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Time-based Innovation Strategy Game

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Abstract

Innovations strategies, based on the introduction of new products to the market with the aim of gaining larger market share and raising profitability, have a significant time element. The work presented examines the behavior of two firms based on the time-strategies they follow, with the help of a system dynamics simulation model. The inability of a firm to follow the competition's rate of introduction of new products undermines its own long-term competitiveness. On the other hand accelerated introduction of new products may undermine the investment amortization in existing products. Here, the evolution of corporate performances in a duopoly environment is presented; firms adopt strategic behaviors in response to the competition's choices. The model developed, provides to decision makers the ability to assess the advantages and disadvantages of different strategic choices and commitments and to analysts the opportunity to explore the formation of equilibria under different industry environment parameters and time-strategies.

Keywords: Time-based strategy, innovation, system dynamics

1. Introduction: the acceleration trap

Competition, technological progress and changes in customer needs, have led to a continuous improvement of competitive paradigms with an emphasis on time-based strategies (Stalk, 1995). As a result, there is significant pressure for reduction of new product lead times, while product life-cycles are being reduced as well. The competitive environment pushes firms to constantly introducing new products in greater variety and at accelerated pace. This phenomenon is much more intense in high-tech industries - such as the microprocessor industry - where technical change occurs at higher rates. Being the fastest, in terms of achieving higher performance, new characteristics, better quality, more attractive design first, is a good way to beat the competition (Sin-Hoon Hum & Hoon-Hong Sim, 1996). Possible benefits from a strategy of quick market entrance are related with market dominance, the increasing variety of available product versions and possibly better cost management based on the firm's learning curve.

Accelerated market entrance strategies may have unpleasant effects for a company. These may derive from the trade-off with production efficiency or product performance (Pisano, 1997; Stamboulis et al., 2002), the shorter window available for investment amortization - with an immediate effect on production cost – as well as reduced sales as a result of the fact that potential product users may resist to or be put-off adopting a constantly evolving product and –therefore- not buy it. At the same time firms have to commit greater resources in order to achieve the intended acceleration, increasing further the investment that has to be returned upon.

Thus, an accelerated pace of innovation will eventually meet with unavoidable limits. Phased with this reality firms would be expected to slow down to a sustainable innovation rate. However this does not necessarily happen. Faced with pressure from competition, firms are induced to stay in the race unless they decide to resign from a significant share of the market. In every case companies have to balance among the factors that are critical to the success of a product and decide according and in comparison with the competition whether they should increase or not the speed of introducing new products. In a game of signals and a race for accumulating tangible and intangible resources – such as product portfolio and customer base – firms have to assess opponents's commitments and to respond in anticipation of them, thus leading to an escalation of the race to reduce intervals between new product introductions. Hence, firms find themselves in an acceleration trap (von Braun, 1997) as they have to stay in touch with the competition or they may suffer significant technological disadvantages against them.

2. The model presentation based on system dynamics

A modular system dynamics simulation model has been developed of the dynamic game of duopolistic competition. Systems dynamics is a method initially developed by Forrester (1961) which is well proven in the study the systems behaviour that seem to have great complexity due to the dynamic interaction among the different constituent elements. The model was developed in a system dynamics environment, using Powersim Studio Express 2003 simulation environment.

The model that has been developed during the study of this problem consists of three basic subsystems (Diagram 1), which by their turn consist of smaller subsystems which are analyzed latter.

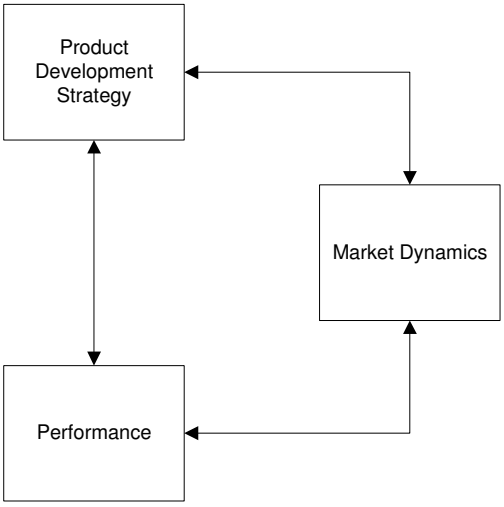


Diagram 1: The interaction between conduct, market and performance

The subsystem "Product development strategy" consists of the process of developing of a new product and the strategies of market entrance that are been followed. In the "performance" subsystem, company performance is modelled in terms of production cost and of cash flows and capital accumulation. Finally in the "Market Dynamics" subsystem, the interacting sales of competing firms are modelled - based on the Bass diffusion model (Sterman, 2000) – as well as their dependence on strategy decisions and their impact on performance.

2.1 Presentation of the models interactions in every subsystem

Below every subsystem is studied separately by forming causal-loop diagrams.

2.1.1 Subsystem "Product development Strategy"

The main interactions of this subsystem are shown in diagram 2.

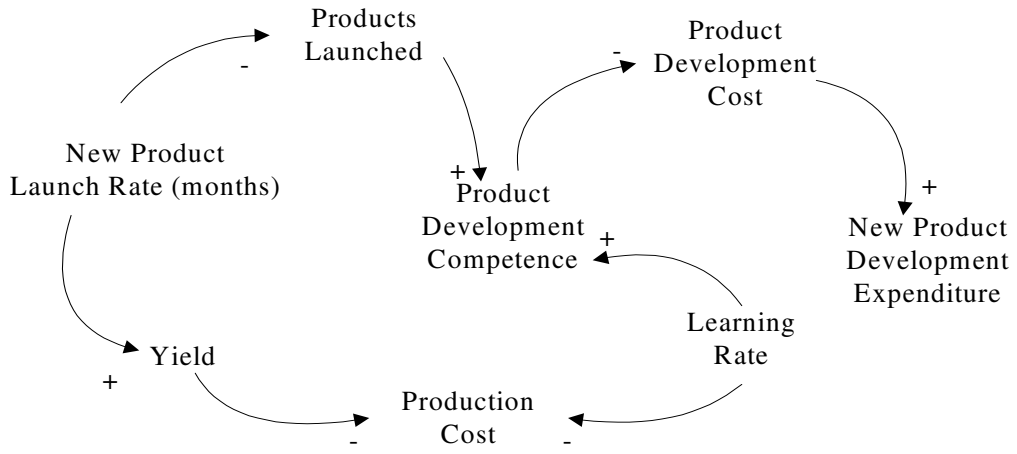


Diagram 2.:Subsystem "Product development Strategy"

As shown in Diagram 2, the reduction of the time needed to complete the development of new products and at the same time the reduction of market entrance, does not always have a positive effect. This happens because when the time of developing a new product is being reduced, then the efficiency (in terms of yield) of production is being reduced too. This has been well documented in high technology companies such as pharmaceuticals and microprocessors (Pisano, 1997). The last variable that should be taken into consideration is the rate of learning in R&D, which represents the capability of learning from successive projects.

2.1.2 Subsystem "market dynamics"

This subsystem is based on the model developed by Frank Bass (1969), which has been adapted changed according to the interactions arising from a duopolistic situation. According to the model the rate of sales of each new product depends on advertisement expenditure and mouth to mouth reputation (Diagram 3). Both factors act positively on sales contributing to the profits of each company. The first is decided upon by each firm. The impact of mouth to mouth reputation things is less easier to conclude because of the dynamics of human interaction and the fact that its impact depends on the rate at which adopters are added or subtracted from the customer base of each firm..
Additional parameters have to be taken into account. The terms "relative price" or "relative performance", impact on market dynamics according to the commitments made (in the case of product performance at earlier stages) by each firm. Therefore, the sales of the first company are reduced as the competitor reduces its product's price or increases its performance.

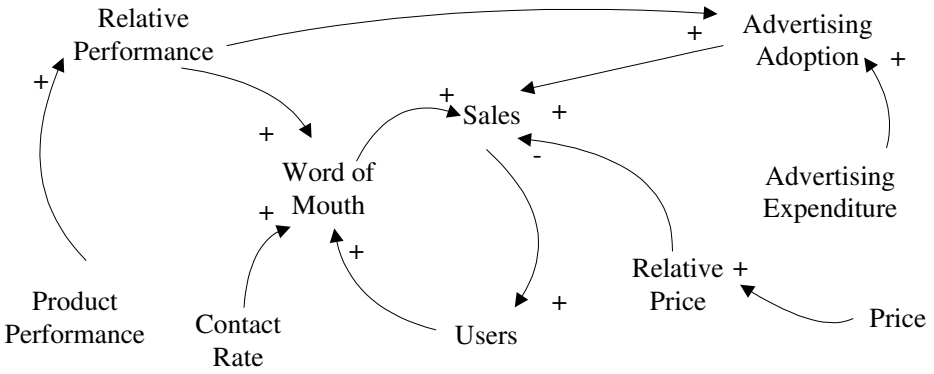


Diagram 3: The dynamics of market interaction

2.1.3 Subsystem "performance"

In this subsystem the effects of the strategic choices concerning the cost of production, the price of a product and the cash flows, are examined.

As the time of developing a product is reduced and the rate of R&D activity increases, there is an increase of the rate of the products the company makes, while the rate of R&D expenditures is increased..

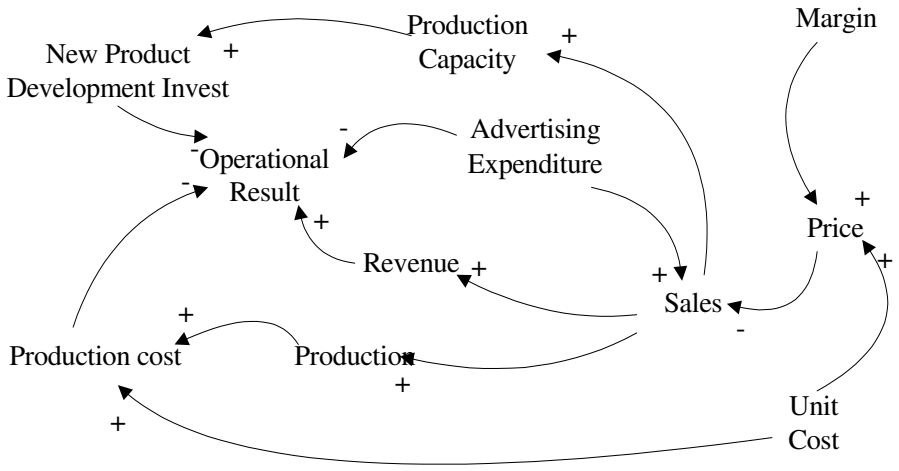


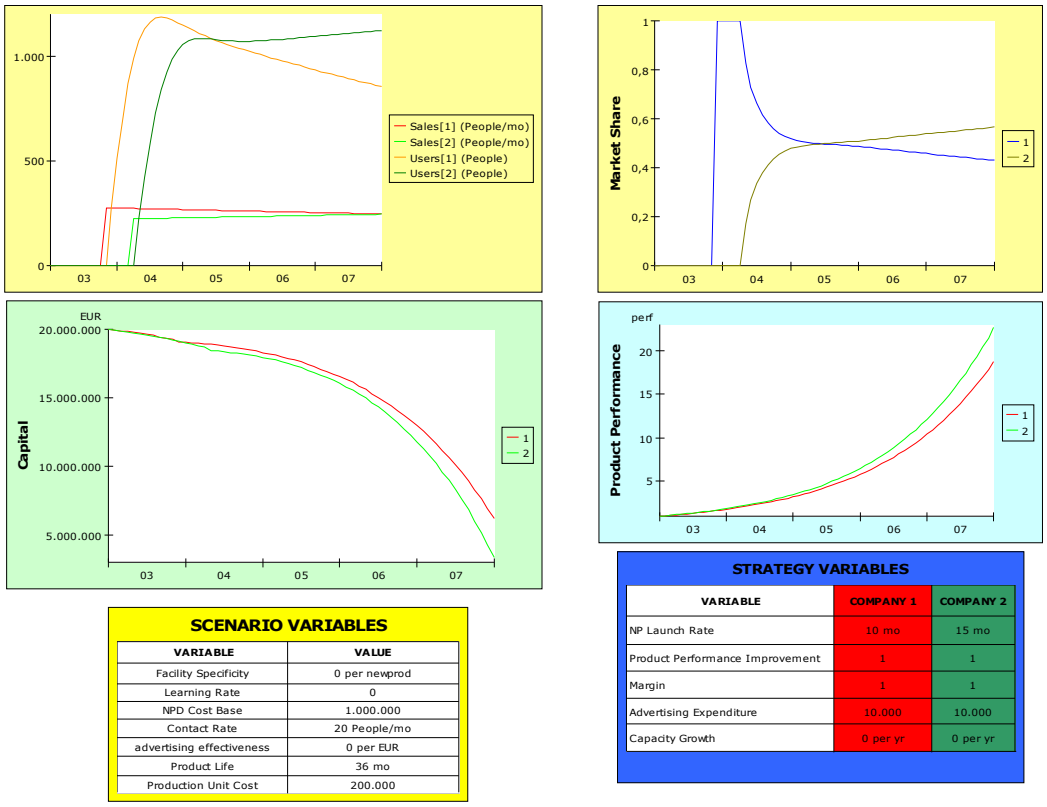
Diagram 4: The dynamics of performance

As a company increases the rate of new products launched into the market, the production units are made obsolete faster. This leads to a reduction of the production capability of the company and can lead to the reduction of sales if the demand is bigger than the company's capabilities. The maximum production capability of the company depends on the production units and their availability. The reduction of the production capability from the introduction of a new product to the market depends on the degree of specificity between production process and product generation. The stronger this is the more each firm has to invest in production capacity in order to compensate for obsolescence, in addition to the investment necessary to meet increases in demand.

3. Use of the simulation model

The decision variables chosen were the rates of new product launch, the degree of performance improvement between successive products, profit margin and advertisement expenditure. These take different values for each company.

Scenario variables may be taken into account such as learning rate, rate of market growth, facility specificity, and initial unit production cost and so on. Firm specific ones take the same value for each company. The scenarios have been built with the semiconductor industry in mind and the case of PC microprocessors in particular. Simulations run for a seventy two months period of time (6 years).



SCENARIO VARIABLES

VARIABLE	VALUE
Facility Specificity	0 per newprod
Learning Rate	0
NPD Cost Base	1.000.000
Contact Rate	20 People/mo
advertising effectiveness	0 per EUR
Product Life	36 mo
Production Unit Cost	200.000

STRATEGY VARIABLES

VARIABLE	COMPANY 1	COMPANY 2
NP Launch Rate	10 mo	15 mo
Product Performance Improvement	1	1
Margin	1	1
Advertising Expenditure	10.000	10.000
Capacity Growth	0 per yr	0 per yr

Diagram 5: Simulation interface

The purpose of this model is twofold. First, as a decision support tool it may be used a learning laboratory, exploring the various options management needs to consider. In Diagram 5, one may see different performance metrics: sales and customer base (cumulative sales), market share, free cash flow and product performance. In the scenario depicted here, one may notice the effect of delay as well as contradictory performances amongst different performance metrics. It is shown that under specific circumstances, entering the market in a later stage may result positively as superior product performance may play a decisive role. This performance may lead consumers to change the product they use already with a competitive one, always taking prices into account. Second, the model may be used for the exploration of evolutionary games. A most interesting question is whether there are conditions or strategies (or combinations of both) that may result in Nash equilibria or sustainable innovation rates for both firms in the long-run.

4. Conclusion

In this paper, we have explored the dynamics that lead to the emergence of the acceleration trap. The performance of two companies with different new product market entrance strategies, were examined. The dynamics of competition in an industry characterised by time-based-strategies and high rates of technical change were examined. Modelling has taken into account the processes of asset accumulation and their impact on performance in the context of market interaction. The system dynamics model constructed has allowed to explore the interacting and ambiguous in nature decisions that agents make in the context of repeated games. It has helped to

show the importance of asset accumulation and of sustainable advantages in the long-run.

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