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# Analysis of Duopoly Model Patent-Standard In Terms Diffusion of Innovations

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**Summary:** Efficiency of two channels of diffusion of innovations: the patent or the standard is considered in the article. It is supposed that market size for the patent and the standard for a certain product is fixed and divided between the patent and the standard. As criterion of efficiency the share of users of the channel of diffusion of innovations is chosen. Conditions under which the standard is more effective than the patent were determined.

**Key words:** Standard, patent, diffusion of innovation, duopoly model.

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## 1. INTRODUCTION

At present time it is recognized that the innovative behavior model of business becomes dominating [1]. It predetermines relevance of researches of the factors influencing competitiveness of innovative systems. One of such factors are distribution channels of innovations as which we will understand the set of organizational technical solutions fixed by means of the relations between the holder of knowledge and potential users for their transfer in the codified and (or) not codified format [2].

The main distribution channels of industrial innovations are licenses (patents) and standards [3]. Within the investigation of innovative process naturally there is a question: is it possible to treat standardization as the effective channel of diffusion of innovations in comparison with patenting. Concerning the last such question doesn't rise as for the companies the patent is the excellent tool for business for the purpose of receipt of exclusive rights on a new product or a method, gains of a strong market position and an additional profit as a result of licensed activity [4].

The quantitative analysis of channels' efficiency from the view point of their impact on macroeconomic indicators (GDP), was conducted in a number of research works [3, 5-7]. The comparison of elasticity coefficients in relation to standards and patents specifying the degree of impact of the sets of Standards/Patents on GDP, does not enable to make a firm conclusion about the efficiency of a given channel (Table 1).

*Table 1. Elasticity Coefficients in Relation to Standards and Patents*

Elasticity coefficients	Russia 1998–2012	Germany 1960–2005	France 1950–2007
Elasticity as per standards	0,41	0,18	0,12
Elasticity as per patents	0,03	0,34	0,37

As viewed from data analysis in Table 1, the importance of patents for Germany and France is of more value if compared with standards, and for Russia it is reverse. Making comparison of innovations' distribution channels it is important to note the behavior of market operators, dealing with innovations launch. Let us consider the behavioral model of the market participants from this view point.

## **2. TASK ASSIGNMENT OF INVESTIGATION**

Suppose it is known that the distribution of a specific innovative product may be handled by the patenting procedures and further license sale or through the development of a national standard for it. In other words, the market participant has a choice: obtain a license for this innovative product or a standard. However, it is being supposed that a purchaser makes use of a patent or a standard. If forgo from this assumption, then, as it will be stated below, the efficiency of a standard in capacity of innovation diffusion channel becomes evident.

Let us see, if a standard may be competitive in relation to a patent?

Patent holder aims at maximizing his profit establishing a license cost unlike with a situation when the information about the product is coded in a standard which value and dissemination process are incomparably less than a license price.

The aim of the present analysis is to compare, under these conditions, the efficiency of each innovation dissemination channel on the assumption of the "market capture" potential. In fact this task assignment reminds of the task for the model of complementary suppliers - monopolists within the duopoly model framework [8,9].

Let us assume that the license purchaser:

- a) initially aimed for license purchase, and it is a high price only that may force him to purchase a standard instead of a patent. Herewith, it is supposed that the product considered is available in both the patent and the corresponding standard;
- b) the patent owner tends to maximize his profit, establishing a patent (license) disposition price;
- c) it is assumed, that each purchaser uses either patent or standard;
- d) the license price is much higher than the price of a standard.

The last assumption *d)* calls for an appropriate argument. To this end it could be possible to compare the average price of an ordinary license and the average price of a standard (for example, international or national) for the analyzed products. The problem is, that the information in regard for license prices is a commercial secret, and that is why the comparison of license/standard values may be conducted only for particular cases.

It should be noted that the information is open only in regard for license cost expressed in nominal units such as fixed rates (royalty) as a percentage of licensed products net realizable value, its prime cost, gross profit or on a per production unit basis.

Let us view two examples. In 1995 the company Interline Resources Corp. signed a licensing agreement with Gadgil Western Corp on its contaminated oil refining technology for Bahrain and Singapore [10]. Gadgil Western agreed to pay Interline an initial installment (lumpsum payment) in the amount of US\$ 1M and make further royalty payments in the amount of 2c per refined gallon. At that, a throughput performance equaled to 82M of gallons per year (Bahrain) and 165M gallons per year (Singapore). Thus, the license price equaled to US\$ 5,94M in 1995 prices or US\$ 9,35M in 2015 prices [11].

At the same time, according to ISO data ([www.iso.org](http://www.iso.org)) one international standard in oil refining segment varies from 58 CHF to 198 CHF (Table 2) or from 59-202 US\$.

*Table 2. Selective Data on Oil Refining International Standard Prices*

ISO standard	Standard price, CHF
ISO 10426-1:2009	158
ISO 10426-2:2003	198
ISO 13879:1999	58
ISO 16165:2013	138
ISO 16446:2013	38
ISO 21070:2011	88
ISO 21072:2009	88

Thus, the license cost is 46 thousand times higher than a standard price<sup>1</sup>.

The second example refers to the Russian Federation. In accord with CJSC KORMAKO information, the price of an ordinary license (in lumpsum form, i.e. single payment) as for corrosion rate monitoring service [12] ranges from 400K RUB to 1,750M RUB. Therewith, the national standard price (inter-state) in the area of anti-corrosion protection ranges from 770 RUB to 1084 RUB (Table 3).

*Table 3. Selective Data on Corrosion Control Inter-State Standard [13]*

GOST number	Standard price, RUB.
GOST 9.302	1084
GOST 9.304	701
GOST 9.308	893
GOST 9.311	701
GOST 9.409	893
GOST 9.502	1020

Hence, for the case at issue, the average license cost is 1440 times higher than the standard cost. Thus, it is believed that, in fact the license cost is much higher than a standard price.

<sup>1</sup> As an example only because corresponded standard is absent.

### 3. DUOPOLY MODEL

Let's introduce the following notations:

$C$  – license cost;

$Q$  – market capacity;

$x_1(C)$  – number of license purchasers with  $C$  cost;

$x_2(C)$  – number of standards users with license  $C$  cost;

$d$  – fixed costs connected with a patent support;

$b, k, L$  – coefficients,  $b > 0, k \geq 1, L > 0$ .

Let us consider that the market is divided between patent and standard purchasers. Moreover, assume that the demand function on the patent is linear with respect to  $C$  :

$$x_1(C) = Q - b \cdot C \quad (1)$$

Then the market for a standard of the product at issue is equal to:

$$x_2(C) = Q - x_1(C) = b \cdot C \quad (2)$$

Under these conditions the profit  $P$  of a patent owner is regulated by a license price:

$$P = C \cdot x_1(C) - d = C(Q - b \cdot C) - d \quad (3)$$

It is easy to see that function (3) with respect to  $C$  reaches the maximum with  $C_m$  :

$$C_m = Q/2b$$

Herewith, the maximum profit of a patent owner is equal to

$$P_m = P(C_m) = Q^2/4b - d$$

Hence, with patent cost  $C_m = Q/2b$ , the demand will be

$$x_1(C) = Q - b \cdot C = Q/2 \quad (4)$$

In other words, the patent owner, even with the optimal policy of licenses sale (within this model frames), will not be able to capture more than a half of the potential market. It is evident that the market will be equally divided between a patent and a standard.

In a general case the elasticity of demand at value is not viewed as a linear function, as exemplified from the results of (Zelenyak, 2013). For this reason let's consider a more complicated situation, when the dependency of patent demand at value is described by a non-linear function:

$$x_1(C) = \frac{b}{(C^k)} + L \quad (5)$$

At that the condition is fulfilled: with  $C = 0, \frac{b}{\square} + L = Q$

Function (5) appears to be universal enough, specifying a general case of the patent demand dependency on the value. On Figure 1 there is a family of functions (5) for case  $Q = 1000$ ,  $b = 0,1$ .

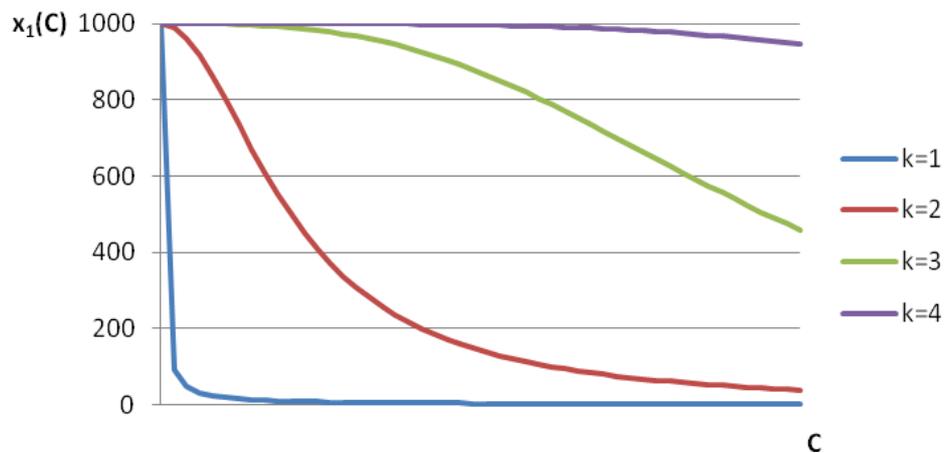


Figure 1. Family of Curves (5) for Case  $Q = 1000$ ,  $b = 0,1$ .

It is evident from (5), where it follows that the profit of a patent owner with the license  $C$  cost will make:

$$P = C \cdot x_1(C) - d = C \cdot \frac{b}{(C^k)} + L. \quad (6)$$

After simple computations it follows that the maximum profit of a patent owner is provided in case of cost:

$$C_m = \left( \frac{L}{(k-1)} \right)^{\frac{1}{k}}. \quad (7)$$

In this case the demand for patent will make

$$x_1(C_m) = \frac{(k-1)b}{Lk}. \quad (8)$$

Then the market of a standard will be equal to

$$x_2(C_m) = Q - \frac{(k-1)b}{Lk} = \frac{b}{L} - \frac{(k-1)b}{Lk} = \frac{b}{Lk}. \quad (9)$$

In a specific case when  $k = 2$ , the market will be divided in halves between a patent and a standard and this is checked by a simple plugging of  $k = 2$  into equations (8) and (9).

In cases when  $k > 2$ , the market will be reshaped in the favor of a patent (demand for license has no elasticity as for price), as in this situation the inequation:

$$x_1(C_m) > x_2(C_m) \text{ is correct.}$$

In cases  $1 < k < 2$  the market will be redeployed in favor of a standard (demand for license is elastic at value), as:

$$x_1(Cm) < x_2(Cm).$$

Separate consideration is attributed to case  $k = 1$  as expressed by (5). It is easy to see that the optimal price for the patent owner in this situation does not exist. It is evident that with cost  $C = L$ , the market will be equally divided between a patent and a standard, as it follows from the chain of equalities:

$$x_1(C) = \frac{b}{(C^k) + L} = \frac{b}{C + L} = \frac{b}{2L} = \frac{Q}{2}.$$

In case if a patent cost  $C < L$ , then the inequation is correct:

$$x_1(C) > \frac{Q}{2} \tag{10}$$

In case the patent cost  $C > L$ , then the inequation is correct:

$$x_1(C) < \frac{Q}{2} \tag{11}$$

Inequations (10) and (11) correspondingly mean, that with a patent price lower of a critical value  $L$ , it can “capture” over half of a potential market, and with a patent price greater of a critical value  $L$ , it comes the turn of a standard to “capture” over half of a potential market.

Abandoning the assumption *c*) with provision for correctness of condition *d*) leads to the conclusion that the standards is a far more efficient channel of innovations’ disseminations (within the frames of this model), since its price is relatively low if compared with a license. That is why a party concerned practically always, together with a license, can obtain a standard (if available).

#### 4. CONCLUSION

In fact, for the first time, patent/standard duopoly model is developed (in respect of a hypothetical innovative product), which demonstrates the standard’s efficiency being a channel of disseminating new developments as more competitive if compared with a patent.

This conclusion fully corresponds to the results of research (Miotti, 2009) where, among others, the inquiry data of 1790 French companies are presented. It is noted that “in economically developed countries, such as France, where technological improvements are considered as main reasons for growth, the standardization process directly contributes to the widening of technological horizons, thus bringing benefits to the majority of people. Similar to patents, voluntary standards are viewed as one way to accumulate knowledge... and moreover, motivate for the knowledge dissemination”.

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