DYNAMIC COMPETITION WITH BI-DIRECTIONAL PRODUCT DIFFERENTIATION, BOUNDED RATIONAL CONSUMERS, INNOVATION, ADVERTISING, AND FINANCE

by Valentino Piana (2003)

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Overview

The present paper describes the **software model of a modern competitive market** you can download from [here](#). The successful diffusion of a new good on the market is a competitive race among two or more firms, engaged in Research and Development activities aimed at improving product features and [production costs](#). [Advertising](#) plays a key role but the ultimate resource is finance.

The most innovative feature of the model is a **fully microfounded demand**, with heterogeneous consumers, following several decision rules and judgement parametres.

While playing and taking decisions, **you as one of the players will develop your own point of view** on what is dynamically crucial in innovative market environments. Thus, the model is at the same time a business game to improve managerial skills.

Although the entire model is quite extended and articulated along many variables, even a non-economist or a non-manager can find it understandable.

At the same time, the more you already know about competition theories and models, the more you will appreciate the differences.

1. Description of the model

1.1. The context: consumers

In this model, there exists **a potential market for a new good**. A selected group of consumers feels a specific need. As soon as [advertising](#) will make them know of the existence of the good and will convince them that the new good would fulfil their need, they will consider the opportunity of buying it.

Based on their individual decision-making rules and income, the consumers will compare the differentiated product versions offered by different firms. In the case they find no satisfactory product, they will give up and wait for further technological improvements and lower prices.

Their [consumption](#), thanks to buying acts, will thus depend on their disposable income, tastes, product and process [innovation](#).

In other words, consumers are not, as in the standard neoclassical models of demand, utility maximisers exhausting a budget but rather bounded rational decision makers:

- relying on [advertising](#) for some of key pieces of information;
- following easy, but reasonable, rules of thumb when taking decisions.

The goods fulfil the same main need, thus they are [substitutes](#).

As a player, you should not know more than that about demand, exactly as the many firms that do not carry out activities of market research. Please, however, read "Consumer decision rules for agent-based models" for in-depth presentation of the demand side of the present model.

1.2. The context: the differentiated good

The good is a **durable**: once bought, it can be used forever without any need of repurchase.

Beyond its obvious **price**, the good has two main features:

- the **performance** it guarantees with respect to the fulfilment of the specific need it addresses;
- the **easiness of use**.

In this way, we condensed several minor features in two main categories, leading to a bi-directional vertical differentiation.

In one direction, we find more and more powerful versions, as with successive waves of mobile phones.

In the other direction, the consumer evaluates how easily he can exploit the good. A quite difficult phone will be rejected by unskilled and unwilling people.

In this way, we can simulate and understand price competition in product differentiated markets.

1.3. The context: competitors

The software internally allows for many firms, each producing several versions of the good. But for simplicity's sake the basic version of the model, which is freely distributed here, explicitly considers just two firms: you and computer-guided competitor.

In this way, the software is an agent-based simulation model with a human player in a computer-generated competitive environment.

It's just a matter of checking another available option to transform the software into a **two-humans game** or a **two-computers** game. In the latter case, it becomes - in full - an agent-based economic model [1].

In the rest of this paper, we shall always assume you as the human player and one computer-guided competitor.

1.4. The context: supply, production, orders

The supply is in this model based on **direct orders** by consumers, possibly through an un-modelled distribution network, not on inventories, as it is the case of two other models of ours ("You are a monopolist" and "You are an exporter").

In this way, supply is always equal to production, which in turn is always equal to the demanded quantity. There is no quantity-based competition, as it would be the case of Cournot's oligopoly.

1.5. The context: cost structure

Costs belong to three categories:

1. **production costs**;
2. **discretionary costs**;
3. **financial costs**.

In the first category, there are both fixed costs (independent from the quantity produced) and variable costs. In particular, there are **firm-wide fixed** costs of functioning, **product-related fixed** costs, **directly proportional variable costs**.

Discretionary costs comprehend **advertising** and **R&D**. Each period their level is autonomously decided by you and your competitor depending on strategy. They may even be zero.

Financial costs are due to the **payment of interest on debt**. They depend on the debt stock and the current interest rate. **Reimbursement** reduces the debt stock but they are not costs in accountancy terms.

2. Key decisions

2.1. Price

You and your competitor freely decide the price of the respective products. Price competition and price leadership, thus, are fully feasible strategies. How much they are decisive and winning

you'll soon see by playing.

In particular, at game level 1, you'll be able only to modify price (and advertising), whereas your competitor will further carry out R&D.

For statistical purposes, the market price level could be computed as an ex-post weighted average of your prices, with weight reflecting market shares.

2.2. Product features

The performance of the good is measured on a scale from 1 (very poor) to 10 (excellent). Similarly, how easy is the product's use is measured on a scale from 1 (very difficult) to 10 (extremely easy).

The initial situation is always the following:

- you to offer a relatively low-performance good (performance mark: 2) that is quite easy to use (6);
- your competitor to offer, symmetrically, a relatively high performance good (performance mark: 6) that is quite difficult to use (2).

In the very first level of the game, you will not able to change the given level of performance and easiness of your own version of the good. In the second level, you will be free to fix them as you want (a big advantage!). In the third level, you can change them only by carrying out R&D expensive activities.

Your competitor can always change its' product features only by carrying out R&D expensive activities.

Accordingly, **a fair game is only the game level 3**. But economic life is not always fair!

2.3. Advertising

At the beginning, consumers do not know that your products even exist. Thus, advertising is necessary to start their product comparisons which, in proper conditions, lead to buying acts.

The role of advertising in real markets is much larger than that: it influences the extent the same need is felt and it orientates consumers' tastes and habits.

But, for the moment, this model considers advertising just a crucial source of trustworthy information.

2.4. Research and Development

One of the main sources of innovation is formal R&D carried out with a specific investment of resources. The goals of R&D are threefold:

1. to reduce the (variable) cost of production;
2. to improve the product performance;
3. to make the product easier to use.

You have to allocate separate funds for these three objectives.

Since the R&D activity is risky, you are "buying" just probabilities of getting the innovation you needed. More precisely, the model expresses innovation as a two-stage process. In the first stage, a random extraction determines whether the innovation has been reached (the higher the expenditure, the higher the probability). In the second stage, it is decided how deep the improvement will be [2].

With R&D activity extending over time its effects, the relevant expenditure for innovation keep into account what has been invested in the past. As an extreme case, it is possible to obtain an innovation even without any current investment, provided in the past there was enough investment.

2.5. Finance

Firms can always ask for money from some financial institutions, which, according to certain control rules, concede credit. In this way, firms are given additional funds for discretionary costs. Production costs are covered by sales, since the production is based on orders and there are no unsold inventories.

Once indebted, firms have to pay interests on debt, whose amount is a percentage (the current interest rate) of the debt amount.

To reduce these financial costs, firms may decide to pay back, partially or in full, the debt through reimbursement.

The starting capital of the firm is automatically increased by the profits earned each period or decreased by losses. There is no distribution of dividends.

3. Open questions for you

Now it's high time for you to play the business game. And to observe others playing. And to reflect on the results. This is your open space to better understand dynamic competition. We just add a few words about some issues we think might deserve your reflections.

Leaderships in market shares, technology, profits

Over time, the leaderships evolve. Is the market leader in terms of current sales the same as the technological leader, i.e. who has the best product? Who has the highest current profits, the heavy-investor in R&D or the cow-milker?

Long-term vs. short-term profitability

In mainstream models, the long run is just the sum of many identical short runs. Thus, the long-term profit-maximising strategy is often simply the replication in each period of the same static profit-maximising choice. Is this still true in the model? Or, instead, in order to supply an interesting product at reasonable price, one has to heavily invest in R&D, sacrificing current profitability for the sake of the long-run?

In another perspective, are sunk costs (R&D, advertising) really irrelevant for your subsequent decisions?

The choice of the investment direction

Discretionary costs of investment can be symmetrically or asymmetrically allocated to advertising and R&D in its three main direction (cost, easiness of use, performance). How did you decide this allocation? Is this choice changing over time? Is it linked to gap with your competitor, by increasing funds for your weakest point?

Income distribution and innovation diffusion

As an available option, you can choose a consumer income distribution with a large middle-class or a polarised society with few rich and many poor. Which changes do you meet when playing in the two situations? When is market penetration easier? When profits higher?

Is the interest rate relevant to investment in R&D and advertising?

As an available option, the interest rate of loans to businesses can be let changing. Is this relevant for your decisions about discretionary costs? Do you invest more when interest rates are lower? Or, instead, it is fundamentally the market situation to dictate your most reasonable behaviour? Which is the role of your current level of owned capital in investment decisions?

Who are the early adopters?

As you can easily experiment, in this model a product-life dynamics emerge, with many variants and reasons. Early adopters are usually, but not necessarily, followed by late adopters, until exhaustion of market potential. Which are the main driving forces of consumer decision rules in the different stages of market development? Micro-data about consumers can give you specific answers, by looking at average and median income of buyers and not-buyers, as well as their respective preferences about product features.

4. Next steps

We hope that this model answered to some of your questions and, even more, raised your interest in new strands of research in industrial economics.

In the future, we shall launch a massive experimentation of this model, with possibly a more flexible version of the software. If you liked to take part to the experiments, or simply have more information, just send us an e-mail with the subject "Dynamic competition".

NOTES

[1] The author co-operates with CESSBA - the Italian Centre for agent-based social simulation. For further information about the agent-based research lines go to the site maintained by Leigh Tesfatsion: http://www.econ.iastate.edu/tesfatsi/ace.htm

[2] For simplicity's sake, in this basic version, the second stage is fixed: an improvement of 20% in variable costs, +1 in performance, +1 in easiness. Two-stage models of innovation are common in evolutionary economics models.