The interrelationships between the PDO product's specification, its link to the terroir and its technological development

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Abstract

This paper is based on an European study on products with a Protected Denomination of Origin and particularly analyses four cheeses and their supply chain: Parmigiano-Reggiano, the Grana Padano, the Comté and the Cantal. After short theoretical considerations concerning technological development in agriculture, the importance for a PDO product to be very specific in order to differentiate itself from substitutes product is explained. This specificity must have a link with the product terroir. This paper looks then at how the link between a product and its terroir can be defined in the product’s specification (code of practices) and how it can be threatened by technological changes. A supply chain can indeed take advantage of a loose code of practice to reduce its costs production and standardise its production, but such a development not necessarily generates overall benefits for the supply chain. The players’ strategy might however rather tend to reinforce the specific technological trajectory of the product in order to strengthen its specificity. We will finally see how the co-ordination within a supply chain and the actors’ motivation are important to preserve the product uniqueness.

Keywords: PDO cheeses, code of practices, terroir, specificity, technological development, parmesan, cantal, comté, grana padano, Etivaz, gruyère, origin, quality, typicity
INTRODUCTION

Our research was conducted within the framework of the European project "PDO-PGI products: Market, Supply Chain and Institution" (contract FAIR CT 95-306). The project's overall objective was to assess the economic and institutional conditions necessary for the development of Protected Designation of Origin (PDO) and Protected Geographic Indications (PGI) in the European Community (EC) under EU Regulation 2081/92 and in Switzerland. Within this research project, twenty PDO and PGI products have been studied (cheeses, potatoes, fruits, lamb meat, hams and olive oils).

In this paper, the technological development of four cheeses with a PDO has been studied: Cantal, Comté, Grana Padano and Parmigiano-Reggiano. Despite a common regulation, we could see that these PDO and PGI codes of practices do not always give the essentials elements to differentiate the product from substitutes or imitations. Some products are very precisely defined while others are poorly described.

The first paragraph describes the theoretical framework for our considerations. Special emphasis will be put on relevant "pieces" of economic and sociological theory able to understand the technological development of agricultural systems primarily based on local resources. The specificity of a PDO is to have characteristics that are linked to the place where it is produced. We will thus explain the French concepts of terroir and of typicity.

After having understood the importance for a PDO product to keep its link with its terroir, we will focus on the specific technological development in the supply chains of four cheeses. We will try to understand why in some chains actors neglect to preserve the strong specificity of their product (costs reduction strategy), while in others attempts are made to reinforce the PDO specificity (quality strategy). The Cantal and Grana Padano supply chain will be examples of supply chains where the first strategy predominates. The degree of typicity of the product, the sense of belonging of the actors of the chain to the cultural specificity of the production area and the degree of incorporation of the PDO product in global markets are used as key variables to explain their technological development.

1. THEORETICAL ASPECTS OF TECHNOLOGICAL DEVELOPMENT IN LOCAL TERRITORIAL SYSTEMS

Throughout Europe, a very large variety of dairy systems is to be noticed. This variety mainly depends on the type of final product and the climatic and pedological characteristics of the production area. At one extreme, we have the dairy systems using primarily artisanal production techniques where new technologies are either the product of controlled, filtered and adapted innovations generated outside the system or the result of the combined forces of local actors. At the other extreme, we have the global industrial dairy systems where the technological development path is based on the adoption of universally applicable innovations generated by research centres in different parts of the world. The four supply chains analysed in this paper have both artisanal endogenous elements and industrial exogenous elements.

Immediately it has to be stressed that there is no single economic theory able to explain the divergent technological development paths of local territorial systems (Romano, 1995). The standard economic theory does not contain a sufficient explaining power of reality. Too much this theory leaves out of consideration the influence of local factors on the economic behaviour of actors. A principal defect of this theory is its rigidity in treating the social, cultural and historical variables as exogenous and as constraints to the explanation of economic behaviour of actors. There cannot be any economic theory, when important causes of change in the economic system (technology, tastes, demographic conditions) remain outside the analysis (Quadrio Curzio & Scazzieri, 1990, p. 15).

This paper is based on three pieces of theory concerning technological development on local territorial systems:

1. The concept of industrial districts proposed by mainly Italian economists in the eighties.
2. Theories on endogenous development patterns in agriculture as developed by agricultural sociology.
3. The sources of innovations and its relation with regional specific factors.
1.1. The concept of industrial districts

In the eighties, Italian economists rediscovered the concept of Industrial Districts developed by Marshall to explain the survival and the dynamics of technological development of small enterprises, geographically concentrated in the regions of the North-East and Central Italy (Beccattini, 1987). Hundreds of different industrial districts, each specialised in the production of one main product, have been identified (Sforzi, 1987). In these districts, small, extremely flexible and dynamic firms are producing often high quality products for domestic and export markets. A fundamental theoretical explanation of their economic efficiency lies in the presence of economies external to the firm generated within the district, which become internalised in the firm balance alleviating overall firm production costs (iacoponi, 1990). The externalities one can think of are the economies of agglomeration, of technical progress and of innovation. Of high relevance for the origin of a district is the condition that the production process is flexible and with limited scale economies (Saccomandi, 1994, p. 22).

It is important to stress however that the mere geographical concentration of firms in itself is not sufficient to sustain the economic efficiency of the firms of the area. The nature of economic relationships between the firms is decisive for the solidity and competitiveness of the district. Here the concept of the costs of using the market or transaction costs introduced by Coase (1937) and further elaborated by Williamson (1975) becomes crucial. To know whether a district will continue to exist, one has to investigate the causes of why in one district the costs of using the market are lower than in another. When transaction costs within a concentration area of specialised firms are high, one cannot speak of a marshallian industrial district, but only of a specialised production area. Within those areas, small firms have more difficulty to survive, as the external economies, although present, are translated into the firm balance only to a limited extent. The advantages of the geographical concentration in this case become less incisive for the economic efficiency of the firms.

When transaction costs are taken into account the boundary of the firm becomes more fluent. As a consequence, the question of the optimal economic size of the firm, although still relevant, loses importance. To judge the economic viability of the firm one has not only to investigate the internal production costs, but also the costs of the transactions the firm sustains for the delivery of raw materials and services and for the selling of final goods. At this point of the analysis, economic theory is not sufficient anymore, as the relations between firms are strongly influenced by the social context and culture of the economic actors. Without a complete understanding of the social behaviour of the economic actors, no progress can be made in the analysis of the nature of their mutual relationships. The competence of the economist has to be enlarged to the study of how and why local systems rise and decline (Becattini, 1989; p.16). "Too important is the continuous interaction between economic activities and the "social culture" (systems of values), the whole set of economic, social and cultural variables which condition the nature of the social and productive structure, the relationships between actors and the behaviour of actors" (Garofoli, 1989, p. 76). The external economies will only be internalised when the relationships between firms are based on reciprocal cooperation (Dei Ottati, 1987).

1.2. Theories on endogenous development patterns in agriculture

The existence of regional specific development paths in agriculture mainly based on endogenous development sources has been stressed by Van der Ploeg in numerous publications (Van der Ploeg, 1990; 1994). An important analogy is to be noticed with the remark of Garofoli concerning the different possible strategies in industry largely independent from relative input-output and factor prices. Different styles of farming are distinguished in agriculture within a homogeneous exogenous economic environment. An important distinction with industry is that farming needs the resource "nature" which is even more regional specific. Exactly the diversity in relations of farmers with the input markets give rise to different styles of farming: at one extreme a relatively autonomous style of farming based on endogenous factors, at the other a more market-dependent style based more on exogenous sources of development. Farmers relate their farm enterprises in quite different ways to markets, and although markets might represent one and the same set of external parameters for farming, the way in which farming is linked to this set of parameters is highly variable (Van der Ploeg, 1994). Markets and technology do not determine how farming will be carried out, but provide the context in which different positions are possible; they constitute room for manoeuvre (Long, 1984). The essential point is that
different styles of farming can be discovered and understood only when the behaviour of actors is extended from the economic aspects to the social and historical context in which farmers are operating. Then it becomes comprehensible that some farmers support a higher market dependency than others and that dairy farmers may follow quite different strategies of development.

The persistence of industrial districts in time depend according Garofoli on the continuity in technological innovation, the efficient circulation of information, the capacity to control the market and a strong integration of local institutions with the local economy (Garafoli, 1989). All these factors can be controlled from inside the district. From the neo-institutional point of view the persistence of local production systems with a significant contribution of endogenous development elements derives from the high transaction costs (new commercial relationships have to stipulated) and transformation costs (new technical knowledge have to be acquired) of actors to quit the system. Or in the other way around, the benefits related to the low transaction costs of intra-district actors maintain their link with the district. If the benefit/cost balance in the neo-classical firm centred view may in certain periods demonstrate the economic convenience of the firm to quit the system, the high transaction and transformation costs introduced by the neo-institutional theory will continue to link the firm to the system.

1.3. Sources of innovation

The introduction of new technologies or production techniques in a production system is a cumulative process. As Dosi points out "innovative activities are strongly selective, finalised in rather precise directions" and "firms will seek to improve and to diversify their technology by searching in zones that enable them to build upon their existing technological base" (Dosi, 1988). The analogy with the process of technological innovation within marshallian industrial districts is evident when Dosi states that technological bottlenecks and opportunities tend to organise context conditions, which are country-specific, region-specific or company specific.

What is even more important to stress is the fact that the innovative process is the introduction of subsequent interdependent technologies. In other words, the introduction of a new technology provokes and obliges the introduction of other new techniques, which have become necessary as each new technology causes new problems to resolve. According to this point of view one has to speak of mutual interdependent production techniques (Benvenuti et al., 1988).

Within each production system different styles of farming coexist, each with a different development strategy. The autonomous style of farming will rely mainly upon locally developed production techniques and bases its technological development on endo-genous resources. The more market dependent style of farming will be influenced more by the fluctuations of relative factor prices and prone to introduce exogenously developed technologies (Van der Ploeg, 1990). To understand the direction of technological development within a PDO production system two questions are highly relevant:

1. Is the "distance" between the different styles of farming that large that within the system clear, distinct and divergent technological trajectories are discernible? Or,

2. Is the distance" between the different styles of farming that small, that one can speak of one single unique style of farming, where technological development is based either on endogenous resources or mainly determined by exogenous forces?

For the analysis of the technological development of the supply chains of Parmigiano-Reggiano, Grana Padano, Comtè and Cantal cheese the aforementioned theoretical framework will be used. A complete understanding of the negotiation process between actors of PDO supply chains cannot leave out of consideration the concept of terroir, which is to be considered an essential element distinguishing PDO products from all other products (agricultural and industrial) produced within economic districts.

2. THE IMPORTANCE FOR A PDO PRODUCT TO HAVE A LINK WITH ITS TERROIR

2.1. The quality as a strategy to be competitive

To be competitive, a firm must have a strategy based either on price or on differentiation (Porter, 1985). A differentiation through quality might be the only strategy possible for a product with rather high production costs. It is the case for most of the PDO products, which come
from remote areas and are produced in small-scale industries or are farmhouse products.

Despite the higher production costs of these PDO products, their survival or even their development are encouraged because these products may contribute to safeguard rural activities in decentralised areas and alpine regions, to stabilise population in remote areas and to satisfy the consumers looking for traditional food products. The PDO-PGI regulations in Europe (Regulation 2081/02) and in Switzerland (the PDO-PGI application order of May 1999) have thus not only the objective of protecting traditional geographic denominations, but they also aim to have direct outcomes which include benefits to rural economy and to consumers. Denominations will be protected in the belief that the name and identity of a product will contribute to its economic success in the market place, and that this success will have positive effects in the whole PDO region.

In order to compete effectively against cheaper items and substitutes products — often its own imitations —, a PDO product has to differentiate itself thanks to a very special quality which will give him its uniqueness, its specificity. The genuine quality for a PDO product is to have an origin which gives him a strong identity that nobody can imitate. We will see in the next section what we mean by original quality.

2.2. The link between a product and its terroir: a quality to preserve

2.2.1. The notion of terroir

A PDO product originates from a place which has both geographical (natural) characteristics and human ones. It is the French concept of terroir which can be broadly defined as the result of the combined effects of the physical characteristics of the production area and the human culture of the site. A terroir has thus historical, traditional, social and cultural dimensions, as well as agronomic and environmental ones.

A terroir is (Barjolle, Boisseaux, Dufour, 1998):
1. A natural site,
2. A set of knowledge and human practices,

The production area of the Parmigiano-Reggiano is for instance characterised by a continental climate with rather hot and humid summers and relatively cold winters. Its soil has a significant productive aptitude and its flora is rich and diversified. Moreover, in this production area is operating a group of milk producers and of cheese-makers who have the skill to process raw milk which may vary from farm to farm and from season to season, without using any chemical additives. The production of the Parmigiano-Reggiano is deep-rooted in the region and it is a part of the cultural identity of the local people. The Parmigiano-Reggiano terroir has thus both physical and socio-cultural dimensions.

In the Comté area, the climate and the landscape provides permanent meadows rich of different flowers which have all been listed (CIGC, 1997). This physical terroir is associated to human and cultural practices specific to this region: local people have been producing hard cheeses since the ancient times and the Comté production is still an essential element of the agricultural life of the region.

2.2.2. The notion of typicity

The terroir is deemed to confer to a PDO product its unique characteristics. We will say that characteristics conferred by a terroir are not only specific but also typical because they depend on a place, have a link to an origin and are the result of production conditions which are located in a particular spot (Barjolle, Boisseaux, Dufour, 1998).

This typicity gives the PDO product its core identity. It is an element which makes it significantly different from an imitation or a substitute. Typicity differs thus from specificity: specificity differentiates a product from other ones, but without reflecting its terroir and its origin (for instance a special packaging).

Product typicity can be highlighted not only through the specific characteristics of the finished product (for instance organoleptic properties of a cheese due to the natural flora of the milk or texture of a meat due to the dry climate and the processing), but also through know-how and production methods (cheddaring by hand, cheese processing on a wood fire). Being the foundation of the product identity, this typicity has to resist changes in technology.
The Etivaz cheese produced in Switzerland (Pays-d'Enhaout region and Alpes vaudoises) is a good example to understand what typicity means. This cheese would be quite similar to a Gruyère cheese if only the basic steps of its manufacturing were taken into account, that is to say acidification, enzymatic (rennet) coagulation, cutting of the coagulum, pressing in large moulds and salting. Furthermore, both are raw milk hard cheeses. The typicity of the Etivaz is yet based on the flora and rare plants of its alpine pastures (around 50 different species belonging to 15 botanical families) which confer a typical aroma to the milk and to the cheese (Bosset and ali, 1999). The raw milk is consequently highly important because pasteurisation would alter the indigenous microflora of the milk. Moreover, the milk is processed in huge copper cauldrons over open wood fires which give both a strong image to the cheese and specific aromatic hydrocarbons (Boisset and ali, 1998) to the final product. The identity of the Etivaz cheese is therefore based on its taste, its chemical components, the landscape of its production area and on the fact that it is processed only in summer, in mountain chalets, under a wood fire.

2.2.3. The link between a product and its terroir

The link between a product and its terroir is thus very important to preserve, it is the genuine quality of a PDO product. Clear evidence must be provided to prove such a link. Firstly in terms of production: the source of raw materials must be identified, and it can go as far back as a particular breed of animal (Montbéliarde or Pie rouge de l'Est for the Comté) and fodder. Such elements might be enshrined in the product specification because they contribute strongly to the identity of the product (Barjolle, Chappuis, Dufour, 1998). Secondly in terms of production methods and know how.

The PDO product must then demonstrate the product's economic, human, historic and cultural link with its terroir. The Cantal is a non-cooked cheese because the farmers used to have little wood when they were in the mountains. The milk was coagulated just when it has been milked and the curd was not cooked at all. This method was developed as an answer to environmental requirement and this is one of the links between the Cantal and its terroir.

Furthermore, a PDO must also have a traditional dimension. This condition imposes a continuity of collective practices through time within a well-defined geographical area. This traditional dimension is also part of the link between the product and its terroir (Bérard and Marchenay, 1995).

The product typicity must be highlighted in the product specification. The players involved in the PDO supply chain must determine which elements they want to write down. They have to define their product quality. The product specification is thus the result of negotiations, decisions which depend on different motivations, economic necessities, technical constraints or cultural choices. It is what has been called by several authors a "social construction" (de Sainte Marie, Casabianca and ali, 1995).

B. Sylvander (1995), M.T. Letablier (1995) or C. Delfosse (1995) rather speak of a "quality convention", a concept which well indicates that a code of practice emerges from an interactive process and that it is not defined one for all. Moreover, the consensus reached by the players does not guarantee that the product, its typicity and its quality have been a strong incentive in their decisions and choices. This explain why the EU research pointed out that several PDO or PGI code of practices have few requirements (Pommes de terre de Merville PGI, Scottish Lamb PGI, Noord Hollandse Edammer PDO, Cantal PDO...).

3. THE EVOLUTION OF THE INNOVATIVE PROCESS

The four cheeses analysed in the empirical part of this paper all have a considerable economic size. In France, the leader PDO cheese is Comté with a production of almost 40,000 tons a year and Cantal ranks third in the
list of French PDO cheeses behind Roquefort reaching a production of about 17,700 tons a year. Grana Padano and Parmigiano-Reggiano are the first two PDO cheeses of Italy with a yearly production of 130,000 tons and 105,000 tons respectively. They can be considered as the most important PDO cheeses in Europe. This economic dimension makes them particularly vulnerable to external pressures to introduce technologies and innovations to industrialise and standardise the production process in order to reduce production and processing costs, and enlarge in this way market shares. As has been pointed out by Slee, *artisanal* production may be able to survive or even expand in small market niches, but is likely to be the victim of predatory raids from larger firms that should the niches expand (Slee, 1994).

In other words, it is much easier to maintain high cost *artisanal* production techniques for small products, as they operate at small premium price niche markets, than for large products where the drive towards the reduction of production costs may become predominant.

In all PDO supply chains, attempts are made to reduce production costs, as in most cases the observance of the production rules laid down in the product specification raises the costs of production. The introduction of a series of cost reducing technologies may compromise the link of the product with the terroir, as the maintenance of a certain degree of *artisanal* is crucial for the *typicity* of the PDO product. In other words the product, although produced at lower costs, runs the risk to lose one of its main distinguishing characteristics: a product quality related to and embedded in its terroir. A PDO label in itself, without distinct and specific organoleptic characteristics of the product with respect to its main substituents, is not sufficient to strengthen its market position. This is why the introduction of new production techniques and technologies is the result of often long periods of debate among the actors of the chain. The questions always are in the first place to which extent the new technology does effectively reduce the production costs and secondly, how much does the new technology alter the final product quality?

The first important change in three of the four production systems has been the substitution of local cow breeds with the Holstein breed. In the sixties and seventies, this substitution took place in the Grana Padano, Parmigiano-Reggiano and the Cantal production system, whilst the Comté dairy farmers continued to milk the traditional Montbéliard breed. The process of *holsteinisation* was made possible as the production specification of the first three cheeses did not contain the prescription to use certain cow breeds. Deliberately farmers renounced of the genetic improvement of the local breeds and adopted the productivist model importing first from the Netherlands and afterwards from the United States and Canada high yielding cows and semen of premium bulls for artificial insemination.

This development brought about a weakening of the link between the product quality and the natural and physical characteristics of the production area. First of all because the Holstein cow breed, although producing more milk per cow per year, is less adapted to the production of cheese. For example in the milk of the Holstein breed the frequency of the B-variants of k-casein is much lower than in many local breeds as Reggiana and Montbéliarde (Rossi & Vecchia, 1994). This variant of k-casein is responsible for a higher cheese yield, a quicker coagulation and a better consistency of the curd. On the other hand, Holstein milk contains more b-lactoglobulin, resistant to heat and it is therefore highly requested for pasteurised milk. In other words, in the three cheese production systems a cow breed has been introduced, which is much more suited for industrial pasteurised milk production, than for high quality cheese based on the processing of raw milk.

The introduction of the Holstein breed caused new problems for animal feeding. The high-energy requirements of this breed made it necessary to find a feeding system able to sustain the high yielding cows. In the Cantal and the Grana Padano system, maize silage has been introduced, but in the Parmigiano-Reggiano a new code of practice for cow feeding, adopted in 1973, prohibits the use of any silage for milking cows. The consequence of this prohibition is that most dairy farmers delivering milk for Parmigiano-Reggiano cheese are forced to use high quantities of concentrate feed in order to cover the high energy requirements of the Holstein cows (De Roest & Fornaciari, 1994). The introduction of silage in the Grana Padano and Cantal dairy farms meant a further weakening of the product quality with their terroir, as the development of Clostridium spores made it necessary to introduce new techniques in cheese production, which have driven the product further away on the road towards industrialisation. The *holsteinisation* of the Parmigiano-Reggiano system caused a reliance upon an important import of feedstuffs produced outside the production area.
The Comté system remained loyal to the Montbéliard breed. As the use of silage is concerned, the CIGC maintained the prohibition of its use. In the lowlands of the production area, the cultivation of maize silage increased. To prevent any pressure to admit maize silage in the product specification, it has been decided to cut off the lowlands from the typical production area (Bobon et al., 1997).

Next to the use of silage a technology able to sustain the energy requirements of high yielding cows is the feeder trailer, mixing roughage and concentrate feed in a mixing wagon, also known as the unifeed system. As in almost all Italian dairy farms the zero-grazing system is applied, this technology has found a large diffusion as it enables the farmer to standardise cow feeding. Especially in the maize silage based farms of Lombardy this technology is very much used. If in these farms a good mixture can be obtained of hay, maize silage and compound feeds, on the Parmigiano-Reggiano farms water has to be added to the feeder trailer in order to obtain a right density of a ration composed of only hay and compound feed (Biseglia et al., 1991). It should be stressed that this technology is not congruent to a feeding system based primarily on hay and concentrates. It is an example of an exogenous technology, which increases feeding efficiency in particular in areas where maize silage is one of the main types of roughage used. This is why the Parmigiano-Reggiano Consortium has been very reluctant in admitting this technology in the product specification. Nevertheless, after years of heavy debates the product specification has opened the possibility to use this technology under strict conditions.

In the Comté area, a similar debate has been conducted about the unifeed technology. The pressure of farmers to admit this technology has not been as strong as in the Parmigiano-Reggiano system. First, because the yield of Montbéliard cows can be reached without difficulty with high quality hay and concentrates and second, for almost six months the cows are pasturing and the trailer would thus be used only for half a year.

A technology much more congruent to the hay-concentrate feeding system is the use of artificial hay drying. In the Comté and Parmigiano-Reggiano system, many farms invested in this technology. The raised quality of hay induced by this technique may reduce significantly the use of concentrates in the feed ration, particularly useful on the Parmigiano-Reggiano farms.

As has been stated before the road towards industrialisation causing the almost complete rupture with the terroir has been taken by the Cantal and Grana Padano system. This becomes quite clear by illustrating the innovations introduced in cheese making.

In the cheese dairies of Grana Padano, the use of maize silage first induced the double processing of milk. It consists of processing the raw milk twice a day after having creamed off all the milk by natural floating instead of only the milk of the evening milking, like is done in the Parmigiano-Reggiano dairies. This technique is a procedure to get rid of the clostridium spores (Bottazzi, 1998). As this technique was not sufficient to combat the spores, first formaldehyde has been introduced as an additive and later lisozyme has found capillary diffusion among cheese dairies. Another technology adopted by some dairies, which is able to reduce the presence of spores in the milk and, is the elimination by centrifugation.

An even more drastic cost reducing technology has been the milk cooling, which permits a milk collection of once a day instead of twice (Grana Padano) or even once each two days (Cantal). The cooling of milk is a technology which reduces the typicity of the cheese significantly. When cooling is admitted imitation of the cheese in other distant areas becomes much easier. Moreover, this technology has introduced a series of new problems in both systems, of which most relevant is the reduced rheological capacities of the milk. An almost automatic innovation following the milk cooling is the milk thermisation, a procedure of milk heating up to 57-68°C for 15 seconds to re-establish the rheological capacity of the milk lost during cooling (Bottazzi, 1997). In the Cantal dairies, this technology has already been introduced years ago. Nowadays some Grana Padano dairies started to use the technique generating conflicts with the Grana Padano Consortium, as it is in open conflict with the product specification.

From this overview, it is quite clear that both Cantal and Grana Padano gradually moved away from an artisanal production process, where the key actor responsible for a significant part of the cheese quality is the cheesemaker, towards an industrial process dominated by artificial milk standardising techniques and the use of additives. The introduction of one production technique always raises new problems causing the introduction of other related technologies. Largely, the technological
development of Cantal and Grana Padano has opened the possibility for reproducing the product elsewhere in the world. Reducing significantly the artisanal elements in the production process, these two systems have become more vulnerable for imitation. Their degree of typicality has been reduced and their link with the terroir has been relaxed.

Comté and Parmigiano-Reggiano are both subjected to a continuous process of innovation, but have more or less maintained their link with the terroir. The typical quality of milk of Montbéliarde cows fed by grasses and hay produced in the Jura and the high artisanal capacity of the cheese-maker of the Parmigiano-Reggiano dairy are hardly reproducible elsewhere. In the last chapter, we will try to answer the question, which variables explain most of the variance of these quite divergent technological developments.

4. THE COHESION BETWEEN ACTORS : AN IMPORTANT EXPLAINING FACTOR

4.1. The importance of common objectives within the supply chain

Although all four cheeses have an economic dimension, which make them highly vulnerable to a standardisation of the production process, each of the systems has reacted in a different way to these external pressures.

An important factor in explaining the divergent technological development trends between the four systems is the size and the internal physical and cultural variability of the production area. Cantal and Grana Padano are both produced in huge areas with a very high differentiation in natural and physical production circumstances. For Grana Padano also, pronounced cultural differences have to be taken account. This cheese is being produced in the three northern regions of Italy (Piemont, Lombardy and Veneto) where very different styles of farming co-exist. At one extreme, the very large vanguard farms of Lombardy and Piemonte, at the other, smaller sized farms in Veneto and the province of Mantua. Within the area, even small mountain farms continue their farming activities. Similar differences are to be noticed in the Cantal production area. The large intensive dairy farms in the lowlands of the southern part of the production area are pursuing different objectives than the mountain farmers in the northern part of the production area.

In a very differentiated and large production area, as is the case of Cantal and Grana Padano it is easy to discover different styles of farming, each embedded in their local social and physical environment. The coexistence of different styles of farming hinders the formulation of common collective objectives. It should be stressed that although the Parmigiano-Reggiano production area knows a high natural an physical differentiation (Apenines and lowlands of the Po Valley), the dairy farmers, cheese-makers and ripening firms still express a quite strong cultural identification with the product, which goes even beyond the product itself and includes other typical products of the Emilian culture (Antonello, 1999). In other terms, the actors of the chain express a strong sense of belonging to the system (Becattini, 1988). The result of this strong affection to the product is a product specification, which sets boundaries to the technological development. Nevertheless, also in this area, different styles of farming are emerging and evidence of the increase of differentiation in farming is the harsh debates with which new technologies are admitted or not.6

The strong cohesion among actors of a supply chain pursuing common objectives transforms in certain sense the sum of farms in a single firm, which acts through its representative body, adopting production rules valid for everybody to defend its product against competitive action. Technologies and product quantities are planned and defined, as they are the prerequisites of each firm. In the Comté this process of identification in common objectives is complete and explains the resistance to decline as has also been mentioned by Collet and Pierlot (1987). The 25-km maximum range for milk collection has been introduced to create obstacles to the entrance of industrial food groups into the system and to maintain a certain degree of homogeneity of the production units. The production area has been reduced to cut off areas where a tendency towards industrialisation came up. In the Comté system, the "distance" between the different styles of farming is that small, that one can speak of one single unique style of farming, where technological development is based on endogenous resources or where each exogenous technology is severely filtered and adapted to the production system.

Very important for the technological development in the Comté system has been the prohibition to use other cow breeds than the Montbéliarde. As has been described in paragraph 3, the holsteinisation in the other three cheese production systems has induced the introduction
of a series of interdependent technologies. In the case of Cantal and Grana Padano, this chain of technologies leads to an almost complete industrialisation of the production process and in the Parmigiano-Reggiano system the holsteinisation provoked a continuous tension between the feeding system and the high yielding cow breeds. In a certain way, the product specification of Parmigiano-Reggiano acts as cork on a bottle of Lambrusco! Recently the rules for feeding cows have been sharpened to prevent the use of plastic covering the round hay bales and to put limits on the imports of roughage and concentrates.

4.2. The threat of large industrial companies and the emergence of local-sub chains

The lack of cohesion among the actors of the chain, especially in large differentiated areas, leads to a weak product specification and to the entrance in the chain of large industrial multi-product companies, eager to exploit the product name for their own economic interests and to enlarge their portfolio on the market. This legitimate firm strategy however does not coincide with the collective interests of actors in the production area, in particular when technologies are introduced which lead to an industrialisation of the production process and to the rupture of the link with the terroir. Two reasons can be mentioned:

1. A condition that within a marshallian district externalities will be internalised in the firm balance is that the relationships between firms are based on reciprocal co-operation (Dei Ottati, 1987). This condition is more easily fulfilled when the size distribution of the cheese dairies is not too much skewed. This is the case in both the Comté and the Parmigiano-Reggiano system, but not in Cantal and Grana Padano where large industrial groups and small cheese dairies co-exist.

2. The economic strength of a marshallian district is enforced when the production process knows limited economies of scale (Saccomandi, 1994). In particular, an artisanal production process is a guarantee for limited economies of scale, as again is demonstrated by Comté and Parmigiano-Reggiano dairies, where milk processing costs do not decline beyond a dairy size of 4,000 tons of milk a year (De Roest & Corradini, 1998).

A predictable reaction to a lack of cohesion among the actors in the Cantal and Grana Padano chain is the emergence of local sub-chains, composed of actors in smaller areas within the boundaries of the PDO area, which agree upon a stricter product specification in order to differentiate their product within the supply chain. An example of this development is the supply chain of Trentingrana, a Grana cheese produced in the Alpine regions of the autonomous province of Trentino. Silage has been prohibited in the new specification and milk must derive from a newly defined production area. The objective is to re-establish the link with the terroir, raise in this way the quality of the product and to regain value added. The initiative has been successful, as the price of this cheese is reaching higher levels than Grana Padano produced formerly in the area. Similar initiatives will be expected in other sub-areas of the Grana Padano PDO area.

Within the Cantal system, there is a drive back towards the use of raw milk for the production of authentic Cantal (Bobon et al., 1997). No deadline has however been issued and it is questioned to which extent it will be possible to reintroduce on a large scale the use of raw milk in the cheese-dairies. Years ago already the production of Salers started as a reinvention of Cantal using exclusively the Salers cow breed*. Another example in the area is the "farmhouse" Cantal, produced only in summertime, when the cows are pasturing. The development of sub-chains, which aggregate farmers and dairies having common objectives is inevitable, when the industrialisation of the PDO product proceeds.

In the Parmigiano-Reggiano system, finally mention can be made of cheese produced with the local Reggiana breed, with its own quality mark produced according to a stricter product specification. Attempts have been made to set up a specific supply chain of Parmigiano-Reggiano cheese produced in the Apennines. However, it has proved to be difficult to find a common denominator among cheese dairies when each dairy is proud of its proper cheese quality. As on average the milk price for dairy farmers delivering milk to PR dairy exceeded the milk destined to industrial processing there have been until now only a few attempts to define internal sub-chains with a proper product specification.

If a PDO cheese wants to meet the policy objective to sustain the "benefits to the rural economy, in particular
to less-favoured or remote areas, by improving the incomes of farmers and by retaining the rural population in these areas, as stated by Regulation 2081/92, then the off-farm price of milk delivered to this cheese should be higher than milk destined to generic dairy products. Milk delivered to Cantal and, frequently, Grana Padano dairies did not satisfy this condition, whereas milk prices destined to Comțe or Parmigiano-Reggiano, although variable in time, on average reached higher levels than prices for generic industrial milk. In the former two systems large scale intensive farms prevail, whereas in the latter two systems medium sized family farms survive contributing to a higher employment level in the countryside. A strong cohesion among actors of the chain is a pre-condition for a full exploitation of the potential benefits of a marshalian district. It may direct technological development in such a way that its related positive externalities will become internalised in the firm balance. Technologies will be developed which respect the typicity of the product and its link with the terroir and the introduction of these innovations on the farm and in the cheese dairies will be favoured by low transaction costs, as the basis of cohesion is the reciprocal cooperation between the actors of the supply chain.

NOTES

(1) The authors are jointly responsible for this paper, however, Kees de Roest wrote paragraphs 1, 3 and 4; Martine Dufour wrote paragraph 2.

(2) This group of regions has been called by Bagnasco the Third Italy, with respect to the North-West (large industries and the South (structurally backward).

(3) Some examples of industrial districts in Italy are the district of ceramics (Sassuolo), of textile (Prato, Carpi), of furniture (Cerea, Oderzo, Poggibonsi), of stockings (Fermo, Montecatini), of glasses (Belluno) etc., etc.

(4) Comțe Interprofessionnel du Gruyère de Comțe, the quality control and promotion body of Comțe producers.

(5) In the trailer, moulds may develop when it is not sufficiently cleaned. To have a good quality of the mixture, roughage and concentrates have to be mixed twice a day.

(6) In particular we refer here to the admittance of feed trailers on the Parmigiano-Reggiano dairy farms.

(7) It has been recently decided that Salers cheeses only produced from milk of Salers cow breeds will be called Tradition Salers.


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307