Decision Making Environment in the Information Product Markets

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ABSTRACT: *Specific characteristics of digital and information good markets are investigated. The market structures are considered as an environment for decision-making on product quality and price competition . A game theory approach and a modified monopolistic competition model are used to capture the interrelation of costs/quality/price decision-making and quality/demand feedback under the specific conditions of information product markets. The suggested approach may help to understand why some traditional supplier strategies are not effective in information product markets, and explore the conditions, under which non-traditional strategies, intuitively selected by a number of producers and sellers, can be successful.*

INTRODUCTION

The emerging information economy plays an increasingly important role in modern world. Almost every business needs to watch carefully the disposition, major forces, and new developments in the battlefield called Internet and consider opportunities and challenges provided by new technologies, new products, and new markets.

New realities force us to rethink the traditional ways of conducting business. The case of Encyclopedia Britannica is striking evidence of how fast the underestimation of new technologies can turn a well established and respected traditional market into a total failure[1]. On the other hand, there is some contradictory evidence of E-business success. For example, Amazon.com has successfully established itself as an Internet brand name and has built an impressive range of services and devoted customer base. Is this a successful e-business, given that Amazon.com reports huge financial losses each year? The question asked by everybody is how to build a successful and profitable business in this emerging area? From experience accumulated to date we can say quite confidently that there is no straightforward general and universal model for success. At the same time, understanding the theory, principles and peculiarities of information markets may lead to the development of effective strategies that are specific to each firm and market.

In this article, we investigate specific characteristics of digital and information goods markets. The market structures are considered as an environment for decision-making on products and price competition. The game theory approach and a modified monopolistic competition model are used to demonstrate that the competitive strategy of a firm, producing an information product, is based on costs versus quality features dichotomy. The outcome of this study may help to understand why some traditional supplier strategies are not effective in such markets, and shed some light on the conditions under which non-traditional strategies intuitively selected by a number of software producers and sellers can be successful.

MARKETS OF INFORMATION GOODS: CONCEPTS AND STRATEGIES

Core information products possess some distinctive characteristics and properties, which take their extreme form when information products are digitised[2]. Those properties include:

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[1]. See, for example, description in Economist, February 2000

[2] See Varian and Shapiro (1998) for discussion of information products costs structure. Torlina *et al* (1999) discuss different categories of information products and implications of their conversion to digital form on value attributes.

- Multiple and heterogeneous sources of value embedded in the product itself;
- Specific cost structure - high fixed costs, near-zero variable costs and zero marginal cost. Initial fixed costs, including usually high marketing and promotion expenditure, in most cases are sunk costs, that is, they cannot be recovered if a product fails;
- Extreme economies of scale - in the general case of an information good there are no natural or economically justified limits to production of additional copies;
- No direct interconnection between costs spent on the first copy and product price. Information is priced solely according to the consumers' utility valuation and demand.

The above-mentioned properties make such markets a special case with quite different implications for market structures and the behaviour of both suppliers and buyers.

So what are the observable characteristics of real information products markets?

Such markets consist of a limited number of suppliers. Each of the suppliers enjoys a limited degree of monopoly power for its particular product variant. The competing products are close substitutes with, nevertheless, differentiated properties. The information technology used in the production, in principle, is available to everyone. Barriers to entry are low. The market shows a strong tendency towards "commodisation". The market participants therefore try to distort the market and "decommoditise" their products to secure their market niches. To compete successfully, suppliers have to periodically issue updated versions of the products with improved or new features targeting existing as well as new customers.

At the same time, wise pricing strategies are even more important then in traditional markets. Zero marginal cost makes it impossible to compete on the basis of the traditionally dominant strategy of reducing prices. Price can be anything between buyer's reserved price and zero. The volume of production, sales, initial costs recovery and profit totally depend on how well the adopted pricing strategy responds to the customers' valuation of the product. Hence, knowledge of product valuation and demand by different categories of real and potential buyers is crucial.

APPROACHES TO SUDIES IN INFORMATION GOODS MARKETS AS DECISION-MAKING ENVIRONMENTS

Different aspects of decision making in information goods markets based on both theoretical analysis and observation of practices, have been discussed in literature, such as:

- pricing mechanisms as means for fixed costs recovery;
- price discrimination as a control mechanism over products and services differentiation and availability;
- products variety and quality available under different market conditions;
- influence of product technological component on market entry and exit; and
- feedback of price sensitivity and demand on products properties, production volume and pricing strategies.

The following publications cover a wide range of information products and services, such as content-based information goods, software products, television programs, network services, etc.

A number of models (Lancaster (1975); Salop (1979); Eaton and Lipsey (1989)) investigate a composition of a size of fixed costs, consumer demand characteristics, and product variety. Waterman (1991) is concerned with welfare tradeoffs between product quality and variety under the conditions of different pricing arrangements (direct payments from consumer versus advertiser's supported products), and fixed or varying investments in the first copy. Varian (1994) describes scenarios of cost reduction in the industry due to entry of new firms possessing unique technological advantage or one easy to imitate. Several authors devoted their studies to a specific problem of valuing and pricing Internet services under the conditions of congestion or limited availability. Gupta *et al,* (1998) analyses charging schemes for the overall use of the Internet and their benefits from the service

provider and the user point of view. MacKie-Mason *et al* (1995), Clark (1996) Varian (1999) offer approaches to price controls based on technical solutions to services differentiation. An example of theoretical analysis of information economic properties combined with practical observations of how these properties translate into real-markets strategies is presented in Varian (1998) . The above-mentioned as well as some other works on the topic (e.g. Economides (1989), Cabral *et al* (1999)) have influenced the ideas presented in this paper.

At the same time, our approach is different from previous works in a number of ways.

- We assume that multiple sources of value embedded in the product, including both tangible and intangible components should be reflected in the product quality and price determination. However, we consider the simplest case where all the quality characteristics of each of the products can be aggregated into the scalar quality indicator.
- Traditionally it is assumed that the cost functions are identical across firms (Varian 1994). In our opinion, this approach is not applicable to information goods and markets. As it was shown earlier, such products are indifferent to scale of production, and theoretically, the average cost function does not have a minimum. That is why we assume that the firms are characterized by different cost functions and that changes in product quality features are uniquely associated with firms' cost levels.
- A model offered in the following section is essentially constructed upon the assumptions listed above and information markets properties described in the earlier sections. The purpose of the model is to capture the interrelation of costs/quality/price decisions and quality/demand feedback under the specific conditions of information products markets.

A MODEL OF THE INFORMATION PRODUCT MARKET

Consider a market for an information technology product that satisfies the conventional properties of monopolistic competition (H.L. Varian, 1984; G. A. Jehle, 1991). The market consists of $\mathbf{n}$ mono-product firms. The products $\mathbf{i} \in [1, \mathbf{n}]$ are viewed by the buyers as close, though not perfect, substitutes for one another. Therefore, each of the sellers can be considered as the monopolist of its particular product variant with a limited degree of monopoly power.

Meanwhile, let us reconsider another conventional assumption, that is perfect availability of the technology used in the production of all product variants. We see information technology as perfectly available to everyone wishing to enter the market as well as to the existing market participants. However, each portion of cutting-edge technological information does not spill over immediately. Its availability, for the time being, may be restricted by commercial secret protection, patenting or licensing. Therefore, within each particular short-run period, each of the firms possesses some unique product-attributable elements of otherwise common technology. These unique elements of use of the technology are what make the product variants different. The differences are viewed by the buyers as differences in several quality characteristics. We assume, however, the simplest case where all the quality characteristics of each of the products **i** can be aggregated into the scalar quality characteristic $\mathbf{q_i}$. We also assume that, in the short run, the quality variable $\mathbf{q_i}$ depends upon the cost of the production of the original copy of product $\mathbf{C_i}$:

$$\mathbf{q_i} = \mathbf{q_i}(\mathbf{C_i})\ ^{3}. \tag{1}$$

where

$$\frac{\mathbf{dq_i}(\mathbf{C_i})}{\mathbf{dC_i}} > 0; \quad \mathbf{C_i} \in \boldsymbol{C}_{\mathrm{i}} \subset \mathbf{R}^{+} \tag{2}$$

(2) means increase in the value of the quality variable as the result of increase in costs within a particular range of costs $\boldsymbol{C}_{\mathrm{i}}$ for a particular firm **i.** However, it does not say anything about

[3]Here and below, differentiability of functions within continuous intervals of independent variables is assumed by default, if is not stated otherwise.

comparison between the values of quality variables of two firms. They depend upon the differences between the cost functions of different firms. In other words, a greater costs of firm **i** compared to firm **j** generally can lead to a lower value of the quality variable of firm **i,** as it is viewed by buyers. In the long run, the quality can be also improved using technological innovations, which are not directly associated with the cost $\mathbf{C_i}$.

The key assumption about the IT product is that the costs $\mathbf{C_i}$ associated with the first copy of the product is the actual total cost of production of the first and any further number of copies:

$$\mathbf{C_i} = \mathbf{C_i}(\mathbf{y_i}) = \mathbf{const} \tag{3}$$

or, in other words, marginal cost is equal to zero.

The demand $\mathbf{y_i}$ for product **i** is measured in the quantity of copies. The same buyer does not simultaneously purchase two analogous products from two different competitive sellers. Therefore, it is possible to measure total demand for all the variants of the product (**y**) by adding together the number of copies sold by each of the firms:

$$\mathbf{y} = \sum_{\mathbf{i}=1}^{\mathbf{n}} \mathbf{y_i} . \tag{4}$$

We assume that demand conventionally negatively depends upon the price $\mathbf{p_i}$ as well as upon the demand for the competitive products $\mathbf{y_{-i}} = \{\mathbf{y_j} \mid \mathbf{j} \in [1, \mathbf{n}]; \mathbf{j} \neq \mathbf{i}\}$. Based on (4) it can be measured as

$$\mathbf{y_{-i}} = \mathbf{y} - \mathbf{y_i} . \tag{5}$$

It also positively depends upon the quality variable $\mathbf{q_i}$. Therefore, the demand for product **i,** as viewed by a seller **i,** can be represented as a function:

$$\mathbf{y_i} = \mathbf{y_i}(\mathbf{p_i}, \mathbf{y_{-i}}, \mathbf{q_i}(\mathbf{C_i})); \tag{6}$$

or its inverse

$$\mathbf{p_i} = \mathbf{p_i}(\mathbf{y_i}, \mathbf{y_{-i}}, \mathbf{q_i}(\mathbf{C_i})) . \tag{7}$$

Even though, non-conventional demand functions, are assumed, we are using the model of such a market as a non-coalition game with profit as pay functions. In other words, each of the firms maximises its profit:

$$\Pi_\mathbf{i} = \mathbf{y_i}\mathbf{p_i}(\mathbf{y_i}, \mathbf{y_{-i}}, \mathbf{q_i}(\mathbf{C_i})) - \mathbf{C_i} \rightarrow \max , \tag{8}$$

or, using (5):

$$\Pi_\mathbf{i} = \mathbf{y_i}\mathbf{p_i}(\mathbf{y_i}, \mathbf{y} - \mathbf{y_i}, \mathbf{q_i}(\mathbf{C_i})) - \mathbf{C_i} \rightarrow \max . \tag{9}$$

We are also adopting the standard behavioral hypothesis. Firm **i** makes its product/expenditure/price decision assuming the other firms' behavior will be constant.

The first order equilibrium conditions for (9) appear to be more sophisticated than for the standard model:

$$\mathbf{y_{i,}}\left(\frac{\partial \mathbf{p_i}(\mathbf{y_{i,}}\mathbf{y_{-i}}, \mathbf{q_i}(\mathbf{C_i}))}{\partial \mathbf{y_{i,}}} + \frac{\partial \mathbf{p_i}(\mathbf{y_{i,}}\mathbf{y_{-i}}, \mathbf{q_i}(\mathbf{C_i}))}{\partial \mathbf{y_{-i,}}} \frac{\partial \mathbf{y_{-i}}}{\partial \mathbf{y_{i,}}} \right) + \mathbf{p_i}(\mathbf{y_{i,}}\mathbf{y}, \mathbf{q_i}(\mathbf{C_i})) = 0 ; \tag{10}$$

$$\mathbf{y}_{\mathbf{i},}\left(\frac{\partial \mathbf{p}_{\mathbf{i}}(\mathbf{y}_{\mathbf{i},}\mathbf{y}_{-\mathbf{i}},\mathbf{q}_{\mathbf{i}}(\mathbf{C}_{\mathbf{i}}))}{\partial \mathbf{y}_{-\mathbf{i},}}\right)=0; \tag{11}$$

and

$$\frac{\partial \mathbf{p}_{\mathbf{i}}(\mathbf{y}_{\mathbf{i},}\mathbf{y},\mathbf{q}_{\mathbf{i}}(\mathbf{C}_{\mathbf{i}}))}{\partial \mathbf{C}_{\mathbf{i}}}\mathbf{y}_{\mathbf{i}}-1=0 \tag{12}$$

Combining (10) and (11) gives:

$$\mathbf{y}_{\mathbf{i},}\frac{\partial \mathbf{p}_{\mathbf{i}}(\mathbf{y}_{\mathbf{i},}\mathbf{y}_{-\mathbf{i}},\mathbf{q}_{\mathbf{i}}(\mathbf{C}_{\mathbf{i}}))}{\partial \mathbf{y}_{\mathbf{i},}}+\mathbf{p}_{\mathbf{i}}(\mathbf{y}_{\mathbf{i},}\mathbf{y},\mathbf{q}_{\mathbf{i}}(\mathbf{C}_{\mathbf{i}}))=0 \tag{13}$$

The interpretation of the equilibrium conditions is rather difficult in the general case (12) - (13). However, a meaningful interpretation can be obtained at the assumption of the separability of the demand functions in the Cobb-Douglas form and substituting $\mathbf{y}_{-\mathbf{i}}$ from (5):

$$\mathbf{y}_{\mathbf{i},}=\mathbf{a}\mathbf{C}_{\mathbf{i}}{}^{\alpha_{\mathbf{i}}}\mathbf{p}_{\mathbf{i}}{}^{\beta_{\mathbf{i}}}(\mathbf{y}-\mathbf{y}_{\mathbf{i}})^{\gamma_{\mathbf{i}}}, \tag{14}$$

where $\alpha_{\mathbf{i}}>0$ is *the cost elasticity of demand*. It is positive because it contributes to the quality of the product, and the quality is positively related to demand. $\beta_{\mathbf{i}}<0$ is the conventional negative price elasticity of demand. $\gamma_{\mathbf{i}}<0$ is the elasticity of demand for product **i** with respect to the demand for the competitive variants of the product. It is negative because, in the short run, within a given capacity of the market, the demand for product **i** decreases, with increase in demand for competitive products.

Te inverse form of (14) is:

$$\mathbf{p}_{\mathbf{i}}=\mathbf{p}_{\mathbf{i}}(\mathbf{y}_{\mathbf{i}},\mathbf{y}_{-\mathbf{i}},\mathbf{q}_{\mathbf{i}}(\mathbf{C}_{\mathbf{i}}))=\frac{1}{\mathbf{a}}\mathbf{C}_{\mathbf{i}}{}^{\frac{\alpha_{\mathbf{i}}}{\beta_{\mathbf{i}}}}\mathbf{y}_{\mathbf{i},}{}^{\frac{1}{\beta_{\mathbf{i}}}}(\mathbf{y}-\mathbf{y}_{\mathbf{i}})^{-\frac{\gamma_{\mathbf{i}}}{\beta_{\mathbf{i}}}}. \tag{15}$$

Substituting (15) into (12) and (13) after some transformations gives the following equilibrium conditions:

$$\mathbf{p}_{\mathbf{i}}\mathbf{y}_{\mathbf{i}}=-\frac{\beta_{\mathbf{i}}}{\alpha_{\mathbf{i}}}\mathbf{C}_{\mathbf{i}} \tag{16}$$

and

$$\frac{1}{\beta_{\mathbf{i}}}\frac{1}{\mathbf{y}_{\mathbf{i}}}+\frac{\gamma_{\mathbf{i}}}{\beta_{\mathbf{i}}}\frac{1}{\mathbf{y}-\mathbf{y}_{\mathbf{i}}}+1=0 \tag{17}$$

Equation (17) means that the distribution of demand among the competitive firms does not depend upon the absolute level of prices. It is determined, however by relative values of the parameters of elasticity.

Meanwhile, (16) is the key condition for the understanding of the IT firm's **i** situation in the market. It means that the firm earns a positive profit only if

$$-\frac{\beta_{\mathbf{i}}}{\alpha_{\mathbf{i}}}>0 \quad \text{or} \quad -\beta_{\mathbf{i}}>\alpha_{\mathbf{i}} \tag{18}$$

Combining (18) with the interpretation of the elasticity parameters in (14) gives the following theoretical outcomes with regard to the ability of the firm producing an information product in making a positive economic profit:

- At zero marginal costs, firm **i** absorbs the equilibrium distribution of demand ($\mathbf{y_i}$ following from (17));
- At this value of demand, the equilibrium price ($\mathbf{p_i}$) and cost level ($\mathbf{C_i}$) are established;
- To ensure economic profit, relative increase in demand, associated with increase in quality per unit of relative increase in cost should not offset by relative decrease in demand per unit of relative increase in price; and
- The case, when the inequality (18) is not held, means that the firm's technology is not capable in delivering a competitive level of quality per unit of its costs.

CONCLUSION

The paper gives some insight in the competitive mechanisms of information product markets. In particular, factor quality is included as a variable in the model of monopolistic competition. This enables useful theoretical analysis of competitive strategies with possible outcomes for practice. An essential condition of IT firm survival and competitiveness is its ability to contribute to quality of its product with less than proportional increase in cost components that may affect the product's price. Of course, we should bare in mind that, in reality, other factors may also play important role.

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