Research in Food Economics: past trends and new challenges

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Abstract – *Over the past 30 years, food chains in Europe have undergone a dramatic transformation resulting from technological, economic and other societal changes. In turn, this evolution has opened multiple new areas of research for food economists, and this review attempts to summarise major developments in the field by focusing on four salient topics: (i) the formation of retail food prices in the context of rising concentration in the food chain; (ii) the continuous process of differentiation of the goods exchanged on food markets, and concurrent decline in the importance of commodity markets; (iii) the issue of consumer trust in the safety of the goods supplied by the food chain, following several food scares; and (iv) the problem of the growing burden of diet-related chronic diseases. After summarising the main methodological and empirical contributions in the analysis of those issues, we conclude by identifying gaps in knowledge and unanswered questions which food economists may want to turn their attention to in the coming years.*

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JEL Classification : Q00, Q5, Q18, L00, L66

Introduction

Over recent decades, the food system has been dramatically transformed, leading to profound changes on both sides of the market. On the supply side, the prime objective of the food industry has historically been to conserve and preserve essential nutrients so as to ensure their availability throughout the year. An important turning point occurred with the development of cold chains, which circumvented microbiological constraints and allowed long-distance trade of non-stabilised food products. Subsequently, in order to ensure the constant and controlled quality of end products and increase the variety of foods proposed to consumers, food processing has largely been split into two stages: (i) the "cracking stage", at which intermediate manufacturers

break down the agricultural raw material in order to extract elementary components and produce intermediate food products (ingredients, additives and technological aids), and (ii) the "assembly stage", where firms combine these elementary components to produce a consumable food for the end market.

This deconstruction/reformulation mechanism lies at the heart of modern food industrial processes (Soler *et al.*, 2013). It has made it possible to develop a process in which the construction of product variety occurs at the industrial level (more specifically at the assembly stage) and no longer (or far less often) at the agricultural level. In addition, the standardisation and homogenisation of agricultural raw materials have facilitated the optimisation of industrial processes at the cracking stage.

These trends have resulted in profound changes. Product innovation has become a key element of competition in the food sector, leading to a greatly enlarged number and variety of products offered to consumers. The diversification of end products increased considerably at the "assembly" stage so that delayed diversification has become a marked characteristic of the food system. The drivers behind the creation of a variety of end products for consumers have shifted from upstream to downstream stakeholders, which has modified the sharing of the value created within the food chains.

The marked drop in the transport costs of agricultural raw materials has also played a central role in the observed trends. Agricultural raw materials, which were initially local (and still remain so in part), have become international at little extra cost. All raw materials have become available at all times, with cold chains enabling their preservation. This evolution has relied on the development of new logistical systems that have helped increase competition between the world's different regions of agricultural production.

Lastly, there have been major changes to food products' distribution: the retail sector has become more concentrated, shifting from small, specialised traders to supermarkets that are usually non-specialised. In France, for instance, the transformation of the food distribution landscape has occurred within merely 40 years: while supermarkets only accounted for 5% of food expenditure in 1970, they now have an 80% market share. The concentration of distribution and the development of retailer brands have tipped the balance of power of industry and upstream producers, and led to radical changes in creating and sharing value within the food chains. These days, large-scale retailers drive a considerable part of the supply chain.

On the demand side, and linked to the general evolution of lifestyles in western societies, changes have been observed in the choices made by households in terms of the allocation of their budgets and time, the effects being: (i) the increasing externalisation of the food preparation function, and (ii) the growing demand for prepared foods, to which the changes made at the industrial level have responded.

However, the externalisation of the food production function from the household framework to that of processing and distribution has given rise to a growing "distance" between end consumers and food producers from a spatial (long-distance exchanges of foods) and a technological (multiple levels of food processing chains) point of view. Even if, in a majority of countries most agricultural production continues to be processed in the same country (70% in France), changes to the industrial organisation of different chains have led to: (i) greater complexity of production chains, from upstream to end consumers, and (ii) a disconnection between production and consumption regions. In addition, dissociation of the fractionation and assembly functions has opened the way to changes that have further lengthened food chains and raised the technological dimension of food. It has generated feelings of distrust linked to the loss of control over food production. The greater distance between consumers and food producers, environmental concerns related to food production and consumption, fears generated by several food safety crises since the nineties, the increase in the prevalence of obesity and some chronic diseases are factors conducive to a lack of trust in food innovations (*e.g.* Genetically Modified Organisms – GMOs), which manifests itself in new food consumption behaviours (*e.g.* interest in organic products, local foods, *etc.*).

All these changes have raised important questions and challenges for national and European stakeholders and policy makers. To get a better understanding of the determinants and impacts of food chain changes for stakeholders (including consumers), food economists have been investigating four main fields of research since the eighties:

- The formation of retail prices, in relation to the competitive distortions on the final food market, and the changes in bargaining power and their effects on value sharing in chains.
- Quality management in food chains and the shift from commodities to differentiated food markets.
- Food safety issues and the challenge of restoring consumer trust in the aftermath of repeated food safety crises.
- The drivers of demand for, and supply of, more or less healthy food and the effects of policies aimed at improving nutritional health.

The aim of this article is to characterise the main questions addressed, methods used and results achieved over the last three decades in these four fields of research, which we present in different sections. We do not review the literature in each field exhaustively, but instead focus on a necessarily subjective selection of salient developments and contributions. The conclusion highlights gaps in the literature and important areas for future research.

1. Formation of retail prices and competition issues

A significant proportion of the population, even in developed countries, is extremely concerned about food price inflation. In 2005, food expenditure accounted for 22% of the total expenditure of European Union (EU) consumers in the first income quintile. An even larger proportion, namely 30%, is observed in eight EU countries (source: Eurostat data; structure of consumption expenditure by income quintile). Recent changes in commodity prices, particularly the peak of agricultural commodity prices in 2007-2008, have motivated investigations into the functioning of the food chain and the lack of transparency about price transmission through the different stages of the food chain. For example, Bukeviciute *et al.* (2009) showed that food price inflation in the EU has displayed considerable discrepancies across countries.

Over the last 30 years, the food chain has experienced major changes. To name a few: consolidation of both food processing and retail industries, the increasing role of the retail industry in the chain, the development of private labels as a tool for the retail industry to increase its bargaining power and a lower share of the "food euro" received by farmers (see McCorriston, 2013).[1] In the following paragraphs, we discuss how agricultural economists have addressed these issues over recent decades and how their researches provide insights into the analysis of competition and its impact on value sharing along the food chain. We first explain the analysis of price transmission based on time-series analysis and then present works on the determinants of imperfect price transmission.

Price transmission

Much effort has been devoted to characterizing price transmission using time-series data on prices. This literature analyses the adjustment to price shocks along the food chain from producer to retail prices. The main questions concern the magnitude, speed, and nature of transmission, *i.e.* if there is symmetric or asymmetric price transmission, and lastly the direction of the transmission that relates to the origin of the shocks. A significant part of the literature relates to the presence or absence of asymmetric price transmission, the latter being commonly seen as a symptom of imperfect competition. Recent surveys on price transmission include Meyer and von Cramon-Taubadel (2004), Vavra and Goodwin (2005), and Frey and Manera (2007). As explained by Meyer and von Cramon-Taubadel (*op. cit.*), the methodology used over the past 30 years has improved significantly. Initial studies relied on estimating the coefficients attached to dummies splitting the change in prices into negative and positive changes. The introduction of

[1] Food euro analysis allows to decompose the value chain in the food sector. The share of "food euro" received by farmers is the amount of money that farmers get on average when consumers spend one euro for purchasing food.

lag effects allowed for speed of adjustment analysis (Ward, 1982). A major improvement was the introduction of cointegration techniques into models of asymmetric price transmission (*e.g.* von Cramon-Taubadel, 1998). These models were further improved to incorporate structural breaks (Sanjuán and Dawson (2003) and Lloyd *et al.* (2006) estimating the impact of Bovine Spongiform Encephalopathy (BSE) on the United Kingdom (UK) market) as well as non-linear or thresholds adjustments (*e.g.* Goodwin and Holt, 1999). Threshold models allow for adjustments that might differ with regard to the size of the shock. Recent contributions to this literature include Ben-Kaabia and Gil (2007) on the Spanish lamb sector, Brümmer *et al.* (2009) on the wheat and flour market, Simioni *et al.* (2013) on fish products, and Loy *et al.* (2014) on dairy products. For dairy markets in Germany, Loy *et al.* (2014) showed that the price adjustment of private labels was much faster than that of national brands. This analysis is symptomatic of recent studies that investigate the heterogeneity of situations, recognising that within a product category, firms might have different ways to adjust prices. Lastly, as part of the TRANSFOP project, Hassouneh *et al.* (2013), developed a systematic analysis of price transmission in the EU.[2] They document the heterogeneity of price transmission across countries and commodities.

On the whole, these methods enable us to characterise price transmission in different markets, but the main determinants of food price transmission remain unclear. The general finding is that positive cost shocks are transmitted at a faster rate than negative cost shocks. There is, however, some debate about this result with regard to the robustness of tests (*cf.* Meyer and von Cramon-Taubadel (2004)). Moreover, Peltzman (2000) stated that: "The important result is that there is no evidence of any permanent effects of asymmetries on the long-run trend of output prices: none of the relevant coefficients differ from zero. These results imply that the asymmetries do ultimately disappear but that it takes longer than five or eight months for this to happen." (p. 486-487).

Market power in food industries

In a framework of perfect competition, Gardner (1975) developed a model of farm-retail price spread that forms the basis for explaining changes in the farmer's share of food expenditure. This framework was extended to deal with imperfect competition in the chain by Holloway (1991) and with multiple stages and imperfect competition in the chain by McCorriston and Sheldon (1996). However, major efforts were made to estimate market power at different stages of the chains.

[2] The TRANSFOP project was an EU-funded research project dealing with food price formation in Europe. http://www.transfop.eu.

The traditional view of market power in industry relies on the so-called Structure Conduct Performance (SCP) paradigm. In this view, it is supposed that a one-way chain of causation runs from structure (the level of concentration) to conduct (the degree of collusion), and from conduct to performance measured by profitability (*e.g.* Connor *et al.* (1985) for an analysis of concentration, advertising and pricing in the United States (US) food industries, and Viaene and Gellynck (1995) in Europe). However, this view was challenged by studies on industrial organisation (IO) and game theory that showed that there are strong interactions between conduct (behaviour) and structure. As shown by Sutton (1991) in his book "Sunk Costs and Market Structure", whose applied section is devoted to an in-depth analysis of competition in food industries, in some industries a high level of concentration is consistent with tough competition. This is because the anticipation of tougher competition makes entry less attractive, thus raising equilibrium concentration levels. This fundamental mechanism is ignored in SCP analysis. Sutton's contribution shed light on the fundamental differences between SCP approaches and IO-based approaches.

Studies estimating market power in industries were affected by the development of the IO theory and the availability of data. Early studies tried to estimate a parameter that could be interpreted as an index of market power that is basically deduced from Lerner's equation regarding relative price-cost margins and demand elasticity. These studies are based on aggregate data for an industry. Appelbaum (1982) is one of the first contributors in this field of research. Following this study, numerous contributions tested the presence of market power in the food industry. Bhuyan and Lopez (1997) tested for the presence of oligopoly power in 40 US food industries and concluded the existence of market power in most of them. Lavergne *et al.* (2001) evaluated the impact of oligopoly power on welfare for 21 food industries in France. According to their findings, welfare losses ranged from 0.5 and to 2% of total sales. Other contributions include Millán (1999) for Spanish food industries, Rezitis and Kalantzi (2012) for Greek food industries, and Mérel (2009) in the case of cheese. These analyses were also extended to address both buyer and seller power (Wann and Sexton, 1992).

Data availability at the product level and the development of the IO theory led researchers to evaluate competition between firms. Rather than estimating an "average" index of oligopoly power, the idea of this new research trend was to use theoretical models of competition (based on game theory) to derive relationships between different variables (using the first order conditions of profit maximisation) for alternative means of competition, to estimate models incorporating the restrictions from the theory, and then to test which model of competition best fits the data. Gasmi *et al.* (1992) analysed the competition between the two leading firms on the soft-drink market in the US. A key contribution in this field is Berry *et al.* (1995). Nevo (2000, 2001) also contributed to this literature by analysing the impact of mergers in the ready-to-eat cereal industry and by decomposing price-cost margins into

three sources: (i) product differentiation; (ii) multi-product firm pricing; and (iii) potential price collusion. According to his results, leading firms were able to maintain a portfolio of differentiated products and to influence perceived product quality, hence the high price-cost margins. This research programme is also useful to analyse vertical relationships between manufacturers and retailers (see below).

Retail industry strategies

The analysis of market power developed within the food industry was applied more recently to the retail industry. Gohin and Guyomard (2000) analysed the market power of the French retail industry and estimated both oligopoly and oligopsony power. Various authors concluded that there is a positive correlation between retail concentration at the local level and consumer prices: Barros *et al.* (2006) in Portugal, Smith (2004) in the UK, and Biscourp *et al.* (2008) in France. Biscourp *et al.* (2008) also analysed the role of regulation on competition and demonstrated that the enforcement of the ban of below-invoice retail prices has weakened competition among retailers. Richards and Patterson (2005) explored in more detail retail pricing. In their view, fixed prices are facilitating mechanisms for tacit collusion. Using scanner data (*i.e.* information on quantities, prices, characteristics of the products obtained by scanning bar codes for individual products at electronic points of sale in retail outlets), they showed that price fixity does support collusive *equilibria* among retailers, but other factors may also explain retail price behaviour.[3] Richards and Hamilton (2006) explored price and variety competition between retailers.

A major factor in the retail industry's evolution is the development of retailers' own products - the so-called private labels. These products, which now represent 10% to 40% of retail food sales in the EU countries, are a strategic tool used by retailers to increase profits through gains in market power. With this strategy, retailers are less dependent on specific upstream suppliers, can reinforce their bargaining position and can extract more profits. Private labels also modify competition among retailers. Because a private label is a specific product of a given retailer, retailers use it as a differentiation tool, which thus potentially softens price competition among them. From a theoretical point of view, it is mainly the impact of private labels on vertical relationships that has been explored. Important contributions to understanding the role of private labels have been made by Mills (1995),

[3] Scanner data are electronic records of transactions that establishments collect as part of the operation of their businesses. For food related studies, researchers mostly use two types of scanner data: "retail" scanner data from scanning bar codes at checkout lines of retail stores, thus providing information at the store level, and "consumer" scanner data that provides information of (food) purchases of a panel of consumers.

Scott Morton and Zettelmeyer (2004) and Gabrielsen and Sørgard (2007), while Bergès-Sennou *et al.* (2004) provide a survey of the literature. In parallel to this "theoretical" literature, an empirical corpus emerged in the 2000s, looking at the price and welfare effects of private label development. One of the first contributions is from Ward *et al.* (2002) who studied the impact of the development of private labels in the US. The authors used monthly data on prices, market shares and advertising expenses for 32 product categories. For each category, they analysed how national brands reacted to the development of private labels. They showed that an increase in the private label market share is consistent with (i) an increase (or no change) in the price of national brands, (ii) a decrease (or no change) in the price of private labels, (iii) a decrease or no change of average prices, and (iv) a decrease in advertising activity for national brands. Following this paper, numerous analyses were developed in order to confirm or contradict these results (*e.g.* Bontemps *et al.* (2008) for France, Sckokai and Soregaroli (2008) for Italy). Some researchers investigated the impact of the introduction of private labels rather than the increase in market share. For example, Gabrielsen *et al.* (2002) found that the introduction of private labels generates an increase in national brand prices. This is in line with the idea that, after the entry of a private label, the national brand focuses on "brand addict" consumers, while the private label is targeted towards "switcher" consumers.

The literature developed to analyse competition between firms was also extended to the analysis of vertical relationships between firms. For example, Sudhir (2001) considers strategic interactions between manufacturers and a single retailer in a local market. His analysis assumed linear pricing between manufacturers and the retailer. Berto Villas-Boas (2007) extended the analysis to multiple retailers and also considered other types of contracts. Bonnet and Dubois (2010) further extended the analysis to various forms of two-part tariff contracts, including contracts with resale price maintenance. They also took into account the role of private labels even if these products do not play a strategic role. Bonnet and Réquillart (2013a) extended the analysis to cover the strategic role played by private labels, as the outside option of retailers depends on the presence of private labels. A significant proportion of this literature deals with food markets (*e.g.* dairy products in Berto Villas-Boas (2007), mineral water in Bonnet and Dubois (2010) and soft drinks in Bonnet and Réquillart (2013a)).

Vertical relationships in the food chain

An alternative way to analyse price transmission is based on structural models allowing for the analysis of changes in mark-up. In this literature, price transmission is frequently referred to as cost pass-through and is defined as the proportion of a change in input cost that is passed through to the final price of the product. In a context of perfect competition, cost pass-through is lower than or equal to one and depends on the elasticities of supply

and demand (*cf.* Gardner, 1975). In a context of imperfect competition, cost pass-through also depends on mark-up adjustments. In particular, the literature on taxation under conditions of imperfect competition has shown that the cost pass-through might be less than or greater than one depending on the curvature of the demand function (see for example Stern (1987) and Delipalla and Keen (1992) in a context of quantity competition; Anderson *et al.* (2001) in a context of price competition with differentiated products).

In the food sector, Bettendorf and Verboven (2000) developed a structural model of the Dutch coffee industry. They found that firms slightly under-shift on final prices the cost changes due to variation in coffee bean prices. Firms slightly reduce their mark-up when coffee bean prices increase. Nakamura and Zerom (2010) studied the US coffee industry and reported a long-run pass-through of coffee commodity prices to retail prices of 0.92 (0.26 when evaluated in elasticity terms, *i.e.* reporting on percent variation of prices and costs). They developed a structural model that takes into account the competition between differentiated products as well as price rigidity in the short run. To do this, they assumed that firms must pay a menu cost to adjust their prices. They found that menu costs are small but play a role in the delayed response of prices to cost variations.[4] They also found that mark-up adjustments play a significant role. These adjustments are linked to the change of demand elasticity when prices vary. Hellerstein (2008) showed that mark-up adjustments at the manufacturer and retailer levels play an important role in explaining the pass-through of cost changes in the US beer industry. Recently Bonnet and Requillart (2013a) found that the cost pass-through in the French soft drink market is 1.16, on average. Moreover, as shown by Bonnet *et al.* (2013), the pass-through rate for upstream cost shocks to downstream retail prices depends on the form of the contracts between manufacturers and retailers. This literature suggests that, to assess price transmission along a particular food supply chain, it is necessary to consider key characteristics such as the structure of the chain, consumer substitution patterns and the type of contracts between manufacturers and retailers.

2. From commodities to differentiated food markets

Product differentiation based on innovation and market segmentation has been one of the main components of food industry strategies implemented in recent decades. In contexts in which consumer demand is already satisfied in terms of volume, many agribusiness sectors have competed by proposing product characteristics perceived by consumers as having more value (Grunert, 2005). In this context, research in food economics has mainly focused on three types of issues: the analysis of consumer behaviours and preferences

[4] Menu costs refer to all costs that a firm might incur when modifying the price of its products. Those costs might include updating computer systems, re-tagging items, costs to develop new pricing strategies, *etc*.

related to quality and food characteristics; the consequences of quality scheme implementation within the food chains; and the analysis of public policies related to food quality.

Consumer-related issues

In the aftermath of food safety crises, consumers have become more demanding and critical in their food choices. In this context, food firms have engaged in product quality differentiation to meet the preferences of various consumer segments (Grunert, 2005). Some product characteristics used by the food industry for segmenting the market are related to taste (*e.g.* new flavours, new recipes, *etc.*), convenience (ready-to-eat, easy to prepare, *etc.*) or use of foods (frozen, canned, *etc.*). Other characteristics are related to societal challenges such as the environment, fair trade or animal welfare, or have raised contestation and fears among the populations (*e.g.* GMOs, food irradiation or nanotechnology). Research in food economics has mainly focused on the latter in order to determine consumer preferences for such characteristics, and to assess the potential contribution of product differentiation strategies to deal with these societal challenges.

What is consumer Willingness-To-Pay (WTP) for quality and specific product characteristics? What are the impacts of quality labels and information delivered to consumers on their perceptions and purchases? What are the effects of differentiation strategies on market segmentation and food prices? Methodologies used to answer these questions and analyse consumer reactions to food characteristics are various and can be distinguished depending on the data they use. Some studies are based on real choices made by consumers: in this case, data come from purpose-designed surveys, consumer expenditure surveys of actual purchasing behaviour or scanner data collected at supermarket checkouts (Bonnet and Simioni, 2001). In other studies based on hypothetical choices made by consumers, the relative importance of various attributes in purchasing food has been explored with stated preference techniques such as contingent valuation (*e.g.* Buzby *et al.*, 1995) and choice experiments (*e.g.* Alfnes *et al.*, 2006; Loureiro and Umberger, 2007). More recently, the experimental approach has also been used by employing auctions and lab experiments (*e.g.* Roosen and Marette, 2011; Lusk and Shogren, 2007; Combris *et al.*, 2009).

As shown by Grunert (2005), research addressing consumer perception and behaviours about food quality shows the complexities involved, both with regard to how consumers form judgments on the quality of a product and how these judgments are traded off against price in consumer food choices. Many studies have dealt with the trade-offs between price, health, environmental and sensorial dimensions. Generally speaking, a systematic result is the strong heterogeneity of consumer preferences and behaviours (*e.g.* Burton *et al.*, 2001;

Brécard *et al.*, 2009), depending on socioeconomic and demographic attributes (age, gender, education, income, *etc.*), psychological characteristics or national contexts.

Apart from price, an important issue for consumers remains taste and sensory aspects (Combris *et al.*, 2010; Bazoche *et al.*, 2013); appearance and cosmetic damage may also significantly affect consumer WTP (Yue *et al.*, 2009). However, food crises, uncertainties about the real content of food products and the increase in diet-related diseases have led many consumers to give even greater consideration to the health aspect. For example, a study on consumer reactions to nanotechnology shows the importance of health issues and related uncertainties in the introduction of new products (Roosen *et al.*, 2011).

Consumer reactions to food innovations illustrate the complexities of how consumers form judgements on a product's quality (Loureiro and Hine, 2004; Noussair *et al.*, 2002 and 2004). A review addressing GMOs has shown that consumer attitudes towards genetically modified (GM) food are driven by several factors (Costa-Font *et al.*, 2008). Risks and benefit perceptions associated with GM food determine acceptance and final decisions. These perceptions of a GM product are found to be conditioned by "individual values" such as altruism/selfishness or environmental consciousness. Attitudes also depend on "objective" and "subjective" consumer knowledge, "subjective" knowledge being more closely related to values and having more impact on individual attitudes than "objective" knowledge. In addition, the value of information for consumers is affected by conditions of access and its precise content, and the sources and types of message (newspapers, public authorities, non-governmental organisations, *etc.*) have a crucial impact. This is of particular importance in a market with different kinds of scientific uncertainty and information available, as is generally the case for food innovations (Marette *et al.*, 2009).

Another example of the complexities involved in consumer choices concerns animal welfare, which has been an important issue in public debate over recent years. Most studies report consumer expectations for positive changes in animal welfare (Lagerkvist and Hess, 2011; Napolitano *et al.*, 2010). However, as stressed by Lagerkvist and Hess (2011), animal welfare clearly includes both human (*e.g.* more tasty meat) and animal aspects (animal well-being). A clear separation of these elements would be needed to attempt to understand consumer preferences. How do they trade off consequences for themselves versus consequences for the animal? In their recent meta-analysis, Lagerkvist and Hess (2011) suggest that current literature contains no evidence that is statistically strong enough to distinguish WTP for healthy food from WTP for animal well-being.

Quality signals, brands, and certification of quality play a key role in consumer behaviours and trade-offs. A large proportion of economic literature has dealt with this issue and compared the impacts of different types of labels and signals. Regarding environmental issues, the growing interest in organic agriculture has prompted numerous studies that compare various aspects of

organically and conventionally produced foods (Thomson and Kidwell, 1998; Huang, 1996a; Krystallis and Chryssohoidis, 2005; Hughner *et al.*, 2007; Didier and Lucie, 2008; Napolitano *et al.*, 2010; Janssen et Hamm, 2012; Van Loo *et al.*, 2011; Loureiro *et al.*, 2002; Hu *et al.*, 2012). A review of pesticide risk valuation literature (Florax *et al.*, 2005) provides strong evidence that the WTP for reduced risk exposure increases when going from low to medium and low to high risk exposure levels. Are premiums that consumers are willing to pay for an eco-labelled product driven by selfish or altruistic motives? A review of empirical studies comparing organic products and conventionally grown alternatives tends to show that concern for human health is a key factor that influences consumer preference for organic food (Yiridoe *et al.*, 2005). However, Bougherara and Combris (2009), using an incentive-compatible experiment, suggest that consumer WTP for eco-labelled products are motivated by the desire to contribute to a public good for purely altruistic reasons or selfish motives other than food taste or safety.

Another important issue regards market segmentation (Gil *et al.*, 2000): is there a place on the market for moderately demanding environmental specifications, between conventional and organic products? Bazoche *et al.* (2013) show that for European consumers there is nothing but organic because the inclusion of less stringent production rules does not add value to products. Marette *et al.* (2012) show that the introduction of a new label signalling apples that use few pesticides compared with conventional apples increases the average consumer surplus whatever the information context for participants, because of higher quality than conventional apples and a lower price than organic products.

For consumer preferences regarding the origin of food, many studies have focused on WTP for country-of-origin characteristics (*e.g.* Mabiso *et al.*, 2005; Lusk *et al.*, 2006; Verbeke and Roosen, 2009) and geographical indication quality labels (namely Protected Designation of Origin – PDO and Protected Geographical Indications – PGI) (*e.g.* Bonnet and Simioni, 2001; Loureiro and McCluskey, 2000; Menapace *et al.*, 2011; Aprile *et al.*, 2012). Recently, investigations have also been conducted into local foods (Darby *et al.*, 2008; Onozaka and Mcfadden, 2011; Hu *et al.*, 2012). Based on surveys in France, Germany, and the UK, Bieberstein *et al.* (2013) have analysed consumer preferences for alternative beef labelling strategies. The findings suggest that consumers place more importance on labels of origin as opposed to private brands. According to Stefani *et al.* (2006), the region of food products' origin affects consumer valuation in two different ways. Firstly, origin can act as a quality cue hinting at other characteristics of the product. Secondly, origin can directly affect the value of food due to its symbolic or affective role. The narrower and more precisely defined the area of origin, the higher the quality expectation of consumers, and thus their WTP, supporting the role of origin as a quality cue. Aprile *et al.* (2012) suggest that the highest price premium is for a product with a PDO label, followed by an organic farming label, then by a quality cue describing the product as extra-virgin olive oil and finally by a PGI

label. Bazoche *et al.* (2013) show that WTP for PDO certification is almost equal to that for organic labels, while information regarding the reduced use of pesticides does not modify WTP for the PDO label. In the study by Van de Lans *et al.* (2001), the region-of-origin cue and the PDO label both influence regional product preferences through perceived quality, although the effect is limited to specific consumer segments.

From spot markets to vertical supply contracts

Quality schemes aim to increase the total revenue earned in the market by differentiating the supply of a particular product according to the presence, degree or absence of particular attributes that are prized more highly by some consumers. Often, the characteristics promised to consumers do not exclusively depend on downstream stakeholders. This is the case for products differentiated on the basis of production processes (*e.g.* low use of pesticides) or segregation actions within the chain (*e.g.* GMO-free). The entire supply chain needs to be involved in the quality scheme and the challenge is then to ensure the whole chain's commitment to be able to provide and guarantee the characteristics to end consumers.

Research on vertical relationships in food chains with regard to quality management has focused on two mainaspects: the trade-off between spot markets and contracts and its consequences on the vertical structure of the chains (*e.g.* Giraud-Héraud *et al.*, 1999; Raynaud *et al.*, 2005), and the design of the supply contracts encouraging quality commitments from the entire chain (*e.g.* Bogetoft and Olesen, 2002 and 2004; Jang and Olson, 2010).

From a methodological point of view, two main approaches have been adopted. On the one hand, many studies have been conducted in the neo-institutional theoretical framework (*e.g.* Ménard and Valceschini, 2005; Boger, 2001) and rely on descriptive analysis of food chains (*e.g.* Raynaud *et al.*, 2005). On the other hand, industrial organisation models have been proposed to analyse the strategic behaviours and interactions of firms in vertical chains and to assess the impacts of various types of contracts. Only a few empirical analyses have been proposed in this field (*e.g.* Bonnet and Simioni, 2001; Hassan *et al.*, 2011).

Several alternative modes can be used to govern exchange between legally-independent firms: spot markets, relational contracts, formal contracts and cross-shareholding arrangements (Raynaud *et al.*, 2005). A significant change in the vertical organisation of food chains is the shift away from undifferentiated spot markets to formal contracts in dedicated chains. The shift towards highly differentiated supply chains as a response to increasing competition and the heterogeneity of consumer demand has increased the level of information asymmetry between stakeholders in food markets (Young and Hobbs, 2002). To overcome the problem of information asymmetry, food firms have increasingly used explicit contracts with their suppliers. Many

European retailers have therefore moved from spot markets towards more explicit contractual arrangements based on private technical requirements and verification systems and used to develop vertically differentiated "chain brands" (Henson and Reardon, 2005; Codron *et al.*, 2005).

The first reason why vertical coordination is being used to circumvent the marketplace regards the uncertainties about the nature of food quality and problems in detecting quality, and the detrimental consequences of opportunistic behaviours on the ability to provide high-quality products to end consumers (Hennessy, 1996). Many studies confirm the link between product quality and the implementation of explicit contracts in food chains (Boger, 2001; Raynaud *et al.*, 2005; Fischer *et al.*, 2010). However, the adoption of explicit contracts is more likely among large companies than small- and medium-sized enterprises (Fischer *et al.*, 2010). The general trend is also modulated depending on quality determinants: supply chain governance is closer to hierarchical modes of organisation (written contracts or cross-shareholding arrangements) in cases where reputational capital is the main quality assurance device, whereas market-like governance (spot markets) is more prevalent in cases with public certification (Raynaud *et al.*, 2005).

Reducing opportunistic behaviour is therefore a prime concern for contract design and implementation. However, Jang and Olson (2010) show that communication and price discovery costs along with the risk of not procuring an acceptable level of buyer-specific inputs may also be key determinants in the choice between contracts and alternative spot markets. A contract can specify the desired quality attributes and related production systems, if necessary, before production begins. This enables the buyer to reduce the risk and related costs of not being able to access the appropriate quantity of the desired inputs.

The implementation of quality schemes by downstream stakeholders can also have strategic roles in food chains. Examining retailers' differentiated brands, Bazoche *et al.* (2005) proposed a theoretical framework that shows that the adoption of quality schemes based on supply contracts might increase the rival costs of competitors that continue to buy on intermediate spots markets. In a similar theoretical framework, von Schlippenbach and Teichmann (2012) show that retailers may use private quality standards to improve their bargaining position in the intermediate goods market. This is associated with inefficiencies in upstream production, which can be mitigated by enforcing a minimum quality standard.

Lastly, regarding the design of supply contracts, several studies have addressed the indexation of supply contracts on spot market prices. Bazoche *et al.* (2005) analysed the effects of supply contracts on spot prices. Xia and Sexton (2004) examined the competitive implications of contract pricing arrangements that link the contract price to the subsequent cash price. The authors show that some types of contracts may have anticompetitive consequences due to their effects on spot prices.

Firms' strategies and food quality policy

Consumer expectations about food quality have resulted in additional demands for sharing information vertically within the supply chain and providing it to consumers. This raises important public policy issues, and the vertical structure of food chains and supply chain organisation may lead to the under- or over-supply of low and high qualities on the end market, justifying public intervention (Giraud-Héraud *et al.*, 1999; Mérel and Sexton, 2012). Voluntary labelling by firms or private certification procedures may be insufficient to provide consumers with reliable information (Caswell and Mojduszka, 1996; Caswell, 1998; Crespi and Marette, 2003). Collective quality labels such as PDO and PGI may have detrimental impacts from a competition policy perspective. These issues have been considered in many economic investigations in recent decades. Most of this research is based on IO models.

Roe *et al.* (2014) have recently proposed a review that explores when mandatory and voluntary labelling policies may be socially optimal. Although mandatory labelling may lead to subsequent benefits from improved information symmetry, more symmetric information may alter social welfare in other ways, *e.g.* by altering the production of externalities, the exercise of market power or expenditure on rent-seeking activities.

The EU policy on voluntary food labelling emphasises the geographical origin of the products (Bureau and Valceschini, 2003). Speciality products from a given area benefit from a reputation premium that is well-identified by consumers. Public authorities allow exclusive use of the appellation to a group of producers in exchange for commitments on production techniques, certification and control, and obligation of a collective use of the name. Such a policy has been widely analysed to assess its interest for producers on the one hand, and its potential anticompetitive impacts on the other.

Regarding producers' interests, Menapace and Moschini (2011) show that PGI certification improves the ability of reputation to operate as a mechanism for assuring quality linked to some inherent attributes of a particular production area. Yue *et al.* (2013) investigate the choice of producers between geographical indications and brand advertising. Under plausible parameter characterisation, producers may choose PGI and quality improvement efforts at equilibrium. This occurs when the cost of marketing is high and the relative cost of quality effort is low in comparison to the former. A recent empirical analysis shows that the European PDO policy sustains competitiveness within the agricultural sector and reduces exiting risk for smaller firms (Bontemps *et al.*, 2013). However, smaller firms still have a lower survival rate compared with larger ones, which cannot be compensated by the quality label effect.

In terms of competition concerns, a first point is the potential anticompetitive impacts of upstream producers' coordination because they act collectively. Moschini *et al.* (2008) show that it is possible to have competitive

provision of quality in agricultural markets through certification devices similar to geographical indications. However, a competitive equilibrium can exist, but it under-provides the high quality product. Mérel and Sexton (2012) investigate the choice of quality by producer organisations for geographical indications. Assuming that producer organisations choose the quality level that maximises joint producer profits, they show that they have an incentive to supply quality in excess of the socially optimal level. A second point regards measures that allow quantity restrictions associated with PDO as they may have a negative impact on welfare. Giraud-Héraud *et al.* (2003) show that when the quality of the product is strongly decreasing with the quantity of production, the choice of a monopolist is in accordance with consumer interest. The monopolist restricts quantity, which is detrimental for consumers but this is accompanied by a choice of quality that compensates this negative effect. Marette *et al.* (1999) and Crespi and Marette (2003) show that producer collusion may be needed to induce producers to signal quality to consumers. Lence *et al.* (2007) show that some restrictions on production levels can be welfare-enhancing if this induces more investments.

3. Food crises: how to restore consumer trust?

It is not an exaggeration to state that the last 30 years have witnessed a revolution in food safety economics, and more generally in the way the food system and policymaking—especially in Europe—deal with food risks. It should suffice to mention the BSE crisis to grasp the destructive potential of market failures in providing an adequate food safety level. The occurrence of large-scale and cross-borders food scares has also marked a turning point in research issues and methods, and the main driving force behind this change of focus is the globalisation of food supply and demand. At the same time, increased consumer sensitivity to food risks and the complexity of modern food chains have emphasised the role of food safety management at the micro-level.

The month the *RAEStud* published its first issue (under the previous name of *Cahiers d'Économie et Sociologie Rurales*) in 1984, Foster and Just published a preliminary version of a study which would later become one of the most cited works in the field of food scares and consumer response (Foster and Just, 1984). It referred to an incident of milk contamination on a Hawaiian island, consumer response and the time needed to get back to "business as usual". This paper, finally published in 1989 (Foster and Just, 1989), highlighted two elements that would soon become key research issues in agricultural economics literature: (a) What are the costs associated with failures in the food safety market? (b) How do consumers behave when they are uncertain about the safety of foods? The latter reflects the fact that any improvement in food control techniques and food safety regulation will never generate 100% safe foods, always leaving margins of uncertainty and concerns. This has made research on food safety a stimulating arena for economics research at

the intersection of various streams, including the economics of information, economic psychology and behavioural economics. While this type of research has dominated the scene over the last 20 years, more traditional research on the supply side and regulations has also evolved.

Methods

Food safety can be conceived as a market good in its own right, subject to demand and supply forces, and early research in this area has made use of the microeconomics toolkit to explore the functioning of its market. Market failure in providing the socially optimal level of food safety has been explored in the context of its public good characteristics, moral hazard and asymmetric information (Henson and Traill, 1993; Henson *et al.*, 1995; van Ravenswaay, 1995). A variety of research methods and quantitative approaches have been applied depending on the market focus and the type of data.

Demand for research in this field could be broadly classified on the basis of two driving forces: (a) the need for evidence-based regulations and management decisions; (b) the need to adjust standard consumer behaviour approaches to deal with the complex issues associated with food safety.

Considering the risk management stream over the last thirty years, most studies in the first decade were aimed at the economic assessment of food safety failures and related policy interventions. The primary need was to address the "public good" nature of food safety and the associated negative externalities through the monetisation of costs and benefits of food management strategies (Irz, 2008a). These early studies largely relied on valuation methods such as contingent valuation, cost-of-illness, hedonic pricing and conjoint analysis (Ragona and Mazzocchi, 2008; Caswell, 1995; Buzby *et al.*, 1998). The evolution of methods aimed at eliciting WTP has played a major role in this area, to the point of leading mainstream economic research, especially in the design and application of experimental auctions (Shogren *et al.*, 1994; Hayes *et al.*, 1995). The popularity of methods in experimental economics soon expanded beyond the US borders to reach Europe and this literature is growing rapidly (see *e.g.* Rozan *et al.*, 2004; Bocker and Hanf, 2000; Roosen and Marette, 2011; Stenger, 2000). All of these methods clearly rely on *ad hoc* data collection. More recently, studies in decision making have drawn from the literature in operational research through a focus on decision support systems and more specifically on the broad family of multi-criteria analysis (Ruzante *et al.*, 2010; Mazzocchi *et al.*, 2013). An alternative route to quantifying the costs associated with food poisoning outbreaks, food scares or product recalls is based on financial data, using the Event Study Analysis[5] to model the response of stock returns to news and regulations related to food safety (Thomsen

[5] Event studies (MacKinlay, 1997) are based on tests on *ex ante* forecast errors from financial models that are assumed to be representative of the "normal" stock return

and McKenzie, 2001; Henson and Mazzocchi, 2002; Mazzocchi *et al.*, 2009a; Carter and Smith, 2007).

The setting of food standards and their impact on international trade and the main trade agreements have also generated a substantial number of empirical studies. Many of these have explored food standards as a non-tariff trade barrier, especially towards developing countries. There is a relatively rich body of theoretical research based on political economy models (see *e.g.* Swinnen and Vandemoortele, 2011), while the dominating methodology for empirical studies is the gravity model (Anderson and van Wincoop, 2004; Chen and Novy, 2012). Other methods have been adopted less frequently, for example the price-wedge method in Nimenya *et al.* (2012), or panel data models (Colen *et al.*, 2012; Schuster and Maertens, 2013).

Since the BSE scare, however, the most prolific research area in terms of methodological advances and empirical studies has certainly been the one focusing on consumer reaction. The first study, by Burton and Young (1996), employed an Almost Ideal Demand System incorporating a media index to capture coverage of the food scare, and since then, this approach has been widely applied and extended (*e.g.* Verbeke and Ward, 2001; Piggott and Marsh, 2004; Mazzocchi *et al.*, 2004; Mazzocchi, 2006; Mazzocchi *et al.*, 2006), with several articles published in the *RAEStud* (Burton *et al.*, 1999; Gustavsen, 1999; Mazzocchi, 2000). Other empirical studies used a psychology background and the investigation of consumer trust and risk perception, mostly based on established theories such as the Theory of Planned Behaviour[6] and estimated through structural equation models or other latent variable modelling approaches (Smith *et al.*, 1999; Lobb *et al.*, 2007; Schroeder *et al.*, 2007; Tonsor *et al.*, 2009). More recently, applications based on neural networks agent-based modelling have gained interest for their potential to capture complex networking relationships (Chambers and Melkonyan, 2013; Tykhonov *et al.*, 2008).

Consumer behaviour

Until the BSE scare, empirical research on consumer response to food risk information was mainly US-based, and focusing more on long-term risks resulting from unsafe foods than on the occurrence of outbreaks, and where outbreaks and recall were investigated they were primarily product-specific and on a small geographical scale. Most of the literature between 1985 and 1995 explored consumer perception of risks associated with pesticide

behaviours. Given clearly identified events, they test the significance of these events on return for individual securities or groups of securities.

[6] The Theory of Planned Behaviour (Ajzen, 1985) is a psychological theory that traces back behavioural intentions to three main determinants: personal attitudes, social norms and perceived control on own behaviour.

residues in fruit and vegetables, growth hormones in meat, and the dangers of food irradiation (see Caswell, 1991). In Europe, the focus was mainly on the risks of food adulteration (Collins, 1993) or bacterial contamination, especially salmonella outbreaks. Consumer behaviour was framed within a microeconomic perspective, emphasising the risks of market failure because of asymmetric information (Henson and Traill, 1993), and potential mismatches between demand and supply of food safety.

The BSE scare, however, led to an abrupt change of focus in the analysis of consumer behaviour in response to a food scare. The sudden change in consumer purchase choices (Burton and Young, 1996), the social and mass media amplification process (Beardsworth and Keil, 1997), the length of time it took for the demand for meat to begin to recover, and the unexpectedly large impact in international markets not directly affected by BSE, such as Germany, Italy and France, raised questions about the reliability of the traditional consumer theory. Economic psychology was called into action, primarily to explore the distance between objective food risks and subjective risk perceptions (Johansson-Stenman, 2008). The fact that shortly after the BSE scares, other large scale outbreaks hit the meat market, such as the dioxin crisis in the late nineties, or other waves of the BSE scare outside the UK in the early 2000s, prompting further research on structural changes in meat demand (Allais and Nichele, 2007).

A strong emphasis was put on the behaviour of news and information providers, and the way consumers process information (Swinnen *et al.*, 2005; Bocker and Hanf, 2000). A large body of research explored the mediating role of consumer trust in food suppliers, information providers and authorities (Lobb, 2005; Lobb *et al.*, 2007), and a significant change in the approach to food risk communication has occurred (Lofstedt, 2006), invoking more transparent communication not only about the certain facts of food risks, but also about uncertainties. A deeper understanding of consumer behaviour under uncertain risk information is probably the main research priority in this area.

Firms' strategies

Within the well-known framework of risk analysis and its key component of risk assessment, management and communication, strong evidence has been produced on the conflicting *criteria* and expectations by the public and private sectors (Henson and Caswell, 1999). Henson and Hooker (2001) list three main reasons why firms should enhance the level of food safety of their products: (a) market competition and economic consequences of failure; (b) public regulation; (c) *ex post* liability laws. In Europe, public intervention has been based on the precautionary principle, hence a regulatory approach, whereas in the US, the emphasis has been on *ex post* product liability. This has obviously implied a different strategic response by the private sector. Research has shown that firms' compliance depends on the expected economic benefits, and compliance can be voluntary when it generates gains in terms of market

share or profitability, otherwise depending on the dimension of sanctions and the strength of enforcement authorities (Henson and Caswell, 1999).

The introduction of quality management systems in the food supply chain (primarily Hazard Analysis Critical Control Point, HACCP) has thus responded both to the pressure of public regulation and the laws of market competition, but the fact that the application of HACCP has been increasing over time suggests that significant economic incentives exist for food firms (Henson and Hooker, 2001). These incentives are also likely to be in the form of cost avoidance, given the evidence of major costs and brand equity losses associated with product recall (Thomsen and McKenzie, 2001).

Nevertheless, a high degree of heterogeneity in dealing with food safety management exists across firms and food sectors, although firms responsive to food safety issues tend to seek alliances and partnerships with food chain partners that also prioritise such issues (Loader and Hobbs, 1999). This has major implications on a firm's cooperative relationship upstream and downstream the food chain (Sporleder and Goldsmith, 2001), generating vertical strategic alliances within the supply chain, with positive effects on coordination and efficiency. Vertical integration has also been interpreted as the natural consequence of information asymmetry (Hennessy, 1996). Policy analysts have placed a stronger emphasis on co-regulation of food safety, *i.e.* private codes of practice or action plans that are backed by governments (Martinez *et al.*, 2007), with a potential for increased efficiency and savings for both sides, although their application remains limited.

Following the implementation of the General EU Food Law Regulation 178/2002 that imposed strict liability for food firms if they fail to provide safe food, the implementation of private standards has been one major tool to assure due diligence and signal that firms are taking all reasonable precautions to prevent food safety incidents from occurring. Although all stakeholders in the food chain have been engaged in reinforcing food safety controls, the major retailer groups have played a prominent role since the nineties by urging their suppliers to adopt more private standards for unprocessed (*e.g.* Global GAP[7]) and processed (*e.g.* BRC, IFS[8]. . .) foods.

Although these standards deal with a broad range of issues (including both environmental and social dimensions), food safety aspects are crucial.

[7] GAP stands for Good Agricultural Practice—and GLOBAL GAP is the worldwide standard that assures it. It is a global organisation whose objective is to promote safe, sustainable agriculture worldwide.

[8] BRC Global Standards is a leading safety and quality certification programme used by over 22,000 certificated suppliers in 123 countries, with certification issued through a worldwide network of accredited certification bodies. The Standards guarantee the standardisation of quality, safety and operational *criteria* and ensure that manufacturers fulfil their legal obligations and provide protection for the end consumer. IFS Food is a recognised standard for auditing food safety and quality of processes and products of food manufacturers. It concerns food-processing firms or firms that pack loose food products.

They are clearly focused on the business-to-business relationship and not at all used for product differentiation and price premiums on the end market. Instead, they aim at protecting retailer brands and managing relationships with upstream suppliers, either to ensure that these suppliers comply with public regulations or to impose more stringent requirements than public regulations.

These standards, collectively adopted by retailers, raise several important questions. Why do competitive retailers choose to cooperate in imposing collective standards on their suppliers? How do these private standards affect the bargaining power and distribution of value within the chains? How does the existence of such collective standards affect the market outcome? To what extent does it affect how safe suppliers' products are, and how does it affect the risk of failure in the end market? A huge body of economic studies has been developed over the last two decades to address these questions. Existing literature on private food safety standards combines theoretical research based on IO models (Marette, 2007 and 2008; Giraud-Héraud *et al.*, 2012) and more descriptive and empirical works. Issues discussed include the reasons for adopting food safety standards (Jayasinghe-Mudalige and Henson, 2006; Henson and Hooker, 2001; Henson and Caswell, 1999), how standards affect the internal organisation of firms (Holleran *et al.*, 1999), the strategic behaviour of firms and the organisation of the supply chain (Hennessy *et al.*, 2001; Charlier and Valceschini, 2008; Codron *et al.*, 2005), the effects of safety standards on trade (Bureau *et al.*, 1998; Marette and Beghin, 2010), and the political economy of private standards (Swinnen and Vandemoortele, 2011; Vandemoortele and Deconinck, 2014).

Private food standards raise important issues that lead to considering simultaneously their benefits along the food chain, including consumers, and their consequences in terms of market power and biased international trade. Most of these questions are explored in a special issue of the European Review of Agricultural Economics (Hammoudi *et al.*, 2009) and in Swinnen (2007) and Henson and Humphrey (2009).

Public policy assessment

Although the introduction of food safety policies in Europe strictly requires a prior Regulatory Impact Assessment (RIA), the barriers in achieving reliable *ex ante* estimates of the monetary costs and benefits associated with new regulations have severely restricted the availability of robust evidence (Mazzocchi *et al.*, 2013). The integrated RIA procedure adopted by the European Commission since 2002 calls for transparency, rigour, flexibility and a proportionate level of analysis (*i.e.* balancing the costs of *ex ante* evaluation with the relevance of the regulation), but a feasible method meeting all of these requisites hardly exists, and data are scarce. During the nineties, various cost-benefit analyses have been applied to the assessment of HACCP in the US

meat and poultry industry (Roberts *et al.*, 1996; Crutfield *et al.*, 1999; Jensen *et al.*, 1998; Antle, 2000). Most evaluation studies have focused on individual impact (see the review by Ragona and Mazzocchi, 2008), often overlooking costs that are more difficult to monetise, such as compliance costs.

Ex post evaluations of food safety policies are almost inexistent, with a few exceptions; for example Muth *et al.* (2007) evaluated the effects of the 1996 HACCP rule on the survival of slaughter plants, while Otsuki *et al.* (2001) measured the impact of European food safety standards on African countries' exports. This is certainly a research area that requires new impetus in the coming years, although the main constraint for its development is the scarcity of adequate data.

4. Reducing the burden of obesity and diet-related chronic diseases

Over recent decades, economists have investigated numerous nutrition-related aspects of food policies, but the exact focus of research has changed together with the nature of the most policy-relevant nutritional issues. Food economists' initial interest in malnutrition, which followed naturally from concerns about food insecurity during the post-war period in Europe, progressively faded as the abundance of food brought about by fast productivity growth and the Common Agricultural Policy (CAP) became self-evident to policy makers and ordinary citizens alike. However, growing prosperity brought new problems and has been blamed for the deteriorating nutritional health of consumers throughout the continent. In particular, the obesity epidemic has now become a clear European reality (Berghöfer *et al.*, 2008) and there is robust evidence linking nutritional factors to various chronic diseases including strokes, diabetes, heart disease and some types of cancers (World Health Organization, 2003). The promotion of healthy diets, achievable by either influencing consumer food choices or affecting the nutritional quality of products delivered by the food supply chain, has therefore become a priority throughout Europe, as demonstrated by the National Nutrition and Health Programme (Programme National Nutrition Santé, or PNNS) in France (Hercberg *et al.*, 2008) or the platform for action on diet, physical activity and health in the EU.

A variety of economic tools to investigate nutritional health

Methodologically, welfare economics helps clarify the rationale for government intervention at a theoretical level (Cutler *et al.*, 2003) and provides tools such as cost-benefit analysis to establish the social desirability of public policies. Furthermore, from an applied perspective, economics, as the study of optimal choices of consumers and producers under scarcity constraints,

provides a framework to analyse the nutritional effects of decisions made by agents on the demand and supply sides of the food market.

Starting with consumers and models of whole diet choices, traditional demand analysis investigating empirically the allocation of household resources to the consumption of goods including foods, and services including catering, has a long history as described in Deaton and Muellbauer (1980a). These models of food demand are an important tool to analyse nutritional issues because they can be linked to food composition tables, as initially proposed by Huang (1996b), to infer the determinants of nutrient demands and diet quality or simulate food policies. In its modern form, demand analysis establishes a clear link between the rational choice model of the consumer and empirically tractable demand equations. This involves the estimation of a simultaneous system of demand equations, as opposed to single equation models, so as to impose theoretical restrictions (*e.g.* adding-up, symmetry). From the seminal contribution of Stone (1945) who proposed the linear expenditure system, increasingly flexible functional forms have been developed, but the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980b), in spite of its age, remains extremely popular because of desirable properties and ease of estimation (Buse, 1994). It has therefore recently been applied to investigate various aspects of food demand in Slovenia (Verbi *et al.*, 2014), Turkey (Bilgic and Yen, 2014), France (Bouamra-Mechemache *et al.*, 2008), Spain (Lasarte Navamouel *et al.*, 2014), the UK (Tiffin and Arnoult, 2011), Finland (Irz and Kuosmanen, 2012) and Denmark (Smed *et al.*, 2007). However, the AIDS model is also restrictive because it imposes linearity of Engle curves, while empirical work with large expenditure data sets has shown that Engel curves typically differ widely across goods and have complex non-linear shapes (Pendakur, 2009; Blundell *et al.*, 2007). In response to these concerns, the Quadratic AIDS model was introduced by Banks *et al.* (1997) and has also been widely used in food demand analysis (*e.g.* Moro and Sckokai, 2000; Capacci and Mazzocchi, 2011). More recently, the introduction of the Exact Affine Stone Index (EASI) model of Lewbel and Pendakur (2009) has given researchers the possibility of modelling Engle curves as a polynomial of any order, and applications to the European food sector are now emerging (*e.g.* Caillavet *et al.*, 2014).

Apart from the issue of flexibility in space and price dimensions, another difficulty in empirical demand analysis regards the treatment of preference heterogeneity among consumers, which represents an empirical regularity with potentially important implications for the equity effects of food policies and the targeting of interventions to promote healthy eating. Part of the heterogeneity relates to observable socio-demographic variables and can be included in the analysis in different ways, reviewed by Moro and Sckokai (2000), but the dominant view of the profession has shifted to acknowledge that unobserved heterogeneity is also an inescapable and essential part of the modelling problem (Crawford and Pendakur, 2013). In this regard as well,

the EASI model, which accounts for unobserved preference heterogeneity, represents an appealing new development in demand modelling.

While conceptually appealing, analysing calorie and nutrient consumption based on demand systems also presents some limitations, including the high degree of product aggregation imposed by the size limit of the demand systems that can be realistically estimated empirically. Consequently, an alternative "direct" approach has been proposed firstly to translate foods at the most disaggregated level into nutrients and, secondly, to investigate the relationship between nutrient demand and the socioeconomic characteristics suggested by consumer theory (Behrman and Deolalikar, 1987). Estimation of this type of reduced-form equations for industrial countries in Europe has, however, been rare (Fousekis and Lazaridis (2005) represents a Greek exception).

Modern food shoppers must choose among an incredible variety of products that is not easily captured by traditional demand models. Alternative modelling frameworks, made possible with the availability of scanner data sets describing products down to the bar code level, have therefore been developed to analyse consumer choices within food categories. The models follow the seminal contributions of Lancaster (1966) in treating utility as deriving from the characteristics of the foods consumed and consider both the discrete (*i.e.* "which brand should I buy?") and continuous (*i.e.* "how many units of the preferred brand?") dimensions of consumer choices (Hanemann, 1984). These developments are highly relevant to the analysis of the nutritional health effects of food policy given the observation that the nutritional composition of foods within a seemingly narrow product category typically varies widely across brands (see Griffith *et al.*, 2010, for a quantitative example of the "butter" category). Recent European applications tackling nutritional health issues include Bonnet and Réquillart (2011, 2013b) and Griffith *et al.* (2010).

Alternatively, food choices and valuation of attributes across highly differentiated goods have been analysed using choice experiments or other experimental methods, with growing popularity over the last ten years. The flexibility of the methods allows for the possibility of studying a large number of factors on the healthiness of food choices, including nutritional labels (Balcombe *et al.*, 2010), size labels (Just and Wansik, 2013), prices (DiSantisa *et al.*, 2014), or even children's pestering factor (Papoutsi *et al.*, 2014). However, there have been concerns over the robustness of the methods with regard to the hypothetical bias that they introduce in the choice problem, which has recently been shown to be significant and difficult to decrease in an Italian context (Moser *et al.*, 2013).

Consumer food choices have occasionally been investigated in the broader context within which they take place, and taking into consideration their long-term effects on health. Here, the household production model (Becker, 1965) offers a rich platform to analyse how all aspects of food consumption (*e.g.* shopping behaviour, food preparation, convenience, form of eating occasion)

are influenced by multiple constraints, including non-monetary ones (*e.g.* time constraint). In spite of its appeal, especially to investigate decisions to consume food away from home (FAFH) and convenience foods blamed for nutritional health problems, this framework has rarely been used in applied food demand analysis (Huffman, 2011), most notably in a European context, possibly due to the detailed data on time use required to apply it. The health capital model of Grossman (1972), which considers that health enters consumer utility function and is influenced by investments in various health inputs (*e.g.* dietary choices), has been more popular to analyse the determinants of diet quality and obesity (Mazzocchi *et al.*, 2014).

On the supply side of the food market, firms' behaviour with regard to the healthiness of the foods that they produce has not been studied extensively in Europe. However, some efforts have recently been made to monitor the nutritional quality of food products distributed by retailers, in particular in France where it is a remit of the observatory of food quality described by Goglia *et al.* (2010), and in the UK where the Food Standard Agency has assessed progress of its initiatives to reduce salt consumption (He *et al.*, 2013). The economic analysis of firms' strategies with respect to the healthiness of their products remains, however, underdeveloped, although Réquillart and Soler (2014) provide an up-to-date review of relevant contributions from the IO literature focusing on firms' taste positioning.

Key drivers of behaviours and effectiveness of public policy to promote healthy eating

Theoretical investigations have identified food markets' plausible failures to justify government intervention to tackle the obesity epidemic and other diet-related health issues (Griffith and O'Connell, 2010). Most importantly, information and cognitive failures may prevent individuals from calculating the full costs and benefits of their food choices, while externalities generated by the additional cost in terms of healthcare and/or productivity loss of nutrition-related diseases may not be fully taken into account by consumers when selecting diets. Lack of rationality attributable to various behavioural biases and self-control problems has also been put forward in support of intervention (Haavio and Kotakorpi, 2011), but Lusk (2014) and others challenge this view for being excessively paternalistic.

At an empirical level, a large number of studies have investigated the price responsiveness of demand for food and its implications for health. The systematic review of Green *et al.* (2013) found over 1,100 estimates of own-price elasticities in Europe and concluded, on the basis of meta-regressions, that food demand responded significantly, negatively and less than proportionally to price increases, although within populations as well as across countries, own-price elasticities tended to decrease (in absolute value) with income. The conclusion that prices of food matter, while unsurprising

to economists, confirms that of an older systematic review by Andreyava *et al.* (2010). However, investigating the nutritional and health effects of exogenous changes requires an understanding of adjustments in the entire diet rather than a narrow group of products (*e.g.* salty snacks), pointing to the potential importance of cross-price effects. These have also been the subject of a recent systematic review (Cornelsen *et al.*, 2014) showing that cross-price effects are often significant but difficult to characterise in general terms, sometimes reinforcing own-price effects but sometimes undermining them. For instance, cross-price effects are, on average, small for oils and fats, implying that price increases reduce energy consumption due to the dominant own-price effect. In contrast, for sweets, half of calories reduced through the own-price effect of a price rise are compensated by increases in consumption of other foods. Altogether, this indicates the necessity of considering substitutions in the entire diet when assessing the behavioural drivers of nutritional health. Studies at a higher level of product disaggregation necessarily ignore cross-category substitutions but have also provided valuable insights. It has been shown repeatedly that substitutability among highly-differentiated products can be very large, with Griffith *et al.* (2010) establishing, for example, that among margarines defined at bar code level, own-price elasticities typically range between two and three in absolute value.

Given that the magnitudes of own-price elasticities depend on food category and the level of product aggregation, that cross-price effects are a priori unknown but difficult to estimate with precision, and that there are multiple ways to design differentiated food taxes to improve health (*e.g.* food-based *versus* nutrient-based taxes; excise *versus ad valorem* taxes), the lack of certainty about the potential effectiveness of such taxes to improve diet quality and health is hardly surprising. Within Europe, the UK has been studied most extensively but simulations have yielded conclusions varying from broad support (Mytton *et al.*, 2007) to clear scepticism (Tiffin and Arnoult, 2011). All in all, the growing consensus considers that tax or subsidy rates need to be sufficiently high (*i.e.* at least 20%) to bring behavioural change (Irz and Niemi, 2011), that fiscal measures should target noncore foods or beverages for which there are close untaxed substitutes (Thow *et al.*, 2014), and that the distributional effects of the policies, both in their health and economic dimensions, should be considered carefully (Härkänen *et al.*, 2014). It is hoped that ex-post evaluations of actual taxes (*e.g.* Jensen and Smed, 2013, for Denmark), as well as trials or realistic experiments, will bring more definite answers regarding the social desirability of differentiated food taxes in the near future.

While prices and their potential modifications through policies have naturally attracted the attention of economists, to date, healthy eating policies in Europe have, for the vast majority, focused on the promotion of consumers' informed choices though the formulation of dietary recommendations, development of nutritional labels, social marketing campaigns and nutritional education (Traill *et al.*, 2012). Analysis of such policies presents a difficulty

for traditional economics because demand functions derived from the rational choice model do not typically include nutritional information or knowledge as arguments. Furthermore, the data requirements for rigorous evaluation are substantial, but a structured review of evidence within the EU has recently been completed (Capacci *et al.*, 2012). For most policy instruments, the evidence of effectiveness in raising dietary quality is suggestive at best. Hence, while information campaigns clearly modify attitudes and intentions towards healthy eating, the effect on actual consumption patterns is more difficult to quantify but probably quite small (Capacci and Mazzocchi, 2011). Similarly, Grunert and Wills (2007) conclude their review of European research on consumer response to nutrition information on food labels as follows: "There is, however, virtually no insight into how labelling information is, or will be, used in a real-world shopping situation, and how it will affect consumers' dietary patterns."

Broader analyses of nutritional health and food consumption, building on the household production model or health production models, have also been used to develop appealing narratives explaining the obesity epidemic (Etilé, 2011). Cutler *et al.* (2003) suggest that increases in calorie consumption could simply result from a decrease in the time cost of food preparation (due to the enhanced convenience offered by processed foods) and the cash cost of food (due to economies of scale in mass production of food and technological change). Meanwhile, the opportunity cost of home cooking has risen with women's greater participation in the labour market as well as the development of leisure activities (*e.g.* home cinemas). Responses to incentives could therefore explain greater energy intakes, the growing popularity of FAFH, or the rise in snacking, which are all correlates of the obesity epidemic. This thesis has subsequently been elaborated (Finkelstein and Zuckerman, 2008; Mazzocchi *et al.*, 2009b) but the underlying evidence seems too often anecdotal (Irz, 2008b), and its validity in a European context remains to be established.

On the supply side, research on firms' behaviour relevant to nutrition and health is scarce but demonstrates nonetheless that it would be unwise to neglect the topic. Bonnet and Réquillart (2013b) find that ignoring firms' strategic pricing decisions leads to an error in estimating the effect of a sugar tax of up to 40%. The conclusion is qualitatively similar to that of Griffith *et al.* (2010) who studied the impact of a tax on saturated fat in the UK. Without going further because of lack of space, we refer the reader to the up-to-date review by Réquillart and Soler (2014) for many other relevant examples.

Altogether, with nutritional health issues now firmly on the policy agenda, economic research on the subject has increased exponentially in the last decade, helping to clarify the rationale for government intervention and draw attention to potential causal factors. However, this review also reveals a lack of certainties regarding the drivers of dietary problems and the effectiveness of measures to address them. Indeed, Smith (2011) points

out that the empirical evidence can either support the view that the obesity epidemic is "the result of multiple, complex and interacting dynamics, which have progressively converged to produce lasting changes in people's lifestyles", as proposed by Sassi (2010, p. 115), or the alternative interpretation that the research community has yet to pinpoint the real causal factor(s). To be fair, disagreements transcend economics and other social sciences, as competing hypotheses of obesity continue to be hotly debated in nutrition science (Taubes, 2013). Nevertheless, reinforcing the link between economics and biology should be treated as a priority in the future in order to increase the relevance and accuracy of research in the field. For instance, Etilé (2011) explains how biomarkers have been used ingenuously as instruments when estimating the human capital cost of obesity, while demand models linked to epidemiological models of diet-related chronic diseases have been devised to quantify the health effects and cost-effectiveness of policies (Härkänen *et al.*, 2014; Irz *et al.*, 2014). Smith (2004b) also provides an example of how an evolutionary perspective of food preferences has major implications for welfare analysis and presents convincing biological arguments as to why food choices are fundamentally different from choices involving other consumables.

Conclusion

In this article, we have identified the main research topics considered by food economists over recent decades and highlighted important developments in the field. Food economists have provided valuable insights about the main determinants and consequences of the tremendous changes that have affected food markets over this period. Key topics relate to retail price formation and value sharing within the food chains, the development of highly-differentiated markets and the effects of public and private interventions aiming to improve the safety and nutritional quality of foods and diets. In each field, new research avenues have been explored thanks to advances in methods and data availability.

One of the most important methodological developments regards the availability and use of scanner data on household purchases, which describes consumer choices in great detail (*i.e.* selection of products down to the brand level; frequency of purchases; choice of retailer; availability of promotions *etc.*). This has opened up new areas of research and already improved our understanding of price formation and chain efficiency as well as some aspects of consumer behaviour, although much remains to be done. For example, scanner data might be used to understand better the heterogeneity of stakeholders' behaviours and strategies between food industries or within a segment of the food industry. There is also room to use these data to analyse how value is shared within the chain and better characterise the relative bargaining power of the agents in the chain. The evaluation of food policies would also be greatly improved by better taking into account the simultaneity of consumers' and firms' reactions to these policies. At the same

time, the availability of "big data" in food economics creates new challenges, as illustrated by recent findings indicating that the type of data itself has a strong but poorly-understood influence on econometric results (Boonsaeng and Carpio, 2014), and that traditional modelling techniques may fail when considering high frequency data (Ivancic *et al.*, 2011). Reconciling the results achieved with different data sources and establishing the suitability of each type of data for specific purposes is, therefore, clearly required.

Looking at the supply side of food markets, it is becoming evident that firms respond strategically to health, nutritional and environmental issues and that these responses, which are currently poorly understood, mediate the effect of policies – even those targeting consumers. This creates another promising area for future research, but a key challenge here lies with the creation of comprehensive datasets on food product characteristics covering nutritional composition, presence of chemical and microbiological contaminants, ingredients (including origin and mode of production), and even environmental footprints. Furthermore, given the rapidly-evolving nature of modern food supply chains, datasets on food innovations and product introduction/withdrawal would also be very useful to analyse product development strategies and their effects on product variety and prices. All this information is clearly required to analyse firms' responses to public policies linked to safety, health or environmental issues, and therefore to evaluate the welfare impact of these policies.

On the demand side, apart from those related to the use of scanner data, major advances in the analysis of consumer behaviour have been made by using hypothetical methods such as choice experiments, auctions and lab experiments. The development of field experiments has further contributed to increasing the realism of the research findings. Yet, despite all this progress and a large volume of empirical results, our fundamental understanding of consumer behaviour remains limited, with few robust and general conclusions emerging from the available literature. Looking forward, a major challenge in this field lies with the development of an integrated theory of the consumer, taking into accounts insights from neoclassical economics and behavioural economics. It may also be fruitful to recast food consumption within a broader set of household activities, including shopping, food storage, cooking and waste generation, in order to better understand behaviours and their impacts on health and the environment. In addition, there is a crucial need to evaluate public policies aimed at influencing consumers in a far more systematic, independent and rigorous way than is currently done. Only then will we be able to draw firm conclusions regarding the effectiveness and efficiency of alternative policy instruments.

Beyond continuing research in these different domains, food economists will also have to tackle new issues. The concept of "sustainability" put forward in recent reports (Esnouf *et al.*, 2013) refers to high-nutritional value diets, able to induce health benefits in the European context of an ageing population;

whose environmental impacts are minimised, especially those related to climate change; and that are affordable for the whole population, including low-income categories. It highlights the need to consider in an integrated way the various economic, social, health and environmental dimensions of food production and consumption decisions. On the demand side, this means investigating the sustainability of diets by measuring the relationship for real-world consumers between utility, diet cost, health and environmental benefits. By considering different sustainability dimensions simultaneously and characterising potential trade-offs, researchers could identify the major barriers preventing consumers from making sustainable dietary choices (*e.g.* education, motivations, attitudes, values, price, taste, convenience and other food attributes).

On the supply side, the food sector's development has been accompanied by increased consumer demands and public requirements, which have gradually led to the integration of additional functionalities by the food industry: the control of microbiological safety and chemical residues; the control of organoleptic properties and the search for new sensory attributes; the search for nutritional attributes or even health effects. Climate change and foreseeable limitations to the use of non-renewable energy have also introduced new requirements regarding energy efficiency, resource (including water) efficiency, by-product valorisation and waste management. The design (or re-design) of food transformation processes from a sustainable standpoint implies a need to take account of all the constraints and functionalities that are, or will be, imposed. Indeed, change to these processes has been achieved by adding constraints that have gradually reduced margins for manoeuvre, to a point where it appears difficult today to add a further series of *criteria* without reviewing those previously imposed. To some extent, the food sector is now faced with obstacles resulting from a relative exhaustion of gains in productivity and a certain blockage in terms of innovation (Soler *et al.*, 2013).

Is it possible to respond by optimising existing technologies, or will it be necessary to re-design food production processes and the organisation of agri-food sectors more fundamentally? What place is there for process and product innovations to increase the sustainability of the food system when most European consumers are reluctant about new food technologies? To what extent will required changes be voluntarily implemented by the food industry, driven by consumer demand or imposed by public regulation? It is difficult to provide clear answers to these questions at present but they outline new research avenues that food economists will have to address in the coming years.

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