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Full Research Article

Innovation and marketing strategies for PDO products: the case of "Parmigiano Reggiano" as an ingredient

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Abstract. Typical products can contribute to socio-economic development of their place of origin if they are able to take part in the logic of the global market. The aim of this research is to examine one type of innovation, the use of PDO products as ingredients, as a part of a strategy to re-launch PDO products which have a mature market. The evolution of the concept of innovation is discussed; innovation is then considered in relation to product life cycle and information asymmetry. There is then a case study on the use of PDO Parmigiano Reggiano cheese as an ingredient in industrial processing. This case shows that even incremental innovation can have serious effects for the market when it is applied on production phases which lie outside the direct control of the PDO producers. In order to protect the consumer as well as the PDO producer, it would be advisable for new legislation to regulate in more detail innovation involving products bearing origin certificates.

Keywords. Incremental innovation, PDO, information asymmetry, product life cycle, ingredient, mature market, typical products

JEL codes. M31, Q13, O30

1. Introduction

Although the integration of typical production systems in global trade circuits is associated with various risks, such as the commercialisation of tradition (Barthel, 1996; Lindholm, 2008), new power relations in the typical supply chain (Rangnekar, 2004; Dupuis and Goodman, 2005; Arfini *et al*., 2010) and exclusion of poorer farmers from global value chains (Shapiro, 1983; Prost *et al*., 1994; Mancini, 2013), overcoming traditional dichotomies, such as that between typical vs. standardized production systems or local vs. global, is increasingly noted by scholars and is becoming widespread on the market. Murdoch and Miele (1999) and Rastoin and Vissac – Charles (1999) state that the development of typical products goes hand in hand with globalization. In fact, because

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typical products can be strong contenders in national or export markets, they are exposed to the challenges of the global market and their success requires a wide range of strategies, including innovation.

Innovation clearly involves obstacles on both the demand and supply sides, as well as many benefits, particularly when the territorial quality of a product is certified. EU certifications PDO/PGI/TSG[1], for instance, institutionalize three main factors: the specific nature of local resources used in the production process; the history and tradition of production techniques; the collective dimension and the presence of locally shared knowledge (Bérard and Marchenay, 1995; Barjolle *et al.*, 1998; Casabianca *et al.*, 2005; Rocchi and Romano, 2006). These three factors are institutionalized in a code of specifications, approved by EU; so whatever type of innovation is subsequently proposed, formal amendment to the code has to be authorized by the Commission.

In spite of this, however, innovation occurs, especially in sectors where the market for the certified product is saturated and new outlets are required. This study discusses innovation as a strategy for the re-launch of PDO/PGI/TSG[2] products where the market is mature, and focuses on some critical aspects. It focuses on the particular type of innovation which is becoming increasingly common; the use of PDO products as ingredients in industrial processing. The study starts with a literature review on the topic of typical products and innovation (Section 2). This is followed by the definition of a theoretical framework for the discussion of the concept of innovation in relation to typical product life cycles and information asymmetry (Section 3). There is then a case study on the use of PDO Parmigiano Reggiano cheese as an ingredient for industrially processed foods, as a strategy to face the mature market of the PDO product. This is supported by testing of the physical and chemical qualities of industrial products containing processed Parmigiano Reggiano. There is a discussion of possible consequences of such innovation on the market (Section 4) and final remarks are then made (Section 5).

2. Literature review on the relationship between typical products and innovation

For the sake of this research, we define a typical product as "a product which presents unique quality attributes which are the expression of the specific nature of the territorial context in which the production process takes place" (Belletti *et al.*, 2006). A typical product thus derives its unique qualities from being closely linked to a territory physically and anthropically[3].

Because it involves the economic sustainability of production in a significant part of European rural areas, the relationship between typical products and innovation is of

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[1] PDO, Protected Designation of Origin; PGI, Protected Geographical Indication; TSG, Traditional Speciality Guaranteed, Reg. (EC) 1151/2012.

[2] For the sake of simplicity, we use the term PDO below to refer to PDO, PGI and TSG.

[3] In this literature review, contributions both on typical and traditional products were considered. In fact, according to Regulation (EU) N. 1151/2012 of the European Parliament and of the Council of Europe 21 November 2012 on quality schemes for agricultural products and foodstuffs, traditional refers to "the proven usage on the domestic market for a period that allows transmission between generations; this period is to be at least 30 years". The sharing of concepts such as "people", "place" and "time" provide a close link between "traditional" and "typical".

interest to policy makers as well as the academic community. The European Commission encourages these producers to become more competitive through innovation, including modern techniques of production, management, and marketing and promoting nutritional and health aspects of these products (e.g. EC, 2007). But in spite of this, various studies have shown that the relationship between typical products and innovations is complex and often problematic.

In cases where the traditional and territorial nature of products is institutionalized in certifications such as PDO, there are limitations on innovation that can be made. In fact, codified rules on characteristics of production techniques and the product impact on the level of innovation and time required to adopt it in such supply chains (Marty, 1998). For these products, innovation mainly pertains to product innovations, such as packaging innovations and changes in product composition, product size and form or new ways of using the product. Process innovations are less common, given their impact on the authentic identity of the product and its production process (Kühne and Gellynck, 2009). Nevertheless, according to Kühne *et al.* (2010), feasible applications may also relate to improving the production process in order to assure quality and traceability. Moreover, although innovations, in particular organizational ones, can be valuable for typical products, they can meet with resistance on the part of different actors in the supply chain (Kühne and Gellynck, 2009) where small and medium enterprises are not always receptive to changes.

Consumer perception is also a key issue. A good understanding of consumer perceptions, expectations and attitudes towards innovations in traditional food products is crucial for the successful introduction of innovations (Linnemann *et al.*, 2006). According to Guerrero *et al.* (2009), the degree of acceptance of innovations applied to traditional products is closely dependent on type of innovation. Consumers are particularly positive towards packaging innovations because they do not modify the core characteristics of the traditional food product and provide sought-after benefits, e.g. longer shelf life. Innovations meet consumer approval when they increase safety levels or are associated with clear tangible benefits (Bruhn *et al.*, 1992; Caporale and Monteleone, 2004; Cayot, 2007; Guerrero *et al.*, 2009) which enhance nutritional value or improve the nutrient profile of products, e.g. reducing salt, saturated fat or sugar content (Guerrero *et al.*, 2012). But product innovations with implications for the sensory properties are rejected (Cayot, 2007; Kühne *et al.*, 2010) and compromises on taste for health are not welcomed by consumers (Verbeke, 2006). Khune *et al.* (2010) argue that consumer attitudes towards innovation in traditional products are segmented and vary between countries and within countries. Nowadays, the complex relationship between typical products and innovation, on both supply and demand side, is accompanied by the challenges of mature markets where re-launch strategies are required. In recent years, on mature PDO product markets, it has become increasingly frequent to use PDO products as an ingredient of industrially processed foods. But although there is a large amount of literature on the relationship between local production systems and mass-produced industrial systems, the function of innovation, and particularly the use of PDO products as an ingredient, has been very little studied, and little is known about threats to the commercial success of this strategy. This raises new research questions on the potential paths to overcoming the dichotomy between the two production systems, and raises the need for policy discussion on

processing of PDO products outside the certified production system. This paper aims to examine this field and form a starting point for such a debate.

3. Aim and theoretical framework

As stated above, the aim of this research is to examine one type of innovation, the use of PDO products as ingredients of industrially processed food as a strategy to re-launch PDO products which have a mature market. It aims to focus on possible consequences on the market and identify medium - long term critical aspects. The concept of innovation is considered in its evolution and therefore discussed according to product life cycle with particular reference to typical agri-food products. The relationship between innovation and information asymmetry is then discussed.

3.1 Innovation and product life cycle

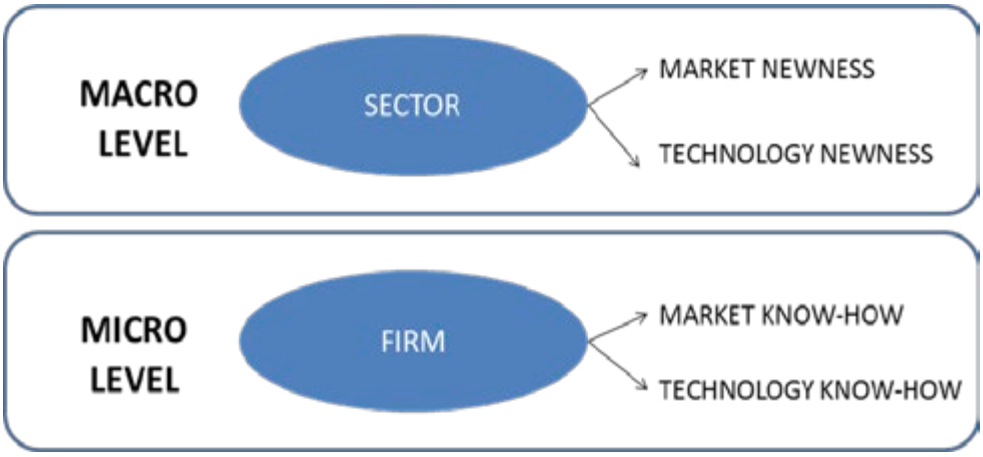
According to the OECD Oslo Manual (2005): "Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations". This definition takes into account progress in understanding the innovation process and its economic impact, as well as the field of non-technological innovation and the linkages between different innovation types. The definition is the outcome of a great deal of literature that has been studying the meaning of innovation, as well as comprehensive classification, for decades. In fact, elsewhere, it is widely agreed that innovation follows invention, where invention is the discovery of something new (Myers and Marquis, 1969; Trott, 2012). As "innovation is not a single action but a total process of interrelated sub-processes" (Myers and Marquis, 1969), it is not only about physical change but can involve the introduction of a new good, a new method of production, the opening of a new market, the conquest of a new source of supply of raw materials, the introduction of a new organization (Schumpeter, 1934) and/or new management tools or services (Trott, 2012). Innovations vary in the degree of newness to an adopting unit, and this variation is captured by the notion of radicalness (Dewar and Dutton, 1986). Incremental innovation introduces relatively minor changes to the existing product, exploits the potential of the established design, and often reinforces the dominance of established firms (Nelson and Winter, 1982; Ettlie *et al.*, 1984; Dewar and Dutton, 1986; Tushman and Anderson, 1986). Radical innovation, on the other hand, is based on a different set of engineering and scientific principles and often opens up whole new markets and potential applications (Dess and Beard, 1984; Ettlie *et al.*, 1984; Dewar and Dutton, 1986). Radical innovation often creates great difficulties for established firms (Cooper and Schendel, 1976; Rothwell, 1986; Tushman and Anderson, 1986) and can be the basis for the successful entry of new firms or even the redefinition of an industry. The distinction between the two types of innovation is not however one of hard and fast categories. Instead, there is a continuum of innovations that range from radical to incremental (Hage, 1980). Although radical and incremental pertain to distinctions along a theoretical continuum of the level of new knowledge embedded in an innovation, the middle values of this continuum are difficult to interpret. A helpful

contribution comes from Garcia and Calantone (2002), who on the basis of existing literature identify a third category of innovation between radical and incremental; "really new". The classification is made according to two pairs of factors: macro/micro perspective and marketing/technological discontinuity. The macro-perspective aims at measuring how the characteristics of the innovation are new to the world, the market or the industry, while micro-perspective is identified when innovativeness of the product is related to the firm (or the customer). The second pair of factors – marketing and technological discontinuity – depends on the forces from which discontinuities may originate (Figure 1). "Product innovation may require new marketplaces to evolve and/or new marketing skills for the firm. Similarly, product innovation may require a paradigm shift in the state of science embedded in a product, new R&D resources and/or a new production process for a firm. Some products, of course, may require discontinuities in both marketplace and technological factors." (Garcia and Calantone, 2002; p.119).

So, radical innovations have discontinuities along both macro/micro and levels as well as marketing/technology sublevels. Really new innovations have discontinuities along a single level, macromarketing or macrotechnology, but not both, and on one dimension of the sublevel macromarketing or macrotechnology. Incremental innovations have discontinuities only along the micro level.

The potential of innovation varies according to the product and the phase of the product life cycle. Product life cycle (PLC) theory identifies a set of common stages in the commercial life of products, shown as a curve divided into four phases: introduction, growth, maturity and decline (see among others Buzzel, 1966; Polli and Cook, 1969; Kotler and Scott, 1998). Each stage has a duration and curve depending on different factors (Cox 1967; Rink and Swan 1979) which have different influence in the different phases (Day, 1981). Literature has also shown that many products have a life cycle that differs from the standard one (Cox, 1967; Swann and Rink, 1982). These include agri-food prod-

Figure 1. Product innovativeness.

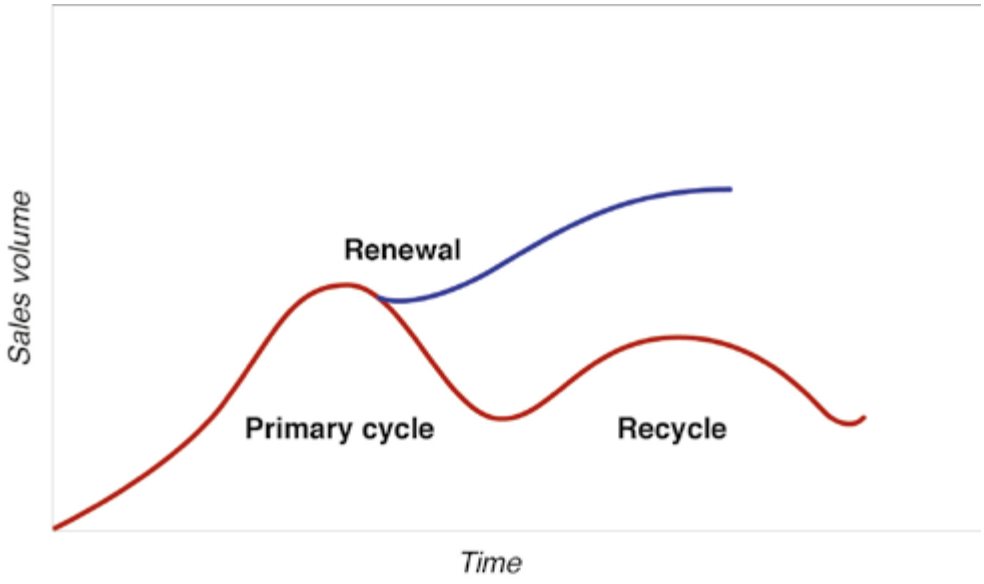


Source: Authors' elaboration on Garcia and Calantone (2002).

ucts, which show a primary cycle and a second cycle. The first corresponds to the usual PLC, while the second cycle is shorter and less intense (Kotler and Scott, 1998). In other words, the fourth decline stage does not end the product life cycle but leads into a re-cycle, by means of extrinsic changes of the product, without there being any modifications in intrinsic attributes of quality, nutrition or taste and smell (Pilati, 2004). For typical products, the PLC is also much longer than the few years normal for other products, and it is thus likely that consumption models will alter during the cycle. The renewal stage which takes place when the market of the product is in advanced maturity and about to decline is different for typical products (Figure 2).

Although there is a great deal of literature on innovation, Minarelli *et al.* (2015) found that there are few studies addressing innovation in the food sector. Their analysis of the food sector suggests that a determinant of innovation is collaboration, in particular when small- and medium-enterprises (SMEs) collaborate with universities and other similar stakeholders[4]. They argue that "further studies should seek to better understand innovation-related interactions where innovation types prioritised by firms can also change in relation to either different stages of a firm's life cycle or the product life cycle in food companies" (p.50). This study aims at reducing this gap by focusing on an innovation aimed at relaunching a mature PDO product which may undergo unexpected changes when adopted by actors external to the PDO system.

Figure 2. Life cycle of an agri-food product.



Source: Kotler and Scott (1998).

[4] The impact of geographical proximity between food producers and universities or public research laboratories is analysed by Maietta (2015).

3.2 Innovation and information asymmetry

The use of a PDO product as an ingredient of an industrially processed food is an interesting strategy not only for PDO producers but also for manufacturers of the food, given that this is enriched by the PDO product and its reputation.

It allows both types of producer to increase frequency of use by customers and/or to find new market outlets, thus halting or reversing falling price trends. The strategy can be particularly effective where the ingredient and the final product are quality brands from differing market segments. The benefits of such innovation may however be subject to limitations due to the information asymmetry of the agri-food market.

Information asymmetry exists on a market where not all agents have the necessary information available to make an optimum allocation of resources (Akerlof, 1970; Klein and Leffler, 1981, Shapiro, 1983, Stiglitz 1987). Because consumers are not able to verify credence attributes, the intangible quality attributes of a product, agri-food markets are particular affected by highly asymmetric levels of information between producers and consumers on the quality of products (Anania and Nisticò, 2004). Search attributes of a product can be identified before purchase and experience attributes during consumption, but credence attributes cannot be verified even after consumption (Darby and Karni, 1973). In recent years, consumers have increasingly started to search for products combining recognizable material characteristics with an intangible content meeting ethical, cultural and health consciousness needs. However, although it is important for the consumer to know as much as possible about intangible attributes it is not necessarily in the producer's interests to supply full and precise information (Boccaletti and Moro, 1993). Information asymmetry thus encourages moral hazard for producers, who may place on the market products of lower quality than what is claimed, while the consumer accepts a different level of risk from what is claimed. In the long term, however, consumers will meet information from sources other than producers, such as consumer associations, magazines and journals etc., and become aware of the moral hazard. Adverse selection will occur, in that consumers realize they have been misled and stop buying high quality products. In the long term, this will lead to a decrease in the number of products offered for sale and a loss of collective well-being (Grazia *et al.*, 2008).

There is thus a pressing need for institutions and private actors to provide information in order to prevent this loss of social well-being (Shapiro, 1983). Intervention is required to ensure that markets are transparent, by way of measures such as the introduction of quality standards, regulations on labelling and advertising, recognition and registration of brands, supervisory authorities, production guidelines etc.

For PDO products, the Italian law in 2004 laid down that the use of a PDO as an ingredient is subject to authorization of the product Consortium. Law D.L. 297/2004 states "that the reference to a protected name in the labeling, presentation and advertising of products made, processed or transformed, is not punishable when authorized by the Consortium for the Protection of the protected name…"[5]. More recently, Regulation EU 1151/2012 of the European Parliament and European Council

[5] In the absence of a recognized Protection Consortium, authorization may come from the Ministry of Agriculture, Food and Forestry.

on the regimes of quality of agricultural products and food extends protection to PDO/PGI products used as ingredients, banning the evocation, misuse and imitation of the name in the list of ingredients of processed products where the product is not present (Art. 13).

4. A case study from the dairy sector: PDO Parmigiano Reggiano cheese

4.1 The Parmigiano Reggiano supply chain

Parmigiano Reggiano is one of the most representative PDO products of the long-standing Italian gastronomic tradition. Its history dates back to the thirteenth century when Benedictine monks began producing it in Emilia. In the late eighteenth century, cheese dairies were introduced, making it possible for small producers to process milk into Parmigiano Reggiano cheese (De Roest and Menghi, 2000). In the twentieth century there was strong growth thanks to the foundation of the *Consorzio del Formaggio Parmigiano Reggiano* (CFPR) in 1934, whose mission has always been to protect the typical nature of the product, the designation and the brand.

In 2013, Parmigiano-Reggiano PDO production stood at 1.12 billion euro (1.97 billion euro consumer turnover). The cheese was made in 340 dairies covering 3,100 farms. It absorbed about 15% of national milk output and employed 20 thousand people, rising to 50 thousand along the whole supply chain[6]. The actors of this supply chain are milk producers, dairy owners, wholesalers-agers and traders; all members of CFPR. For many years, the supply chain was able to ensure adequate income for mountain farms, where sale of milk to cooperative dairies was the only source of income, as well as for hill and flatland farms. But since the 1980s, global competition has severely damaged mountain farming and many farms have been forced to close (Arfini and Mancini, 2013). Today, the Parmigiano-Reggiano supply chain is no longer able to provide the same level of economic and social support to disadvantaged rural areas as in the past.

4.2 The Parmigiano Reggiano market

Parmigiano Reggiano is traditionally and most frequently used to add flavor to food. As a hard cheese, it is mainly grated and used with pasta, the first course in an Italian meal. Parmigiano Reggiano and Grana Padano represent a specific market segment within the overall cheese market because of the way they are used (De Roest and Menghi, 2000). But in the last few years, sales on the Italian market have fallen. An increase in stocks on the supply side has led to a fall in market price. Time analyses of the trend of prices on the wholesale market of 12 month matured Parmigiano Reggiano cheese show that prices are sensitive to output quantity, which is typical of a commodities' market, even though this PDO cheese should behave like a niche product, with a degree of price stability (Arfini and Mancini, 2013). The problem is also due to the policy of large retailers which currently sell about 70% of Parmigiano Reggiano at promotional prices (Pugliese, 2010; Giacomini, 2010).

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[6] Agricoltura (2014), La filiera del Parmigiano Reggiano. Supplemento 56.

On the demand side, consumption of Parmigiano Reggiano on the Italian market is today in a context of economic crisis[7] which has decreased purchasing power of Italian households and has led to a decrease in food consumption in real terms. A key factor in domestic demand for Parmigiano Reggiano in the current period is the price difference with its main competitor, Grana Padano. This is a similar cheese with a long ripening period, but it is produced using more industrial techniques. If the retail price difference between these two cheeses rises, then some consumers – particularly those living outside the Parmigiano Reggiano production area – will switch over to Grana Padano. In other words, demand varies according to the absolute price level of Parmigiano Reggiano cheese and to the price difference between it and Grana Padano cheese (De Roest and Menghi, 2000; Giacomini, 2010; Cersosimo, 2011). Stagnation in consumption is also a result of changes in diet in Italy, as hard 'grana' cheese is being replaced by lower calorie fresh cheeses[8]. Finally, the degree of penetration of Parmigiano Reggiano in the domestic market is very high. Data show that around 60% of Italian households consume Parmigiano-Reggiano (Arfini *et al*., 2006) and nearly 100% consume Parmigiano Reggiano and/or Grana Padano (Rama, 2010). The frequency of consumption is also high, mainly due to the type of consumption: on average, among customary consumers, Parmigiano Reggiano is consumed 5 times per week; 60% of these consumers use Parmigiano Reggiano daily.

The Parmigiano Reggiano Consortium and producers have responded to these problems by rationalizing supply in a supply regulation plan approved by the Ministry for Agriculture. The plan was based on the EU Regulation 261/2012 as regards contractual relations in the milk and milk products sector, and its key element was the continuation of "Parmigiano Reggiano milk quotas" given to farmers. The aim was to regulate supply and re-balance the relationships of strength between farmers and dairies in the supply chain (Giacomini and Manfredi, 2013). Another measure adopted by the CFPR to rationalize supply on the domestic market is promotion of exports, for which it has renewed financial support. In 2014, a total of €4 million was spent[9]. Finally, CFPR has been promoting technical and marketing innovation for years. The Parmigiano Reggiano supply chain now collaborates with external actors, such as food manufacturers, working towards new packing and consumption models. Vacuum packing of pieces of cheese for longer periods of storage, and individually packaged portions for snacking, were introduced as far back as the 1980s. In the 1990s grated cheese was launched in response to requirements for time saving; more recently, the strategy of co-branding is meeting new types of demand.

4.2.1 Parmigiano Reggiano PDO as an ingredient

An increasingly successful type of innovation of PDO products, including Parmigiano Reggiano, is the use of the product as an ingredient in industrially processed food. An example is the co-branding scheme of 2007 between the CFPR and McDonalds for a

[7] In 2014, final demand for Parmigiano Reggiano fell by 3% compared to 2013, and in 2013 it had fallen by 1% compared to 2012 (Sole24Ore, 2014).
[8] Mark up (2008), "Mercati. I formaggi 2008", ottobre; Mark up (2013), "Il formaggio fresco resiste alla crisi", luglio; Agricoltura (2014), La filiera del Parmigiano Reggiano. Supplemento 56.
[9] www.parmigianoreggiano.it

Parmigiano-Reggiano burger. This successfully combined McDonalds, an emblem of the global market, with the consolidated reputation of Parmigiano Reggiano, a product representing the gastronomic culture of a place[10]. The co-branding of this innovative product brought added value deriving from the synergy between the reputation of the two brands and the taste preferences of two types of consumer. Other products using Parmigiano Reggiano as an ingredient include filled pasta containing the cheese, and crisps flavoured with Parmigiano Reggiano and black pepper[11].

The spread of such products suggests that consumers are appreciating the guarantee of the typical nature of the PDO ingredient associated with new uses. Earle (1997) and Martinez and Briz (2000) classify this as an incremental innovation.

PDO Parmigiano Reggiano is also being used as an ingredient in processed dairy products made by melting cheeses. These are processed cheese slices or wedges[12], used in cooking, traditionally perceived by the consumer as made from reject pieces of various cheeses, and thus as low value added products. In fact, processed cheeses have an average price 30% lower than the average cheese price. In 2013, processed cheeses accounted for 7% volume of the Italian cheese market, or about 530 million euro, and their penetration was 85% for cheese slices and about 50% for wedges[13]. The use of a PDO product as an ingredient gave Parmigiano Reggiano producers entry to a new market segment and, at the same time, the opportunity to update consumer experience of processed dairy products. Today on the Italian market there are Italian and overseas brands of processed cheese products which feature PDO Parmigiano Reggiano as an ingredient[14], and their advertising often cites benefits of enrichment with the nutritional characteristics of PDO Parmigiano Reggiano.

4.3 Product characteristics and production techniques

The product specification code defines Parmigiano Reggiano as: "a hard cheese, slowly matured, produced with cow's milk, raw, partially skimmed in a natural process" and states that: "The milk… must come from cows whose diet is based on the use of fodder obtained in the area of origin."

Parmigiano Reggiano is produced exclusively in the area defined by the code of specifications[15] where the cows' diet is fodder produced in the area. Silage and fermented foods are not permitted. Strict feeding regulations are the main reason for lower milk

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[10] The burger was sold at a higher price than others and was on sale for a limited period of time (13 months) (Reitano and Pantano 2009). The characteristic of scarcity influenced the consumer to consider this product rare (Walchli, 2007; Geylani *et al.* 2008).

[11] The main brands of pasta using co-branding with Parmigiano Reggiano are Barilla and Fini, and the crisps are produced by Kettle.

[12] Processed cheese products enriched with Parmigiano Reggiano PDO include various brands of cheese spread (Parmareggio, Boni, Margi, etc.); their market value however is residual.

[13] Assolatte, (2014) *Relazione annuale settore lattiero caseario anno 2013*. Editoriale il Mondo del latte, Milano.

[14] The same type of innovation involves the PDO Grana Padano production system. Grana Padano is used as an ingredient for the production of stuffed pasta and processed cheeses. Therefore, Parmigiano Reggiano and Grana Padano are competitors in this segment too.

[15] The provinces of Parma, Reggio Emilia, Modena and part of the provinces of Mantova and Bologna, plains, hills and mountains between the Po and the River Reno.

yield per cow, and higher production costs than for industrial milk, and competitor cheeses such as Grana Padano.

Production standards define the method of processing milk into cheese as well as the area of production. These methods are the core of the scheme because they ensure that traditional methods are followed. One of the main provisions, for example, is that no preservative except salt can be used in the processing phase.

During the long phase of ripening, which has to be at least 12 months, the main constituents of the cheese are transformed; particularly important nutritionally are the protein transformations. The milk protein is 'digested', or decomposed into smaller components right down to amino-acids. This gives Parmigiano Reggiano its distinctive taste and makes it more digestible.

4.4 The survey

In the industrial production of processed cheese, cheeses are added to other ingredients, including water and emulsifiers[16], then heated and mixed to a stable homogenous emulsion. In traditional processes, the mixture was heated to between 75 and 100°C, but with modern technology the sterilization temperature (121°C) can be reached by way of steam injection heat exchangers.

Given that the advertising of slices and wedges highlights the characteristics of PDO ingredient products and aims to differentiate them from competitor products which do not contain PDO ingredients, this study aimed to establish whether the industrial process, particularly the heating process, impacts on the quantity and/or quality of the characteristics of the PDO ingredient.

We examined nine processed cheese products (wedges) on the end market, of which three contain PDO Parmigiano Reggiano as an ingredient. The three products containing Parmigiano Reggiano represent the universe of such products on the Italian market[17]. For these three, we examined consumer advertising for explicit claims of a direct link between product characteristics and PDO ingredient characteristics. The claims were in fact found: the advertising cited particularly "naturalness", "genuineness", "goodness" and "nutritional quality" of Parmigiano Reggiano[18], and implied that these qualities were transferred from the PDO ingredient to the processed cheese. For the aims of the research, these descriptions were codified into observable product characteristics.

The terms "natural" and "genuine" are applied to unadulterated products which retain the characteristics of their natural factors. These characteristics can be observed in Parmigiano Reggiano cheese, as it is the outcome of a strictly artisan process but it is

[16] Emulsifying agents (citrates and/or sodium polyphosphates) are essential, as without them, the mixture loses water through evaporation and the fat separates, leaving a rubbery mass of lumps.

[17] The other six products (not containing Parmigiano Reggiano) are those brands available on the shelves of Coop, Conad and Esselunga. Market share of these three retailers is nearly 40% of the total market.

[18] Company wesbites contain the following statements about wedges enriched with PDO Parmigiano Reggiano: "[they] are a completely new type of processed cheese, enabled by the outstanding natural and genuine qualities of Parmigiano Reggiano"; "…Parmigiano Reggiano, with its special nutritional qualities, is the only cheese ingredient; "All the authentic goodness of our Parmigiano Reggiano, the only cheese ingredient, can be found in our soft slices; they are delicately flavoured and perfect for adding flavor to dishes every day as well as for making toasted cheese sandwiches.

more difficult to define and observe such characteristics in industrially made products such as processed cheeses, where the production process necessarily affects the natural and genuine qualities of the ingredient. An analysis of consumer perception of these qualities and their relationship to industrial processing would be necessary, but lies beyond the scope of this research.

"Goodness", on the other hand, is the presence of characteristics which meet consumer taste. The product specification for Parmigiano Reggiano says the cheese is "fragrant, delicate, full flavour but not peppery", but here again, the verification of whether the characteristics are retained in the processed cheese would require consumer perception evaluation and analysis techniques. These too lie outside the scope of this research.

This research was however able to focus on "nutritional quality". The next section looks at the combination of nutritional elements.

4.4.1 Data analysis

Table 1 reports the ingredients shown on the label for each of the nine products examined[19]. It shows that three products contain PDO Parmigiano Reggiano in a percentage between 19.6 and 30%. All products of course contain the essential raw ingredients: milk, water, milk proteins, whey or rennet, and in some cases, butter and cream.

Emulsifiers are the traditional phosphates (E452 – E339) and citric acid (E330 – E331). Currently, the amount of polyphosphates used in industrial food process-

Table 1. Ingredients shown on the labels of the processed cheese wedges.

Brand	Ingredients
1	Parmigiano Reggiano PDO 25%, water, whey, milk protein, emulsifier: sodium citrate, acidity regulator: citric acid, thickening agent: carrageenan.
2	Parmigiano Reggiano PDO 19,6% (milk, salt, rennet), pasteurized fresh whole milk, water, whey concentrate, cream, butter, milk protein, emulsifiers sodium citrate and potassium citrate, acidity regulator: citric acid.
3	Milk, Parmigiano Reggiano PDO 30% (milk, salt, rennet) cream, milk protein, emulsifier E331, acidity regulator E330.
4	Cheese, water, whey powder, butter, milk protein, emulsifier: sodium citrate; acidity regulator: citric acid; stabilizing agent: carrageenan.
5	Cheeses (milk, salt, rennet), water, whey concentrate and / or powder, butter (cream and / or whey), milk protein, emulsifiers: sodium polyphosphates, sodium citrate.
6	Milk (40%), cheese, cream, milk protein, emulsifiers (E331), acidity regulator: citric acid.
7	Leerdammer cheese 100%, water, cream, emulsifiers E452, E339.
8	Cheeses, water, whey concentrate and / or powder, butter, milk protein di latte, emulsifiers: sodium polyphosphates, sodium citrate.
9	Cheese (milk, milk enzymes, salt, rennet) 43%, water, butter, whey powder, emulsifier: sodium citrate, acidity regulator: citric acid.

Source: Product labelling.

[19] The products have been conventionally called 1,2,3,4,5,6,7,8,9.

Table 2. Percentage composition of protein, carbohydrates and fats of the processed cheese wedges

	Protein %	Carbohydrates %	Fats %
1	14	5	15
2	11.4	5.5	13.1
3	14.0	4.3	16.0
4	11.5	6.5	18.5
5	12	4	17
6	14.7	4.4	18
7	12	3	17
8	14	4.6	16.5
9	10	4	21
Average	12.6	4.6	16.9
dv_std	1.60	1.00	2.23

Source: Product labelling.

ing is undergoing drastic reduction because it is now known that excessive ingestion of phosphorous harms human health by eliminating calcium from the body and weakening muscles and bones (Travia, 1979; Messa, 2008; Cozzolino *et al.*, 2009; Cupisti and D'Alessandro, 2011). Only two of the sample products use polyphosphates, but they are not products using the PDO ingredient.

As noted above, we examined the combination of nutritional elements; it was evaluated and compared by measuring the protein, carbohydrate and fat contents. Proteins vary between a minimum of 10% and a maximum of 14.7%; carbohydrates between 3% and 6.5% and fats between 13.1% and 21% (Table 2).

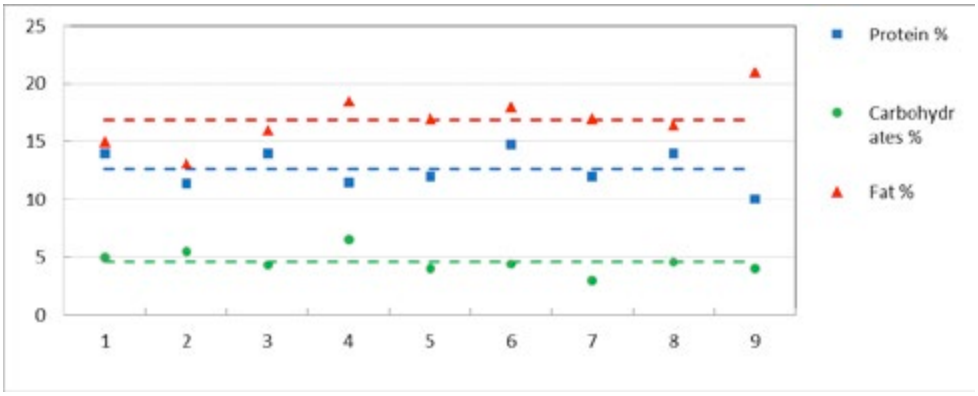
4.4.2 Results

The research question for this test is: "Does the presence of the PDO Parmigiano-Reggiano ingredient enrich the "nutritional elements" of the end product enough to justify consumer advertising claims?"

The three main constituents (protein, carbohydrates and fats) are found to be distributed evenly around the average values with relatively low levels of standard deviation, regardless of the presence or absence of the PDO ingredient. In other words, the three variables are distributed around the average values with no appreciable differences (Figure 3).

In order to verify possible nutritional differences between processed cheeses containing PDO and other 'standard' products, a t-test of hypothesis for the difference between the two group means was run, and results are shown in Table 3. The t-test verifies whether the mean values of the three main constituents are equal across the PDO-enriched (Group A) and traditional (Group B) processed cheeses. The calculated values of the t-test statistics are compared with the tabulated critical values of the Student *t* distribution at 95% confidence level, with 7 degrees of freedom. Because the t-test is known to be sensitive to the number of observations, which in this application is rather limited, the parametric testing is complemented with a non-parametric analysis – less demanding on the data

Figure 3. Distribution around average value of variables (protein, carbohydrates, fats).



Source: Authors' elaboration.

– carried out employing the Mann-Whitney (1947) *U* statistic (Table 3). Both the parametric t-test and the non-parametric Mann-Whitney (1947) *U* statistic provide the same result with respect to the level of statistical significance of the difference between the two sample means for every constituent.

Therefore, the statistical analyses undertaken here suggests that there are no statistically significant differences between the two group means for proteins and carbohydrates, while the mean for fats is statistically significant at the 5% level. But although this is statistically significant, it isn't particularly relevant in nutritional terms. In fact, the legal classification of cheeses on the basis of fat content of dry matter (Art. 53 Law No. 142 of 1992) specifies three categories: full fat cheese containing > 35% fat; light or semi-fat cheeses with fat content between 20% and 35% and low-fat cheeses with <20% fat content. These classifications are broad, in that fat content of light or semi-fat cheeses can vary between 20 and 35%.

Table 4 shows that all samples fall into the 'full-fat' category, so internal variations have little nutritional relevance. Note also that the percentages shown in Table 4 are calculated for about 250 gr., which is an extremely large portion of processed cheese.

More detailed observations can be made on the 'functional' components of the PDO ingredient. The proteins contained in high quantities (33%) in Parmigiano Reggiano are known to be of excellent biological quality. This is thanks to the amino-acid composition which includes essential amino-acids, and because they are easily digestible thanks to the proteolytic enzymes from the milk and the milk bacteria.

The average content of free amino-acids is in fact 23.2% of proteins with a minimum of approximately 19% and a maximum of over 27%. The content of free amino-acids is directly proportional to the length of the ripening period up to 15 months, after which it stabilizes. With continued ripening, the amino-acids increasingly metabolize and are eventually freed.

The second aspect, the digestible nature, is given by the long ripening period when the main constituents are transformed. The transformation of proteins is the most inter-

Table 3. Statistical analyses of group means.

	Protein %	Carbohydrates %	Fats%
Groups A and B (n=9)			
Average	12.6	4.6	16.90
Standard deviation	1.60	1.00	2.23
Group A (n=3)			
Average	13.1	4.9	14.70
Standard deviation	1.5	0.6	1.50
Group B (n=6)			
Average	12.4	4.4	18.00
Standard deviation	1.7	1.2	1.60
t-test for $\begin{cases} H_0 : \mu_A - \mu_B = 0 \\ H_1 : \mu_A - \mu_B \neq 0 \end{cases} t(7)$	0.654	0.708	-2.923**
Student t critical value at 95% confidence		2.37	
Mann-Whitney U test for $\begin{cases} H_0 : \mu_A = \mu_B \\ H_1 : \mu_A \neq \mu_B \end{cases}$	-0.264	-1.037	2.334**

Source: Authors' elaboration using STATA 12.
Notes to Table 3: Group A with PDO; Group B without PDO; ** significant at the 5% level.

Table 4. Fat content as a percentage of dry matter.

	fat %
1	44.1
2	46.6
3	43.7
4	50.7
5	51.5
6	48.5
7	53.1
8	47.0
9	60.0

Source**:** Authors' elaboration. These percentages are calculated proportionally using the formula $H_2O\%$ = 100 - (proteins + carbohydrates + fats) for each sample.

esting from the nutritional point of view, because the action of the proteolytic enzymes breaks the long casein chains up into peptides. The casein is thus much more easily digestible. A growing number of researchers (Gobetti *et al.*, 2002; FitzGerald and Maisel, 2003; Phelan *et al.*, 2009) are focussing on the nutritional content of peptides in dairy products. Certain peptides have been found to have important functional qualities, such as positive anti-oxidant effects and antithrombotic effects on the cardiovascular system, effects on the immune, gastrointestinal, and nervous systems as well as possible anti-tumor effects. These are termed bio-active peptides. But naturally, given that they comprise short sequences of amino-acids, peptides are sensitive to anything that alters protein structure, including heat, acidity and enzyme reactions.

So it is clear that using cheeses ripened over a long period and thus rich in bio-active peptides in heat-treated end products may compromise or 'flatten' the

functional properties of the PDO ingredient (Lund, 2003). In fact, it has been noted that industrial processing affects negatively a series of micro-constituents and/or functional substances and makes their presence less significant (Korhonen *et al.*, 1998)[20].

We therefore find that the nutritional properties of the PDO ingredient are compromised by the melting process and it is not true, as is sometimes claimed, that they are completely transferred to the end product.

5. Discussion

From the point of view of both Parmigiano Reggiano producers and the food industry, this type of innovation can be classified as incremental (Figure 1).

For the actors in the Parmigiano Reggiano supply chain, the use of the product as an ingredient changes nothing at macro level; there is no use of alternative technology and the structure of the sector is unaltered. Only at micro-level producers are given the opportunity to increase sales to the food industry.

The use of the product as an ingredient does not alter the macro level for the food industry either. Technologically and commercially, no innovation is taking place in the sector. It is a micro-innovation at the level of the individual company, in that using the PDO widens the range of products it can offer on the market.

What is unusual in this case is that there is an indirect impact on the Parmigiano Reggiano production system and reputation of the typical product which is caused by an innovation adopted by the food industry, external to the Parmigiano Reggiano production system. It has been shown that as the PDO product can be heavily processed, some of its characteristics may not survive in the end product. These are credence attributes which cannot be perceived by the consumer, and if consumer advertising uses the reputation of such characteristics which have in fact been modified by processing, there is a discrepancy between communication and physical features of the product.

The theory of information asymmetry holds that consumers in the future will have access to alternative sources of information, which will help them to find about credence attributes and become newly aware of certain facts. There will then be adverse selection whereby consumers will stop buying the product. This could negatively affect various different actors. In the first place, the food industry could lose market share, and there could be negative effects on brand reputation. Secondly, PDO producers could also lose market share and see their reputation harmed. Thirdly, CFPR, which encourages and permits the strategy, could suffer. Like many typical product consortia (Mancini, 2012), CFPR has played a key role in protecting and developing Parmigiano Reggiano, but if it loses consumer trust, decades of activity in promoting it could be undone. Finally, there will be debate on PDO legislation which permits PDO products to be used as ingredients without effectively protecting the consumer from information asymmetry.

This case shows that even incremental innovation can have serious effects when it is applied on production phases which lie outside the direct control of the PDO producers. The

[20] Note, however, that this research covers only one of the quality aspects advertised for Parmigiano Reggiano as an ingredient and it would be useful to examine the other important characteristics, the 'authentic', genuine', 'natural' and 'good' qualities, and their effect on the end product.

presence of food manufacturers impinging on the traditional relationship between the Consortium (Parmigiano Reggiano producers) and consumers is causing the Consortium to lose control of the supply of information, and this could have negative effects on the entire PDO production system. Asymmetry of information could compromise the success of the relaunch of mature PDO products, and in general hinder collaboration between typical product systems and industrial systems which is, at present, a promising avenue for the economic development of many rural areas. But as reputation is a necessary condition for food companies to continue using typical products and exploit their name to enhance their own products, collaboration between these two systems depends on the typical product maintaining a strong reputation for excellence. In today's market, where the integration of local and global characteristics is finding increasingly favourable response from consumers, it is therefore in the interests of both production systems to work for the break-down of the dichotomy.

6. Final remarks

Typical products will be competitive and will also contribute to socio-economic development of their place of origin if they are able to take part in the logic of the global market. This study focused on innovation, a competitive strategy, with regard to PDO products which have a mature market. It examined the case of Parmigiano Reggiano PDO cheese used as an ingredient to enrich industrially processed cheese, and found that where innovation is carried out by actors external to a PDO system, it can lead to a loss of control over consumer information by PDO producers, which has potential negative repercussions on PDO product reputation. In order to prevent this, there needs to be effective collaboration between holders of the intellectual property of the designation and those who use its reputation. To date, Italian legislation fails to ensure that consumers are correctly informed, even though it makes compulsory the Consortium to allow the use of the product as an ingredient. European legislation is also lacking, as it does not prevent adverse selection which in the long term can lead to a loss of collective well-being. As Boisvert (2006) says, quality labels, such as PDO, can be used as instruments for policies promoting the preservation of cultural heritage when they are associated with relevant 'smart' rules. It is necessary today for typical production systems to collaborate with the food industry in order to hold their place on global markets. To this end, extensive policy discussion is necessary in order to create legislation to regulate more closely innovation involving products bearing origin certificates, particularly their use as ingredients and, at the same time, preserve their distinctive nature and protect the consumer as well.

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