thomas de Witte, Kathrin Strohm, Hildegard Garming, Walter Dirksmeyer, Yelto Zimmer, Dorothee Bolling, Guido van Huylenbroek, Evy Mettepenningen, 2011. "Assessing farmers' cost of compliance with EU legislation in the fields of environment, animal welfare and food safety". Final Report, Commissioned by the European Commission Directorate-General for Agriculture and Rural Devolpment.

Ministry of Ecological Transition, Fuel prices, permanent link: https://dgsaie.mise.gov.it/open-data (accessed: 05/05/2021)

Mitchell, Donald. 2008. "A Note on Rising Food Prices". Policy Research Working Paper 4682. The World Bank, Development Prospects Group, July 2008. http://www.bio-based.eu/foodcrops/media/08-07ANoteonRisingFoodPrices.pdf (accessed: 10/29/2019).