

**MARKET STRUCTURES AND COMPETITION
IN THE DIGITAL ECONOMY**

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ABSTRACT

The purpose of this paper is to investigate the distinctive characteristics of the competitive mechanism in the digital economy and information product markets. Specific properties of digital goods and information markets are considered. A theoretical model, based on the game theory and modified assumptions of monopolistic competition, is introduced. The suggested approach enables a theoretical analysis of competitive strategies with possible outcomes for practice. The paper discusses essential conditions for IT firm survival; the interrelation of producer costs/quality/price decisions and customer quality/demand feedback; and a rational for entering and exit the market by new and existing competitors.

1. INTRODUCTION

Digital economy is becoming increasingly important in our lives. This fast growing phenomenon raises many questions and requires researches and practitioners to take a closer look at new realities. Both theory and practice should be reconsidered for gaining a better understanding of current changes in the economy and the society. Almost every business, today, needs to carefully consider opportunities and challenges provided by new Internet technologies, new products, and new markets. The case of Encyclopaedia Britannica is a striking evidence that prospects offered by new technologies should not be overlooked or delayed¹. At the same time, there is some contradictory evidence of e-business success. Extremely optimistic forecasts promising huge benefits to everyone interlace with pessimistic ones, persuading readers

¹ E-commerce Survey, *The Economist*, February-March, 2000

that “the king is naked” and, in fact, will soon be dead². What makes a successful Internet business - a popular brand name; effective customer services; or profitability? In traditional economy sectors, all three categories of success used to be in place with profitability going first. Today we see examples of Internet businesses perceived as successful, but making consistent losses over the years, e.g. Amazon.com. The question asked by everybody is how to build a successful and profitable business in this emerging area?

E-business is about utilising Internet as business channel or trading digital products. Hence, an information component of product or service always have to be taken into account. In such a case, product valuation is more complicated and, as it is demonstrated in this paper, essentially depends on the market valuation and specific characteristics of information products. Therefore, understanding the theory, principles and peculiarities of digital goods and information markets is necessary for the development of effective strategies specific to each firm and market.

In this paper, we investigate specific characteristics of digital and information good markets. The market structures are considered as an environment for decision-making on products and price competition. These markets are interesting as a special case with quite different implications on market behaviour. 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. We consider the neoclassical properties of monopolistic competition as the necessary but not sufficient theoretical framework for understanding the peculiarities of IT product markets. We introduce some additional assumptions. In particular, we consider the quality characteristics of IT products as endogenous variables. Therefore, our model is based on both the neoclassical and the additional assumptions.

The logical framework we have developed for this study is presented in Figure 1.

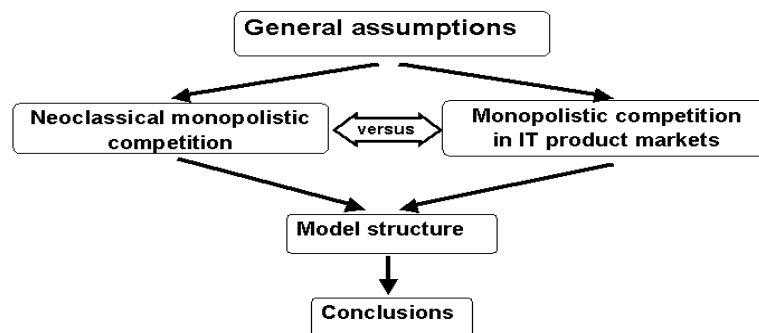


Figure 1: The logical framework of the study

Not surprisingly, the conclusions differ from those reflecting general monopolistic competitive behaviour and help to understand why some traditional supplier strategies are not effective in IT market. The study sheds some light on the conditions under which non-traditional strategies intuitively selected by a number of software producers and sellers can be successful.

The proposed model allows explaining, from theoretical perspective, some observable characteristics of real life information good markets, which are difficult to explain within traditional approach. For example,

Why information product markets tend to be dominated by one or two companies while the rest have a disproportionately low market share?

² See, for example, A.Kaletsky, "E-Commerce is Dead", *Australian*, February 7, 2000.

Why some software companies grow much faster than the others, despite the fact that their products are comparable in quality and are close substitutes?

2. INFORMATION GOODS AND MARKETS: CONCEPTS AND STRATEGIES

Core information products possess some distinctive characteristics and properties, which take their extreme form when information products are digitised³. Those properties include:

- Multiple and heterogeneous sources of value embedded in the product itself;
- Contrary to traditional products, application of digital product is defined at the point of use, not at the point of production;
- 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 first copy production and product price.
- Consumers valuation and demand are key price determinants .

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 "commoditisation". 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 than 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.

3. DECISION-MAKING IN INFORMATION GOOD MARKETS – AN OVERVIEW

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;

³ 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. Whinston *et al* (1996), Wigand *et al* (1998), Willcocks *et al* (1997) discuss essential properties of information and digital goods.

- Products variety and quality available under different market conditions; and
- Influence of product technological component on market entry and exit.

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.

Varian (1998) describes different forms of versioning information products available due to flexibility of digital media. 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) analyses 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 and conditions based on technology availability when market entry by new participants is socially desirable, but privately unprofitable, and vice versa. 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) offers 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).

In this paper, we discuss feedback of price sensitivity and demand on product properties, production volume and pricing strategies. The above-mentioned as well as 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.

- i. 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.
- ii. 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. Hence, 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.
- iii. 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.

4. A MODEL OF THE INFORMATION PRODUCT MARKET

4.1 General Assumptions

The model is based on the common economic theory understanding of market behaviour:

The company's objective is profit maximisation. The willingness of the company to supply is elastic and increases with increase in price.

The consumer's objective is utility maximisation. The consumer demand is elastic and decreases with the increase in price.

In addition, we assume that multiple sources of value embedded in the product, including both tangible and intangible components, are reflected in the product quality; and that product quality affects market price determination through demand and supply equilibration.

4.2 Neoclassical Monopolistic Competition and Competition in IT Product Markets

The model incorporates the generic assumptions characterising the monopolistic competition.

We consider a market for an information technology product that satisfies the conventional properties of monopolistic competition (See for, example, H.L. Varian, 1984; G. A. Jehle, 1991).

- The market consists of n mono-product firms.
- The products $i \in [1, n]$ 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.
- Such a monopolist is enjoying a monopoly power and making economic profit during only a short period of time from the introduction of a unique product or technology until such a technology becomes available to rivals, or until a new “more innovative” product is introduced by a rival.

The following specific features of the monopolistic competition in the IT sector discussed in previous sections are incorporated in the model:

- Traditionally it is assumed that the cost functions are identical across firms. We assume that the firms are characterised by different cost functions.
- In general case marginal cost is non-zero. For information market zero marginal cost assumption is essential.
- In general, technology is perfectly available to existing and new market participants. We assume that cutting-edge technology does not spill over immediately. For the time being, each firm possesses some unique product-attributable elements of otherwise common technology.
- These unique elements make the product variants different.
- The differences are viewed by the buyers as differences in quality characteristics. We consider the simplest case when all the quality characteristics of each product can be aggregated into a *scalar quality characteristic*.
- Increase in quality generates increase in consumer demand.
- Increase in quality can be achieved by a firm only through increase in the cost of the first copy.
- Each firm is characterised by its cost elasticity of quality.

Figure 2 illustrates the key differences between the assumptions of monopolistic competition and the IT-industry-specific assumptions.

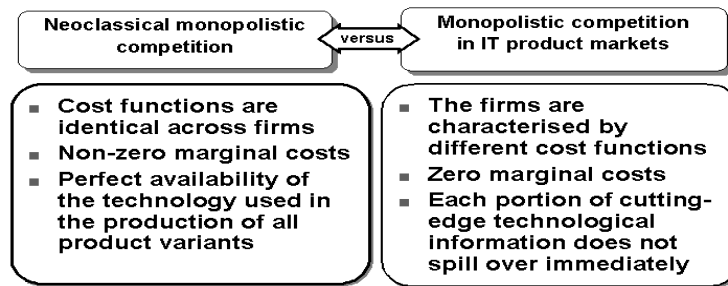


Figure 2: Monopolistic competition: neoclassical versus IT product markets

4.3 The Scope of the Model

The model describes the competitive behaviour of the IT firm in the information product market.

Aiming initially at covering first copy costs and then at earning profit, IT firm struggles for consumer demand and invests in the competitive quality of its product.

Increase in quality can be attained only at additional costs. The firms are characterised by generally different cost functions. Therefore, the incremental cost of increase in quality differs from one firm to another.

Each of the firms sets the price to cover the costs and to earn profit, depending on anticipated demand. Different incremental costs allow them different degrees of freedom in setting a minimum price, which covers the firm's costs and returns a normal profit.

On the demand side, increase in quality causes increase in demand. Increase in price causes decrease in quantity demanded. The total change in demand for a product of a particular firm can be negative or positive and varies from one firm to another. The firms' cost-quality decisions affect their relative competitive positions.

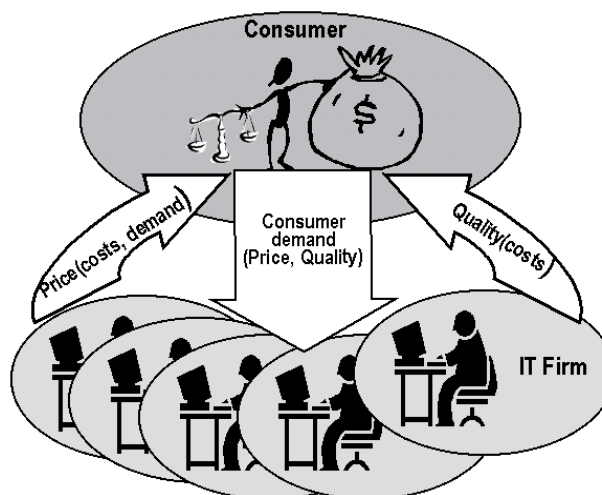


Figure 3: Model structure

To ensure economic profit, relative increase in demand, associated with increase in quality per unit of relative increase in cost should not be offset by relative decrease in demand per unit of relative increase in price. Otherwise, the firm is not competitive.

4.4 The Structure of the Model and Analytical Results.

As it was mentioned earlier, we assume the case where all the quality characteristics of each of the products i can be aggregated into the scalar quality characteristic q_i . We also assume that, in the short run, the quality variable q_i depends upon the cost of the production of the original copy of product C_i :

$$q_i = q_i(C_i)^4. \tag{1}$$

where

$$\frac{dq_i(C_i)}{dC_i} > 0; C_i \in \mathbf{C}_i \subset \mathbf{R}^+ \tag{2}$$

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

The key assumption about the IT product is that the costs 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:

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

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

The demand y_i for product i is measured in the quantity of copies. We assume that 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 (\mathbf{y}) by adding together the number of copies sold by each of the firms:

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

We assume that demand conventionally negatively depends upon the price p_i as well as upon the demand

for the competitive products $y_{-i} = \sum_{j \in [1, n]; j \neq i} y_j$. Based on (4) it can be measured as

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

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

⁴Here and below, differentiability of functions within continuous intervals of independent variables is assumed by default.

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

or its inverse

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

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:

$$\Pi_i = y_i p_i(y_i, y_{-i}, q_i(C_i)) - C_i \rightarrow \max, \quad (8)$$

or, using (5):

$$\Pi_i = y_i p_i(y_i, y - y_i, q_i(C_i)) - C_i \rightarrow \max. \quad (9)$$

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

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

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

$$y_i \left(\frac{\partial p_i(y_i, y_{-i}, q_i(C_i))}{\partial y_{-i}} \right) = 0; \quad (11)$$

and

$$\frac{\partial p_i(y_i, y, q_i(C_i))}{\partial C_i} y_i - 1 = 0 \quad (12)$$

Combining (10) and (11) gives:

$$y_i \frac{\partial p_i(y_i, y_{-i}, q_i(C_i))}{\partial y_i} + p_i(y_i, y, q_i(C_i)) = 0 \quad (13)$$

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 y_{-i} from (5):

$$y_i = a C_i^{\alpha_i} p_i^{\beta_i} (y - y_i)^{\gamma_i}, \quad (14)$$

where $\alpha_i > 0$ 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. $\beta_i < 0$ Is the conventional negative price elasticity of demand. $\gamma_i < 0$ 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.

The inverse form of (14) is:

$$p_i = p_i(y_i, y_{-i}, q_i(C_i)) = \frac{1}{a} C_i^{-\frac{\alpha_i}{\beta_i}} y_i^{-\frac{1}{\beta_i}} (y - y_i)^{\frac{\gamma_i}{\beta_i}}. \quad (15)$$

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

$$p_i y_i = -\frac{\beta_i}{\alpha_i} C_i \tag{16}$$

and

$$\frac{1}{\beta_i} \frac{1}{y_i} + \frac{\gamma_i}{\beta_i} \frac{1}{y - y_i} + 1 = 0 \tag{17}$$

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

$$-\frac{\beta_i}{\alpha_i} > 1 \quad \text{or} \quad -\beta_i > \alpha_i \tag{18}$$

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 (y_i) following from (17));

At this value of demand, the equilibrium price (p_i) and cost level (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 be 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 of delivering a competitive level of quality per unit of its costs.

6. CONCLUSION

The paper gives some insight into the competitive mechanisms of information product markets. The traditional theoretical approach to monopolistic competition has been modified to include specific characteristics of information products and markets. In particular, factor quality is included, as an endogenous variable. This enables a theoretical analysis of competitive strategies with possible outcomes for practice. In the traditional monopolistic competition a partial monopoly power is achieved by releasing an innovative product. The monopoly power ends with rivals gaining access to the new technology and taking over some of the leader's market share. Meanwhile, the rivals' cost functions are not distinguished. In contrary, the essential feature of the IT market, considered in this paper, is different firms' cost functions. This allows to conclude that an essential condition of a firm's survival and competitiveness depends on its ability to contribute to the quality of its product with less than proportional increase in cost components that may affect the product's minimum price.

Of course, we realize some limitations of this study. We bear in mind that, in reality, other factors may also play important role. For example, we have not considered the effects of switching costs or network effects in this scenario. The proposed model includes the factor quality only as an aggregated scalar characteristic. This model does not include long run effects of technological innovation. We have not considered the scenario when the same buyers simultaneously purchase analogous competitive products. This and other factors are left for our further studies.

Another possible development is to consider the competitive positions of the firms that already occupy their shares of the market of a particular product. They are releasing new versions of their products, and plan their

production and marketing strategies targeting both existing and new customers. The approach suggested in this paper has a potential to explain some conditions of inevitable monopolization of IT product markets.

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