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Product Innovation and Imperfect Competition in the Italian Fruit-Drink Industry*

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Abstract

In this paper, the case of the Italian fruit-drink industry is presented to discuss the strategic issues of product-innovation in imperfectly competitive markets. In particular, three main topics are addressed: the incentives to the adoption of innovation-based strategies, R&D investments in imperfectly competitive markets and the role of vertical coordination. To address the topics, a brief description of the industry, a game-theory conceptual framework and a strategic analysis of the marketing channels are proposed.

The major conclusions can be summarized as follows: (i) product-innovation strategies are the result of an evaluation of the option value of the R&D investments, the risk of failure and competitors' strategies (ii) demand pull only may be insufficient to trigger innovation: an efficient retailing system, costs of failure and production efficiency may influence the firm's strategic approach to innovation.

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Product-innovation is a major issue in the food system: the ability of offering consumers new products with special attributes is considered one of the most important competitive advantages in the global food market and in Italy as well. However, innovation-based strategies are risky, as shown by the high number of unsuccessful new products. Careful strategic planning is required to capture the benefits of innovation and manage risks. In this paper, the case of the Italian fruit-drink industry is presented to address three main strategic issues: a) the determinants of innovation-based competition, b) the optimal R&D investment in imperfectly competitive markets, c) the role of vertical coordination in product-innovation.

Two main objectives are pursued: to provide an empirical analysis of the product-innovation strategies in the Italian fruit-drinks industry and to propose a conceptual framework to model product-innovation strategies in imperfectly competitive markets. Empirical evidence from Italian fruit-drinks industry are utilized to support the model.

1. Italian Fruit-Drink Industry

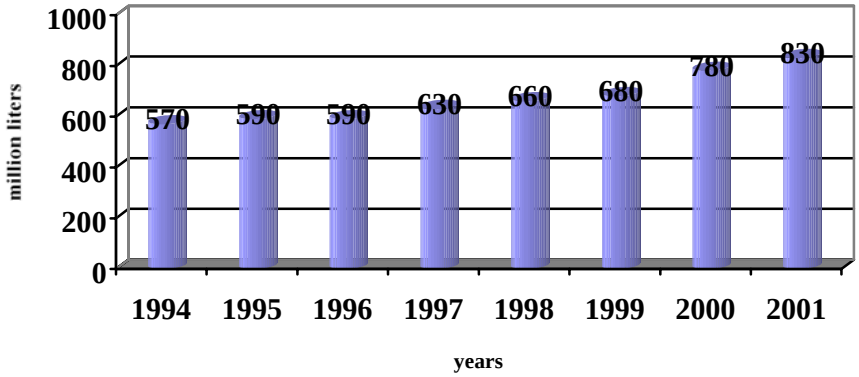
In 2001, Italian fruit-drink industry produced a turnover of 950million euros and marketed 830million liters, representing the 18.4% in volume and the 28.8% in value of the Italian total non-alcoholic beverage market (Beverfood 2002). The fruit-drink market can be broken down into two main segments: traditional beverages, i.e. fruit-juices and nectars (600million liters sold in 2001), and innovative beverages with a lower fruit content and supplemented with vitamins and other nutritious ingredients, such as milk or yogurt (230million liters).

National per capita consumption of nectars equals approximately to 6 liters, while 100% fruit juice consumption is lower (4 liters per capita). In Italy there is a marked dichotomy in consumer preferences: fruit nectars are used mainly as kids' snacks, while fruit juices are consumed primarily by adults as breakfast (Muraca, 2000). Per capita consumption of innovative fruit-drinks is approximately 4 liters per person, but trends are increasing and it is forecasted that they will eventually acquire a leading position.

The market is rapidly growing: in recent years, increasing consumer awareness about quality and healthiness of food and beverages has determined a drop in consumption of alcoholic drinks, offset by a considerable rise in consumption of non-

alcoholic beverages and especially fruit-drinks. Figure 1 summarizes the current industry trend.

Figure 1: *Sale Volume in the Italian Fruit Drink Market*



Source: Beverfood 2002

Overall consumption is undoubtedly rising (+45% in a 8-year period), mainly because consumers often associate fruit juices with the healthy, genuine and natural properties of fruit. The constant growth of sales in this sector has unquestionably been favored by changing lifestyles and trends in consumer behavior, especially the hedonistic lifestyles and healthy eating habits typical of the '90s. Also, consumer behavior has changed over the years; while fruit beverages once were consumed mostly as summer snacks, today they may also accompany meals and are generally consumed throughout the day and the year round.

Within the sector, however, consumer dynamics do not appear to be uniform; in fact, while consumption of the innovative fruit beverages is growing strongly, traditional fruit juices and nectars feature sluggish growth trends. The consumers seem to appreciate the new products more because they satisfy a twofold requirement: they are thirst quenching and improve nutritional intake (Rossi, 2001).

The industry is highly concentrated: the top 4 brands account for 67% of the market. Currently Italy's market leader is Conserve Italia, producing 290million liters with a 35% share of the market, ranking seventh among European manufacturers and owning four brands: Derby, Yoga, Valfrutta and Jolly-Colombani. Second in line is Zuegg, which owns the Skipper brand (110million liters and 15% of the market), followed by Parmalat with Santal (90million liters and 11%) and Cirio-Del Monte with Batik (50million liters and 6%). However, in recent years the entry of new brands has eroded the share of the larger companies, and private labels, that accounted for only 16.2% of total sales in 2000, are growing (Rossi, 2001). In particular, in the innovative fruit-beverage market, competition is

rapidly evolving and the market share of the single manufacturers may vary considerably, according to the launching of new products. The expected entry into this market of soft drink giants, such as Coca Cola e Pepsi, will undoubtedly determine a further increase in consumption, through intense innovation and aggressive advertising (Muraca, 2000).

Innovation is undoubtedly a key determinant of the industry growth (Muraca 2000, Beverage Industry 2002). The raising demand for innovative fruit beverages has encouraged manufacturers to research new products, develop new technologies and design new packaging. The introduction of new colors and new combinations of flavors is an effort to further expand market potential and satisfy consumer demands in terms of quality and assortment. In recent years, the major product-innovations regarded fresh fruit juices and supplemented juices and nectars. The launch of the vitamin and energy drinks (i.e. fruit beverages with the addition of vitamins, fiber and/or mineral salts) meet the growing demand, from adult consumers, for healthy foods and beverages. The most successful brand in this field, to date, is ACE (Derby), a mix of orange, lemon and carrot juices with the addition of A, C and E vitamins. Consumers are willing to pay a price-premium for these products because they are perceived as providing greater nutritional benefits (Muraca, 2000). Packaging is an innovation frontier as well. The advent of tetrapack containers has revolutionized logistics, supermarket displays and practical handling, besides increasing sales. Also, improved container design contributed to enhance the image of the products (Muraca, 2000).

The innovation effort is accompanied with significant advertising investments. Communication campaigns are aimed at emphasizing innovation and the brand image (Rossi, 2001).

2. A Conceptual Framework for Product-innovation

In this section, a simple model is proposed to analyze the innovation process in the fruit-drink industry. Innovation is a major topic in economic literature since the fundamental contribution of Schumpeter (1942), Solow (1956) and Arrow (1962). The present model addresses the issue by applying game theory, a methodology widely utilized to discuss innovation in oligopolies (Reinganum 1981; Fundemberg and Tirole 1991). In particular, product-innovation cannot be fully analyzed by a static model because of influence of time and uncertainty on competitors' strategies (Reinganum 1981, 1982). Thus, a dynamic model is proposed to address the issue. A dynamic game allows players to react strategically to competitors' actions and new state of nature by utilizing incoming information gathered during the game (Dockner et al. 2000).

The game can be defined as follows:

1. the game is non-cooperative, non repeated[1] and non-zerosum. Information is imperfect, complete and symmetric.
2. there are only two players: $N \equiv \{A,B\}$. Both players are currently producing the same standard goods (O)
3. at time t=0, the strategy set of both players is composed of two options: to invest in R&D (I) or not to invest (N). $S_i \equiv \{I_i, N_i\}\ \forall i \in N$. Only pure strategies are allowed. By investing in R&D at time t=0 the firm gain an option of marketing a new product (X) later on.
4. Innovative products cannot be patented: imitation is possible. By assumption, competitors will consider imitation only after the innovation proved to be successful.
5. The random variable p is the probability that the innovation is successful (i.e. is accepted by consumers). An unsuccessful product is retired from the market with an additional cost (F_i).
6. The R&D process takes time (T_i) and financial resources (R_i), strategic variables that are controlled by the management. It is assumed that $p=f(T_i,R_i)$. By investing time and resources in R&D the manager can increase the probability of success: $\frac{\partial p}{\partial T_i} > 0; \frac{\partial^2 p}{\partial T_i^2} \leq 0$ and $\frac{\partial p}{\partial R_i} > 0; \frac{\partial^2 p}{\partial R_i^2} \leq 0$ with $\lim_{Ti \to \infty} p = 1$ and p(0)=0. By accelerating the marketing of the innovative product, the manager reduces the probability of success but can preempt competitors' innovation.
7. The game has a finite, multi-period time horizon at time = H.

In order to complete the description of the game, the payoff functions must be specified and, therefore, the impact of innovation on the market must be illustrated. In the present model, four effects of innovation are taken into account:

1. direct
2. substitution
3. category
4. brand

The direct effect is related to the firm's profits from the marketing of the innovative products. The extent of this effects for the i^{th} firm is the result of the total demand for the innovative product (X), the firm's market share ($\alpha_{X,i}$), the per-unit margin of contribution ($MC_{X,i}$) and the fixed costs ($FC_{X,i}$).

The introduction of innovation is assumed to affect the sales of the non-innovative goods as well. The substitution effect is related to the decrease in the sale volume of the standard goods (ΔQ_O) due to the launch of the innovation. Being the new

[1] The game is non-repeated in the sense that a single innovation decision is considered; multiple purchases of the products by final consumers are assumed. The dynamic approach allows the game to model consumer behavior in a multiple period framework.

product a substitute, the sale volume of the standard product after innovation ($Q_{O|X}$) is expected to decrease ($Q_{O|X} \leq Q_O$).

In the fruit beverage industry, often innovation can boost the sales of the whole category, providing benefits to the standard goods as well. The category effect takes into account this phenomenon and it is described by the equation: $Q_{O|X}+Q_X=\gamma Q_O$, where γ is a constant representing the category effect. The negative impact of the substitution effect may be mitigated by the increase in consumers' total expenditure for the category due to the appeal of innovation.

The brand effect is due to the positive attitude that consumers may develop towards innovative brands. Thus, an innovation-based strategy can bring a positive impact also on the firm's sales of the standard goods (in addition to the possible category effect). Unlike substitution and category effects, the brand impact is firm-specific and it is influenced by the competitors' strategies. The innovation effect on strength of the brand can be described as the simultaneous capability of shifting the substitution effect on competitors' products, capturing the category effect and benefiting of the positive attitude of consumers. This is a result of the considered time period (t form 0 to H) consumers can repeat their multiple purchases.

Given the impact of innovation, payoff functions can be specified. In R&D games, literature usually utilizes the present value of future cash flows, assuming a value-maximizing behavior of the firms (Reinganum 1981; Fudenberg and Tirole 1985, Docker et al. 2000). However, traditional discounted cash flow methods can be insufficient in modeling a dynamic problem, because future cash flows are influenced by competitors' future strategic choices. Thus a real option approach is utilized (Schwartz and Moon 2000). Real option theory allows the model to take into account managerial flexibility by applying contingent claim evaluation and introducing the no arbitrage assumption (Black, Scholes 1973; Pindyck 1991; Trigeorgis 1996).

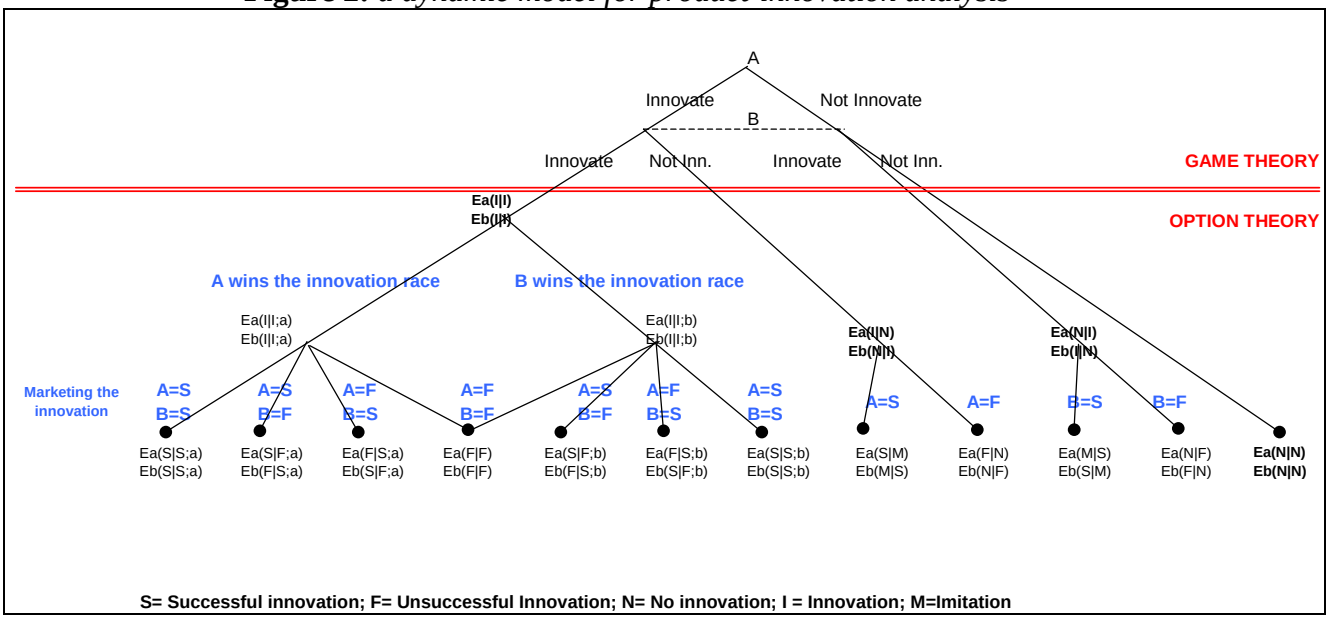
The expected present value of the cash flows related to each strategy – to innovate or not to innovate – is calculated through a backward dynamic programming approach (Kulatilaka 1995). To illustrate the solution of the problem, a discrete-time framework is adopted and a geometric Brownian motion is assumed for the cash flows (Hull 1989).

According to option theory, the expenditure in R&D gives the firm the option of gaining extra-profits (by marketing the innovative product), once the research is completed. If the firm does not invest, it can only market an imitation of a possible competitor's innovation. Innovators face two source of uncertainty: the possible failure of the innovation (i.e. consumers are unwilling to buy the new product) and a possible competitors' pre-emption (that would prevent the firm from gaining

monopolistic profits). Followers do not face such uncertainty, but they cannot gain extra-profits.

By combining the possible outcomes and the players' strategies (innovation, waiting and imitation) it is possible to draw the option tree and to associate an expected payoff to each combination. Figure 2 summarizes the results.

Figure 2: *a dynamic model for product-innovation analysis*



The figure is divided into 2 sections: a game-theory tree, which is utilized to solve the strategic problem, and a option-theory tree, which is utilized to determine the game payoffs. The payoffs for each strategy are specified by calculating the expected values of the related strategic options. According to real option approach, the expectation is calculated by applying the risk-adjusted probabilities and the risk-free interest rate (Trigeorgis 1996). The solution can be calculated by determining the expected present value of the cash flows (CF_i) related to each possible state of nature (θ) at time t according to the following matrix:

Exhibit 1: *possible state of nature*[2]

		Player A production set[2]				
		Monopoly of Innovation	Competitive Innovation	Imitated Innovation	Imitation	Standard product only
Player B production set[2]	Monopoly of Innovation	∅	∅	∅	∅	$\theta_{1,5}$
	Competitive Innovation	∅	$\theta_{2,2}$	∅	∅	∅
	Imitated Innovation	∅	∅	∅	$\theta_{3,4}$	∅
	Imitation	∅	∅	$\theta_{4,3}$	∅	∅
	Standard product only	$\theta_{5,1}$	∅	∅	∅	$\theta_{5,5}$

The cash flow associated with each state of nature $CF_i(\theta_{k,j})$ and the relative risk-adjusted probabilities $p(\theta_{k,j})$ can be used to calculate $Ei(S_A;S_B)$ (i.e. the expected value of the strategic option conditioned to the competitor strategy) according to the equation [1].

$$E_i(S_A;S_B)=\sum_{t=1}^{H}\frac{\sum_{k=1}^{5}\sum_{j=1}^{5}q(\theta_{k,j})_t\left[CF_i(\theta_{k,j})_t\right]}{(1+r)^t} \qquad [1]$$

where, being Θ_z the set of the states of nature compatible with the strategic option $z(S_A;S_B)$,

$$q(\theta_{k,j})=\begin{cases}p(\theta_{k,j}) & \forall\theta_{k,j}\in\Theta_z\\ 0 & \forall\theta_{k,j}\notin\Theta_z\end{cases}$$

By applying the backward dynamic programming approach it is possible to determine the payoff of the four strategic options at time 0 z_1(A and B invest in R&D); z_2(A invests, B does not); z_3(B invests, A does not); z_4 (neither A nor B invest). The actual solution of the game depends on the parameters of equation [1], in particular the relevant factors are summarized in the following determinants:

- The financial investment in R&D (R_i), which influences the probability of having a successful product, which in turn affects $\theta_{k,j}$ (an unsuccessful innovation is retired from the market).
- The time investment in R&D (T_i), which affects both the probability of having a successful product and $\theta_{k,j}$ (a lower T_i increases the probability of winning the innovation race and gaining short term extra-profit from the monopoly of innovation).

[2] Strategic combination may be excluded according to the assumption of a pure-strategy game. Such combination are represented with the symbol ∅

[3] By assumption each production set includes the standard product

- Competitive advantage/disadvantage in production efficiency, which affect CF_i.
- The demand characteristics affecting the direct, substitution, category and brand effects.
- The costs of failure, which are included in CF_i.

The proposed model describes the innovation process in a duopoly as the result of the value maximization strategies of the competitors. R&D investments can be considered as the price to be paid in order to gain an option on the future cash flows from the innovative goods. The competitors are willing to invest only if the option value of the innovative product is higher than the present value of R&D costs. In this framework, strategic issues arise because in non-perfectly competitive markets the option value of innovation is determined not only by demand but also by competitors' strategies.

The model describes the current trends in the Italian fruit beverage industry as the result of the effects of two opposite determinants: the willingness of capturing extra-profit from innovation and the aversion to the risks of unsuccessful R&D. The shift in consumers' preferences provided a significant business opportunity by strengthening the direct, brand and category effects. Thus, the expected value of R&D increased providing incentives to innovation-based strategies.

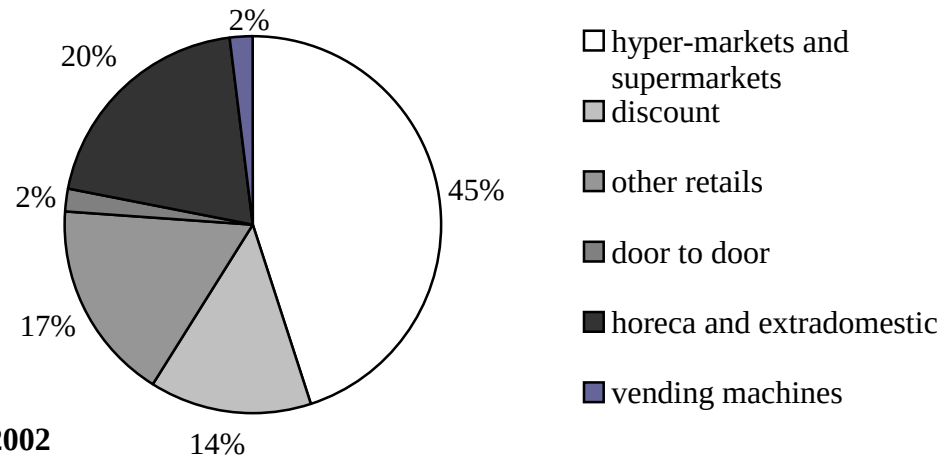
The current race to innovation is consequent to the impact of the investment of time and financial resource in R&D on the firm value. By increasing the investment the probability of success increase (risk reduction) but, at the same time, the delay can prevent the firm from gaining extra-profit, losing the innovation race. The manager must carefully balance the two effects in order to maximize firm value. If the cost of failure is relatively low, the management may consider to accelerate the rate of innovation assuming that the expected extra-profit compensate the increasing.

3. Marketing an innovative product: a supply chain management perspective

The analysis presented in the previous section does not take into account firm's marketing strategies and the vertical relations with downstream retailers. The launch of a new product poses relevant strategic issues related to the choice of the best marketing channel and the optimal marketing strategy (Hultink et al. 1997). The innovating firm must evaluate key decisions, including the setting of the launch price, promotional and positioning activities and it must build a set of vertical relationships in order to ensure an efficient distribution of the new product. In fact, the efficiency of marketing channel is considered crucial for a successful product-innovation (Green and Lassaud 1993). In this section two key performances of the marketing channel are considered: market access and information flow.

In the Italian fruit beverage sector, there are four main marketing channels: supermarket chains, discounts, extra-domestic (bar, restaurants i.e. the so-called HORECA channel) and traditional retailers (Figure 3).

Figure 3: *The fruit juices marketing channels in Italy -2002(% of total sales)*



Source: Beverfood 2002

The marketing channel, usually, is not exclusive: the producer can choose to launch the new product using the whole set of marketing channels simultaneously (especially when the promotion budget is relevant) or in subsequent times. The choice of the marketing channel for an innovative product is a crucial strategic decision: a broad multi-channel approach allows the firm to maximize the purchase occasions for potential consumers (increasing the extra-profits from exclusive innovation), but, conversely, the choice of a limited number of channels can reduce risks, by focusing the marketing effort on a specific consumer target (Filser 1989).

The launch of a new product requires a negotiation with the retailing system. Due to the limited availability of shelf-space in the sale-points, producers must compete for access. Thus, retailers can select the most promising innovations and negotiate the most favorable agreements.

Usually, retailers implement a two-step screening process. In the first step, the general characteristics of the producers are evaluated: reputation, brand image, ability of provide stable supply of the new product, capability of dealing with peaks of demand, logistic capability and cooperative attitude are considered as pre-requisites for a successful partnership. In the second step, the specific attributes of the product are considered. The analysis focuses on the level of innovation, the results of market researches, the programmed budget for promotion and advertising expenditures, the merchandising and the estimates of retailer's gross margin.

Usually, the screening process leads to a renegotiation of the general reference contract as final condition for actual acceptance of the innovation.

Retailers are willing to accept innovative products because of the on-average higher profit margins, but, at the same time, they are concerned about the risk of failure. A unsuccessful new product slows down the inventory turnover and limits the shelf-space for profitable alternatives, reducing retailers' profits. Thus, practices are adopted to manage this risk. The most common practice involves the requirement of a minimum advertising budget and a program of in-store promotions at producers' expenses. Also, depending on producer's market power, slotting fees may be applied as "insurance" against the potential loss of profits and to cover for retailers' advertising costs.

The role of the retailing system in the innovation process is not only of granting market access. The flow of information is also a decisive success factor. In a non-coordinated channel, the producers might be unable to optimize the innovation process and the logistic chain: distorted signal from possibly biased sample surveys can make the producers base their strategy on an incorrect assessment of consumers' demand. Then innovation failure is more likely and excess of production and undesired stock accumulation are possible.

To reduce these risks, cooperation is required to identify actual consumers' behavior and sale trends, stabilizing as much as possible the channel. Synergetic cooperative systems between producers and retailers, through processes of supply chain management and of maximization of the logistic function, can significantly reduce the risks connected to the launching of a new product. A combined action is able in fact to furnish efficient productive answers towards sudden changes of the demand and variation in the behaviors of the competing enterprises (Bowersox, et to the., 1999).

Italian retailing system in the last ten years has dramatically increased its efficiency consequently to significant retail concentration (Mariani 2002). This trend has facilitated the innovation process in the fruit-drink industry. The screening process implemented by retail chains has reduced the number of unsuccessful innovation, encouraging consumers' curiosity toward new products. Also, retail chain are more efficient in information flow, due to the integrated logistic.

4. Summary and conclusions

In this paper, the strategic issue of product-innovation in the Italian fruit-beverage industry is addressed. The subject is relevant because innovation is one of the most important determinant of the remarkable growth of the industry in the late '90s. To address the topic a brief description of the industry, a game-theory conceptual framework and a strategic analysis of the marketing channels are proposed.

The analysis supports the conclusions that although innovation in Italian fruit-drink industry is a demand pulled process, the shift in consumer preferences alone cannot explain the current trend in the industry. Other factors contribute to the high rate of innovation in the industry. In particular:

1. The increase in retailers' efficiency due to the concentration process during the '90s. The more efficient retail system (i) imposes a screening process preventing unsuccessful innovation from gaining access to the market, (ii) promotes a more effective information flow, (iii) allows producers to manage effectively in-store promotions (iv) facilitate the logistic of innovation. As a result, the probability of innovation failure is lower and the cost of unsuccessful products is lower.
2. Price competition on "non-innovative" goods. Pressure provides incentive to product differentiation.
3. Imperfect competition, which gives incentives to accelerate the innovation rate in order to gain extra-profits from and pre-empt competitors.
4. Relatively low R&D costs for innovation and low cost for failure mitigating the effect of the uncertainty in innovation-based strategies.
5. Economies of scale and scope and production flexibility allowing major producers (i) to achieve cost advantage and (ii) to hedge the risk of innovation through diversification (iii) to adopt brand advertising, reducing the marginal costs of an additional innovation considerably.

In the proposed framework, the current race to innovation in the Italian fruit-drink industry is due to option value of the extra-profit from innovation that more than offset the risks of unsuccessful new products. The rapid innovation process is consistent with a value maximizing strategy: currently in the industry there is the co-presence of several factors increasing the opportunities of extra-profits from innovation and reducing the related risks. In this context, the present value of innovation-based strategies increases.

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