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OPTIMIZATION OF PORT TARIFFS

Natalia GLAVATSKA[1]
[1]Student, Odessa National Maritime University, Faculty of Economics and Management

***Abstract**: Port tariffs are one of the main factors that determine freight traffic and financial condition of ports under market environment. This article describes the relationship between harbour profits and the tariff in different values of costs of works, the type of relationship between harbour profits and the tariff in different values of client tariffs (including actual costs of harbour works) and relationship between tariffs and transshipment time of 1 tonne. The article discusses the search an optimal tariff, from the standpoint of the logistics system, that is optimal for the port.*
***Keywords**: port; port tarrifs; profit; prime price; competitors; transshipment time*

One of the main factors that determine freight traffic and financial condition of ports under market environment, are harbor tariffs. "According to statistical data, an error of the price size for freight services causes only 1 per cent of gross losses, and under severe competition these losses may vary from 2 to 3 per cent"[1].

In accordance [2] with polling of 53 respondents, cost of harbour services ranks the last twelfth position among factors of competitiveness between Ukrainian ports. Such results testify that respondents have ignored tariffs as they are the same everywhere. Have tariffs been varied, for example, several times, and then this factor would have played an important role in respondents' consciousness.

Let's resume from ranking to harbour tariffs and it should be pointed out that cost methods have been proved in respect of tariff policy in transport[3] according to which such a tariff contains costs and profits, and these profits shall be proportional these costs, including a normative profit ratio. This approach has its own weak point: if profits are accrued pro rata costs, then the trend of its increase, including a normative profit ratio, depends on the increase of these costs. Indeed, costs must be deducted from the tariff which is set according to the demand, so for the growth of profits, the decrease of costs is to be based on such a principle.

Let's pay attention [4] to determining a relationship between freight operation costs and cargo transshipment at ports. But this relationship is steadily decreasing.

Interpretation to these one-way approaches is based on simplicity of their implementation and complexity of recognition of various factors that is determining harbour tariffs, and to do this we need corresponding economic and mathematical models.

Let's an optimization criteria equals to the upper limit of profit because the business segment is as significant as the tool of earning more profits. But a single step chaise for the profit, as a rule, is negatively reflected on activities of the enterprise[1].

To attack the problem "in pure form", we shall accept an independence, in the context of the demand, costs and production capacities, between different types of freights handled in the port.

Let us denote port tariff for processing units of the cargo through **p**, the demand for port services for this cargo Q (p) , the processing cost per unit of cargo Z (Q (p)). So the profit of the port is:

$$F(p) = p \cdot Q(p) - Z(Q(p)) \cdot Q(p) = (p - Z(Q(p))) \cdot Q(p) \rightarrow \max_p \qquad (1)$$

To calculate an appropriate tariff, we shall set the first-order derivative equal to zero.

$$F_p' = Q_p' \cdot (p - Z(Q(p))) + Q(p) \cdot (1 - Z_Q' \cdot Q_p') = 0, \rightarrow$$
$$p = Z(Q(p)) + Q(p) \cdot (Z_Q' - 1 / Q_p'), \qquad (2)$$

The optimal tariff consists of costs and some term proportional to the optimal volume of cargo $Z_Q' \geq 0$ (costs does not decrease with increasing volumes of work, starting with a certain amount), $Q_p' < 0$ (demand falls with increasing rate) [1].

$$F_{pp}'' = - Q_{pp}'' \cdot Q(p) / Q_p' + Q_p' \cdot (2 - 2 \cdot Z_Q' \cdot Q_p' -$$
$$- Q(p) \cdot Z_{QQ}'' \cdot Q_p') < 0 \qquad (3)$$

if Z_{QQ} □□□ 0 (costs becomes a concave down function toward the scope of works) and Q_{pp} □□ <0 (the demand is a tariff concave upward function), that is an appropriate tariff found, maximizes the profit [6].

The relationship between harbour profits and the tariff in different values of costs of works is represented in Figure 1. If costs are low, then the port is able to set low, favourable tariffs for clients, provided that harbour profits shall be high. With costs moving higher, the port have to increase its tariffs (but less than the growth of costs, that is the profit rate decreases), and the demand of clients will decrease correspondingly along with the increase of appropriate tariffs and decline of top profits. But if tariffs not be increased, the situation would be worse.

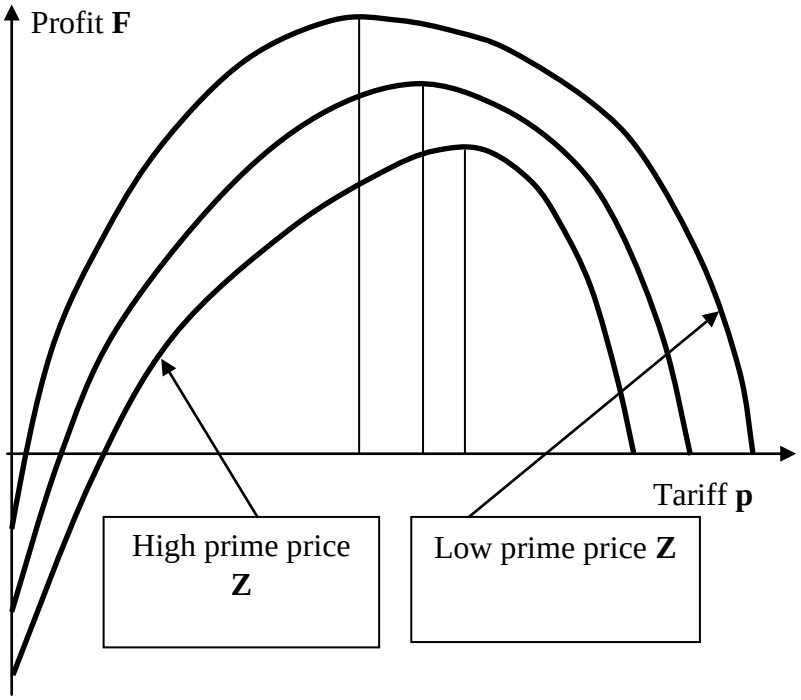

Figure 1. Optimization of harbor tariffs according to the top profit criteria in different values.

The type of relationship between harbor profits and the tariff in different values of client tariffs (including actual costs of harbor works) is represented in Figure 2. In high tariffs of competitors, the port can set rather high and profitable tariffs that will also attractive for clients, provided that harbor profits will be high. In decrease of tariffs of competitors, the port will have to decrease its tariffs (profit rate falls) so that not to loose clients, and consequently, appropriate tariffs will reduced as well as top profits. But if tariffs not be decreased, the situation would be worse.

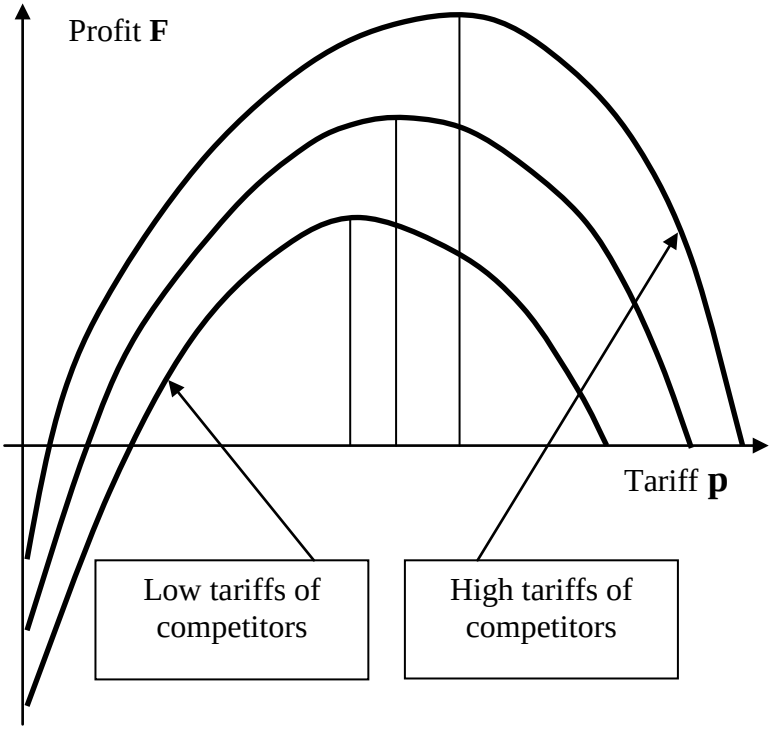

Figure 2. Optimization of harbor tariffs according to the top profit criteria in different values of client tariffs.

Let's try to represent a compatible optimization of harbour tariffs and intensity of works (Figure 3), that is financial and temporal factors [5].

In 3D space "tariff – transshipment time of 1 tonne" we will draw a line of demand level Q5> Q4> Q3. The less tariff values and transshipment time, the more values of demand. In certain limits, the tariff and transshipment time are interchangeable, that is certain increase in tariffs can be interchanged with corresponding decrease of transshipment time and vice versa provided that the size of demand stay unchangeable. But in this case it is impossible to interchange significant increase in tariffs or transshipment time for account of the other factor because the size of demand will decrease and one more line of demand level

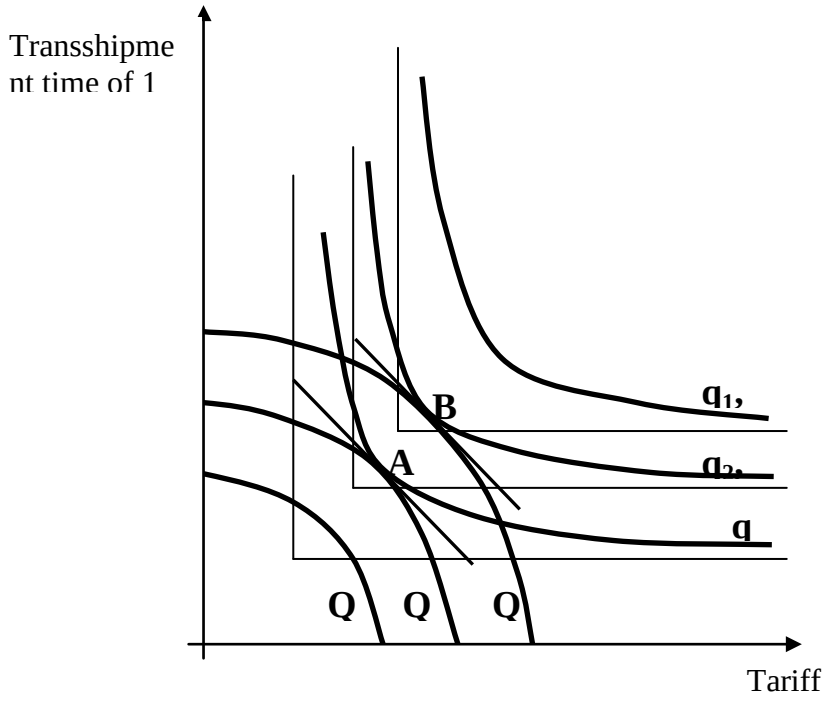

Figure 3 Optimization of harbor tariffs and intensity of work performance

On the other hand, let's draw production capacity lines of the port q1 < <q2 <q3 <q4 <q5 as limits of corresponding multitudes of production capacities. Under small scope of works, the growth of these works allow to decrease costs (and tariff) and transshipment time of 1 tonne for account of increase of labour productivity, specialization, decrease of quota of fixed expenses, that is large scope of works can be performed with small tariffs and transshipment time of 1 tonne and lines of the level shift downwards(it's a paradox). But such an effect is possible only to the certain volume q3, and then another reverse (determinate) tendency comes to an effect: the more scope of works increase, the more costs (and tariff) and transshipment time of 1 tonne increase and lines of the level shift upwards.

Namely adherent points will be appropriate for the port but only in its fixed profitability, when linear relation with a normative rate is set between costs and the tariff. Under terms set, when such optimums coincide, the tariff, in the best context of logistics system, is appropriate for the port [7].

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