SECTORAL INNOVATION SYSTEMS: AN APPLICATION OF THE CONCEPT IN THE BRAZILIAN AND FRENCH FLUID MILK PRODUCTION CHAIN

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Abstract:

The aim of this study is to test a new framework in order to evaluate some fundamental institutional, technological and organizational factors in the innovation process carried out by food processing firms. We use case studies and the sectoral innovation system - SIS approach to give evidence about the innovation process carried out by fluid milk processors in the French and Brazilian sectoral innovation system. The SIS´ approach is defined as the system

of firms active in developing and making a sector's products and in generating and utilizing a sector's technologies; such a system of firms is related in two different ways: through processes of interaction and cooperation in artifact-technology development and through processes of competition and selection in innovative and market activities. The forces that account for the dynamics of SIS and shape their spatial boundaries are represented in the concept of "technological regime" which is defined by the level and type of opportunity and appropriability conditions, by the cumulativeness of technological knowledge, by the nature of knowledge, and the means of technology transmission and communication. We choose a research design with one unity of analysis (food processors that recently launched new products and explored new markets in the fluid milk production chain) and multiple case studies (two firms in Brazil and two in France which launched some of the principal product innovations in this market during the 90's, respectively: Premium UHT milk, sterilized milk, organic UHT milk, and microfiltrated milk). The structure and strategies developed by suppliers, the dairy industry and the retail food distribution system are undergoing rapid change in those countries helping to show the robustness of the phenomenon across different and complex contexts. Afterwards, we compare enterprises with the same structural profile in the two countries: multinational enterprises – MNE (very large multi-product/brand firms) and small and medium enterprises - SME. This configuration is specially useful and robust to confront the theoretical basis, where each case is selected by the researcher to confirm convergent or contrasting evidence between the cases. Finally, the empirical observations are compared with similar and conflicting theory about innovation in the food industry in the hope to generalize them to theoretical propositions.

Key words: technological innovation ; sectoral innovation systems ; food industry ; fluid milk.

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Introduction

Continuous innovation is an issue of vital importance for the strategic management of food processing companies that wish to access quality based markets. In particular, the alignment of product differentiation and market segmentation represent an essential competitive strategy to face the consequences of the changing balance of power in the food retailer-food processing industry relations and the rapid evolution of consumer behavior with respect to agricultural and food products.

The aim of this study is to test a new framework in order to evaluate some fundamental institutional, technological and organizational factors in the innovation process carried out by food processing firms. We use case studies and the sectoral innovation system - SIS approach to give evidence about the innovation process carried out by fluid milk processors in the French and Brazilian sectoral innovation system.

The SIS´approach (Breschi & Malerba, 1997) is defined as the "system of firms active in developing and making a sector's products and in generating and utilizing a sector's technologies; such a system of firms is related in two different ways: through processes of interaction and cooperation in artifact-technology development and through processes of competition and selection in innovative and market activities". The concept of SIS focuses on the overall dynamics in the population of firms considering the role of selection environment and technology specific factors. The forces that account for the dynamics of SIS and shape their spatial boundaries are represented in the concept of "technological regime" which is defined by the level and type of opportunity and appropriability conditions, by the cumulativeness of technological knowledge, by the nature of knowledge, and the means of technology transmission and communication.

We characterized the SIS of fluid milk chain in France and Brazil: i) describing the characteristics of the technological regimes (and the new emerging technological trajectories); ii) associating these regimes with the Schumpeterian dynamics; iii) evaluating the association between those technological paths with the geographic distribution of innovating enterprises in the two countries.

The structure and strategies developed by suppliers, the dairy industry and the retail food distribution system are undergoing rapid change in those countries helping to show the

robustness of the phenomenon across different and complex contexts. The contrast in those two SSI act as a revelatory tool since there is no way to identify an "optimal" and "coherent" sectoral system (Malerba, 1999).

1. Methodology

We use case studies as an approach to give evidence of the systemic relations and the existent trade-offs between the institutional, technological and organizational factors affecting the innovation process carried out by food processing firms. We choose a research design with one unity of analysis (food processors that recently launched new products and explored new markets in the fluid milk production chain) and multiple case studies (two firms in Brazil and two in France which launched some of the principal product innovations in this market during the 90's, respectively: Premium UHT milk, sterilized milk, organic UHT milk, and microfiltrated milk).

The fluid milk market is a hard product innovation to test considering its ordinary character (Siebert et al., 2000) and the domination of retail products (Galizzi et al., 1997). Besides, the supremacy of one process technology (Ultra High Temperature - UHT processing) limits the diversity of technological strategies adopted by the food processors (Révillion et al., 2001).

Afterwards, we compared enterprises with the same structural profile in the two SSI´s: multinational enterprises – MNE (very large multi-product/brand firms) and small and medium enterprises - SME. This configuration is specially useful and robust to confront the theoretical basis, where each case is selected by the researcher to confirm convergent or contrasting evidence between the cases (Yin, 1994) ; (Sterns et al., 1998). Finally, the empirical observations are compared with similar and conflicting theory about innovation in the food industry in the hope to generalize them to theoretical propositions. The implications between the specific theory and the phenomenon are explicit in the discussion of the results.

Data from the selected enterprises were collected in semi-structured interviews with principal decision-makers. In addition, we interviewed independent specialists that closely followed the innovation process (Table 1). The context of the study and the search for conflicting information was obtained in technical journals, sector reports and academic work. Finally, the empirical observations are compared with similar and conflicting theories about innovation in the food industry in the hope to generalize them to theoretical propositions.

The interview guide applied to characterize the two SSI considered four fields of discussion: i) characteristics of the knowledge base: sources of innovation, character of the knowledge base (tacit or codified), level of specificity and complexity; ii) characteristics of the technological trajectories: incremental or radical character, cumulativity (at the firm, sector or cluster level), means and level of appropriability (by the use of patents, industrial secrets, pioneering, structural barriers to imitation, complementary actives), type and level of the accessed opportunities, performance of concurrent technologies; iii) nature of learning processes, competencies, organization and behavior of firms: comportamental diversity in the sector, organizational learning, adoption of new methods and techniques, changes in the strategic orientation, level of technological dependence, internal coordination in the firms; iv) vertical and horizontal inter-relations and complementarities: level of complementary between internal and external R&D, impacts (due to innovation) in the production chain, level of cooperation with universities, financial and research institutions, governmental agencies, technological suppliers, clusterring effects, cooperation mechanisms involved (*joint-ventures*, R&D agreements, licensing, direct investment, user-supplier relationships), importance of the public politics , importance of consumption patterns (emergence of new trends).

Table 1: Case studies and repondents of the semi-structured interviews.

Case studies:	Microfiltrated milk "Coopérative Laitière de Villefranche" SME – France	Organic UHT milk LACTALIS MNE - France	Sterilized milk "Glorinha Indústria de Laticínios Ltda" SME - Brazil	Premium UHT milk "PARMALAT do Brasil" MNE - Brazil
Principal decision-makers	Technical ingenier Director	Director of External Relations	Director	Sales Manager Technical ingenier
Independent specialists	Director - "Laboratoire de Recherche de Technologie Laitière, INRA-Rennes"	Specialist in organic milk - "Fédération Nationale d´Agriculture Biologique des Régions de France – FNAB"	Sales Manager - "SONAE/RS – Distribuição Brasil SA"	

2. Results

2.1 The institutional and competitive context of the innovative process		
	France	**Brazil**
Retail participation in the packaged food sales	80 % (Carrier et al., 2002)	82% (Bortoleto, 2000)
Retail concentration	In 2002 the 3 largest retail possessed 64% of the market (GMS, 2002)	In 2001 the 5 largest retail possessed 38,8% of the market (ABRAS, 2003)
Incidence of distribution brands in the fluid milk market	Over 60% (Carrier et al., 2002)	Over 6% (Blecher, 2002)
Relative bargaining power of retail	Strong and growing (D'Hauteville et al. 2000) ; (Richard & Sylvander, 1997) ; (Dreschner & Maurer, 1999)	Strong and growing (Farina, 2001)
Structure of the equipment supplier segment	In concentration	National clusters in disintegration – growing dependence on international suppliers (Dirven, 2001) Monopolist position (D'Hauteville et al. 2000) ; (Dreschner & Maurer, 1999)
Importance of public research institutions to forster innovation	Very important (specially to SME) (Le Bars, 2001)	Limited (Bortoleto, 2000)
Concentration in the dairy industry	High: 2,1% of the enterprises responds for 55,6% of production (Trail,1997) ; (Trail & Gilpin, 1998) in 1995, 3 groups processed more than 40% of total production(Imelda et al., 2002)	Growing concentration through acquisitions of PME by MNE (Bortoleto, 2000), (Dirven, 2001) ; (Jank et al., 2001).
Dominant technological trajectory	Direct UHT processing / PEAD and carton presentation	
New possible technological trajectory	Microfiltration - MF associated with "light" UHT / PEAD and carton presentation	
Main strategies in the dairy sector - MNE	Product differentiation, extend product line, market segmentation (Richard & Sylvander, 1997) ; (D'Hauteville et al. 2000)	Intensive advertisement, product differentiation (Bortoleto, 2000), brand consolidation, market segmentation (Reardon & Farina, 2002)
Main strategies in the dairy sector - SME	Focus on niche markets (Richard & Sylvander, 1997) and pioneering (Richard & Sylvander, 1997), (Imelda et al., 2002)	Focus on niche markets and defensive strategies (imitation of MNE) (Bortoleto, 2000) ; (Dirven, 2001) Distribution channel selection

		(Révillion et al., 2001)
Fluid milk production	3,9 billion liters in 2001 (CNIEL, 2002)	5,3 billion liters in 2001
Evolution of fluid milk market	Regression (- 8% between 1989 to 1999) (Imelda et al., 2002)	Growing (+50% between 94 to 2000)
Fluid milk market relative to dairy products market (volume processed)	17% in 2001 (CNIEL, 2002)	50% in 1997 (Bortoleto, 2000)
Fluid milk markets (in 2001)	Pasteurized milk: 3,0% (partly differentiated) Sterilized milk: 7,1% (no differentiation) UHT milk: 89,9% (75% generic and 25% modified) (Imelda et al., 2002), (CNIEL, 2002)	Pasteurized milk: 27% (partly differentiated) UHT milk: 73% (90% generic and 10% modified) (Révillion et al., 2001)

2.2 The case studies		
	Organic UHT milk LACTALIS – MNE - France	**Premium UHT milk "PARMALAT do Brasil" – MNE - Brazil**
Characteristics of the new product	Organic UHT milk (4 months of shelf life without refrigeration)– PEAD bottle	Premium UHT milk (4 months of shelf life without refrigeration) – PEAD bottles
Innovation sources	Raw milk suppliers	Process equipment suppliers (integrated) Raw milk suppliers
Motivation	Try to segment ordinary UHT milk market / valuate products and brand	
Trigger event	"Crazy cow crisis" (1996)	"Commoditization" of ordinary UHT milk Valuate products and brand
Strategies	Pioneering Differentiation Positive impact in company image and brand Extend product line Trade marketing	
Product differentiation sources	Health and well being Ethical concerns Quality labeling: *Agriculture Biologique*	"Natural" appeal – raw milk selection First UHT milk in PEAD bottles
Focused markets and distribution channels	National Mainly big retail	
Actual importance of the product to the company	Represents 3% of sales of the UHT line Marginal impact in profitability	Represents 15% of sales of the UHT line

Internal project agents	Multidepartments	Multidepartments and inter-firms (international exchanges with equipement suppliers)
Appropriability	Pioneering Consolidated brand Intensive advertisement	
External inter-relations	Focused in develop raw milk supply and logistics due it's geographic dispersion Better "commercial" relations with retail, but without specific cooperation	Integrated process equipment suppliers
Learning processes	Supply management	Product and process development External relations management
Governmental subsidies	Important to production segment	No
Innovative product's impact in trade marketing	Guaranteed shelf space in retailers' stores even after the launch of identical products with retailers' or processing firms brands Benefits for retail's brand: complete line of products associated with the offer of a cheaper (- 20%) retail brand substitute Better margins with new products	Guaranteed shelf space in retailers' stores No direct concurrence Benefits for retail's brand: differentiate from concurrence Better margins with new products
	Microfiltrated milk "Coopérative Laitière de Villefranche" – SME - France	**Sterilized milk "Glorinha Indústria de Laticínios Ltda" – SME - Brazil**
Characteristics of the new product	Microfiltrated milk (15 days of shelf life a 4-6°C) – PEAD bottle	Sterilized milk (4 months of shelf life without refrigeration) – PEAD bottles
Innovation sources	Process equipment suppliers / Research Institute	Process equipment suppliers
Motivation	Process alternative to small scale dairies / face UHT milk boost	
Trigger event	Rapid market displacement of pasteurized milk by UHT milk	
Strategies	Pioneering Niche exploration Positive impact in company image and brand	Pioneering Differentiation Positive impact in company image Trade marketing Increase logistics flexibility (compared to pasteurized milk) Permits to explore seasonal effects in raw milk productions
Product differentiation sources	Taste profile (close to pasteurized milk) with extended shelf life; gastronomic value, *"terroir"* appeal	First long conservation milk in PEAD bottles
Focused markets and distribution channels	Local, regional and national 80% big retail 20% groceries	Regional

Actual importance of the product to the company	Represents 50% of total sales	
Internal project agents	Director and small team	
Appropriability aspects	Pioneering and idiosyncratic learning	Pioneering
External inter-relations	Process equipment suppliers, research institute, marketing consulting, public entities (sanitary control) Retail: feed-backs about consumer acceptance	International process equipment suppliers
Learning processes	Product and process development External relations management Innovative culture	External relations management
Governmental subsidies	Important to processing segment	No
Innovative product's impact in trade marketing	Guaranteed shelf space in retailers' stores No direct concurrence Benefits for retail's brand: differentiate from concurrence Better margins with new products (MF milk)	

3. Discussion

The SIS of fluid milk in France is characterized by a high level of opportunity due to the availability of a relevant (Huault et al., 1997) ; (CNIEL, 2002), protected (Carrier et al., 2002) and diversified (Richard & Sylvander, 1997) ; (Imelda et al., 2002) market and a structured system for the support and financing of the innovative activities (Christensen et al., 1996) ; (Huault et al., 1997). There is also a great variety of agents (specially domestic equipment suppliers and applied research centers) able to offer and develop a wide array of innovative technological solutions – what is expressed by the emergence of pre-paradigmatic technological variants as the ones considered in the case studies. This institutional base is sustained by numerous and dynamic complementary characteristics of this SIS located mainly in the region of Bretagne, which possesses a diversified sample of dairies, raw milk suppliers, process equipment and package suppliers and specialized research and teaching institutions.

Nevertheless, this SIS is emblematic of the fiercely vertical competition between dairies and retail (D'Hauteville et al., 1996) ; (Huault et al., 1997) ; (Richard & Sylvander, 1997). The high degree of concentration (Trail, 1997) and the diffusion of vertical competitive strategies – as the launching of new products with their own brands (Imelda et al.,

2002) – enable the large retail companies to appropriate a growing share of the rents generated in this supply chain (Trail, 1997).

In this context the level of appropriability of new technologies is critical to the competitive strategies deployed by dairies. The case studies evidenced that pioneering – associated with the exploration of complementary assets (especially brand image and positioning) – and tacit learning are the most important ways to ensure some degree of appropriation of new technologies in this SIS.

Conversely, a promising level of opportunity characterizes the SIS of fluid milk in Brazil - considering the relative importance and the great growing potential of the fluid milk market (Jank et al., 1999). Furthermore, the retail segment is not very concentrated and the market share of products with retail brand is still limited in this SIS (Blecher, 2000).

Likewise, the asymmetries in the population's consumption potential restricts the size of niche markets and destabilizes the demand (Massote Primo, 1999) –and complicates the planning of long range investments in technological innovation (Wilkinson, 2000) and directs responsive behavior of the dairies (Révillion et al., 2001) ; (Dirven, 2001).

The variety of technological solutions in this SIS is also limited by the low public and private investment in R&D (Wilkinson, 2000) and by the poor integration between research and teaching institutions and the dairy processors (Bortoleto, 2000) ; (Dirven, 2001). Indeed, even if the main source of technological advance is originated in very competitive international equipment suppliers, unidirectional relations are hardly able to generate dynamic and sustainable technological advantages (Tigre, 2003). This context is not favorable to the autonomy and capacity of the agents of this SIS. This is reflected by the limited variety of alternative technological trajectories to the dominant design in fluid milk processing. As a matter of fact, the lack of Brazilian MNE in dairy processing is a barrier to the establishment of innovative clusters and the assessment of international (and sophisticated) markets (Wilkinson, 2000) - in order to foster the development of innovative strategies (Iglesias & Veiga, 2003).

The appropriability regime in this SIS is low since the main sources are based on the control of complementary assets - especially the investment capacity in new equipment and processing plants (Wilkinson, 2000) and brand consolidation (Révillion et al., 2001) ; (Bortoleto, 2000). In the long run, the limited interaction between the agents of this SIS

(Bortoleto, 2000) ; (Dirven, 2001) can obstruct co-evolutionary processes with a hardly reversible competitive prejudice - considering their cumulative character (Malerba & Orsenigo, 1996). This perspective is critical for SME since they are not able to compete (in scale, scope and R&D investment and marketing investment) with MNE (Révillion et al., 2001) ; (Wilkinson, 2000) ; (Dirven, 2001).

In comparison, the technological opportunities explored in the two countries are somewhat diverse: i) in Brazil the product innovations in fluid milk still are predominantly incremental, concerning packaging and product formulation variations; ii) in France, the emergence of a new technological trajectory in fluid milk processing (microfiltration) may represent an important technological path. In both situations powerful equipment suppliers orchestrate the sectoral evolution.

All the case studies illustrate the dynamics of a sector which depends extensively on public and private organisms – suppliers of technology, embedded in equipment, suppliers of materials or components and an applied research network (Christensen et al., 1996) ; (Révillion et al., 2001) ; (Trail & Meulenberg, 2002). The switch between the search for external complementarities and the mobilization of internal capacities illustrate the interactive innovation model with feedbacks (where the R&D activities are instrumental) (Kline & Rosenberg, 1986) - as observed for other food processing firms (Christensen et al., 1996) ; (Grunert et al., 1997).

One convergent feature in those SIS is related to the low appropriability of the technologies developed and offered by equipment suppliers - especially, in the case of SME. Even if the knowledge base associated with the technology adaptation presents some elements indicating tacit and complex learning, the effectiveness of marketing complementary strategies (advertising, distribution channel selection, brand positioning) – which can potentially enhance the benefits in pioneering - are limited by the modest financial and technical resources of SME (Grunert et al., 1997).

This is a specially important issue for the SME: the growing need to serve the big retail restrain the opportunities to explore new markets since the bigger dairy processors – with complete lines in each product category and a great capacity to promote them – keep an asymmetric bargaining power and dominate the shelf spaces (as observed in the dairy sector in France (D'Hauteville et al. 2000) and in the food processing segment in general (Galizzi & Venturini, 1996) ; (Connor & Schiek, 1997) ; (Connor, 1981).

In a much more comfortable position, the MNE can establish entry barriers to smaller concurrence - by selecting technologies that demands high financial commitments and benefit from scale economies - and surviving constraints – since the performance evolution of the dominant design tend to be incremental and routinized - stimulating concentration (Utterback & Suárez, 1993). This dynamic is especially true considering that the "development of close and technically creative supplier relationships appear to be keys to successful, continuing dominance" of the bigger enterprises and that the equipment suppliers who head the technological development "may put enough weight behind a particular design to make it a standard" (Anderson & Tushmam, 1990). Besides, following Sutton's propositions (Sutton, 1991), endogenous sunk costs can deter competition from SME too as growing marketing and P&D fixed costs require a higher level of sales to amortize them (Galizzi & Venturini, 1996) ; (Connor & Schiek, 1997) ; (Venturini, 1997). Indeed, product innovation in the food industry will be better explored if the adoptants have the necessary advertising capacity (as in the case of Premium UHT milk) and brand positioning (as in the case of the organic UHT milk) permitting the bigger firms to explore scope economies and shelf space in retail.

Even considering the asymmetries identified, there is similarities in all case studies: the critical effects in the pioneering of the development of new technologies and the offer of new products (Galizzi & Venturini, 1996): guaranteeing shelf space in retailers' stores, even after the launch of identical products with retailers' brands.

4. Conclusions

The results succeeded in showing the growing importance of non-price competitive strategies in a context of accrued concentration in the processing and distribution segments. In this context it is very important to deploy an adequate public policy to generate variety in the technological and organizational forms in order to foster industry competitiveness. In this sense it would be critical to maintain an effective network capable to sustain a process of continuous innovation in the SME of the food industry - as their survival will depend on the exploration of ever-shorter periods in the beginning of technological cycles.

This objective seems to be critical in Brazil considering the fragility of the institutional structure to support innovation in this industry. The establishment of cooperative mechanisms between public research institutes, food processing machinery industry, regularization and

control organisms were more important to the innovative French processing firms than the Brazilian ones.

The SIS approach proved to be a useful tool for a descriptive analysis and for a full understanding of the dynamics and patterns of change of the Brazilian and French fluid milk production chain. This framework is very promising for the identification of the factors affecting the performance and competitiveness of firms and countries and for the development of new public policy trends.

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