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THE ESTIMATION OF DIVERSIFICATION SCALE OF PRODUCTION IN MACHINERY INDUSTRY BY APPLICATION OF THE ENTROPY NOTION

OCENA STOPNIA DYWERSYFIKACJI PRODUKCJI W PRZEMYŚLE MASZYNOWYM Z WYKORZYSTANIEM POJĘCIA ENTROPII

Abstract

Diversification strategy is currently used by enterprises to increase their stability and economic condition. It is not easy to realize the measurement of the process. The application of the parameter of entropy, which is well-known is physics, is one idea of parametrization. In the machinery industry, product diversification is connected with different consumers representing factories from different machinery sectors: mining, steel, building, agricultural and food. The possibility of estimation of the production diversification in the machinery industry by the application of the entropy-based parameters is discussed in the paper.

Keywords: diversification, machinery industry, production engineering, strategy

Streszczenie

Strategia dywersyfikacji jest stosowana przez przedsiębiorstwa do zwiększenia ich stabilności oraz kondycji ekonomicznej. Ilościowe określenie procesu dywersyfikacji jest trudne. Jednym ze sposobów parametryzacji opisu jest zastosowanie znanego w fizyce pojęcia entropii. W przemyśle maszynowym dywersyfikacja produktu jest związana z różnymi przedsiębiorstwami z różnych sektorów: górniczego, hutniczego itp. Pokazana jest możliwość estymacji dywersyfikacji produkcji w przemyśle maszynowym z zastosowaniem parametrów zdefiniowanych.

Słowa kluczowe: dywersyfikacja, przemysł maszynowy, inżynieria produkcji, strategia

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1. Introduction

Among different strategies of firm growth, these two are opposite in the idea and generally commonly used. The first one is concentration strategy, when the action of a firm is connected with single business or product in a single market with a single dominant technology [10]. The opposite one is diversification strategy, when a firm acquires businesses outside its current products and markets [6]. Choosing types of strategy growth of enterprise by diversification depends on its potential. The enterprise management makes a decision about the initialization of production projects: changing the existing ones, starting new innovative ones (connected with enterprise profile or not connected with the existing profile, enhancing the area of interest by merger or takeover of another firm, especially from another sector). Operations for the diversification of production profile are determined be external causes defined by environment or internal ones connected with enterprises reserves.

The possibility of estimation of the production diversification in the machinery industry by application of the entropy-based parameters is discussed in the paper.

2. Definition and types of diversification

The definition of diversification is connected with changing priorities from production specialization to a broader one and differentiating it. Ansoff was one of the pioneers of research of the strategy in firms. For him, diversification strategy denotes enterprise growth by introducing new products, different than those produced until now and their sales in new markets [1].

The importance of diversification process is discussed by Chandler [2, 3], based on empirical studies of growth strategies and management structures done for American enterprises. Chandler presented a model of enterprises growth according to historical stages of economic growth. One of the stages is diversification, which is starting of enterprise activity in new markets for the realization of new client requirements and taking into account market competition. Diversification is a kind of protection from fluctuation of demand, which is dangerous for specialized enterprises. Diversification often requires changes in organization and management structure [11].

The measurement of diversification process is an interesting problem in production engineering and management. Ramanujam and Varadaajam identify about sixty different parameters, which can be applied to classify firms to extent of diversification [12].

Rumelt [14] classified firms, from the diversification point of view, based on the percent of revenue obtained from different products. His definition includes: single-product firms, dominant-product ones, related-product ones and unrelated-product ones. The related-product firms (related diversified firm) derive less than 70 percent of their revenue from a single product domain, and rest of their revenue is from a related product domain. The unrelated product firms (unrelated diversified firm) derive less than 70 percent of their revenue from a single product domain, but the rest of their revenue is from unrelated product domain.

An interesting idea, suitably defined parameter of entropy, which is well-known in physics and engineering, is used in the quantitative classification of diversification process.

Its application is discussed by Palepu [9] and Rangunathan [13]. Thompson, Strickland and Gamble [16] identified the following diversification types:

– Horizontal diversification, when activity is extended on products from the area of current activity of enterprises. Products are based on familiar technologies and are sold on similar markets by its own chain of sales offices. These actions are the reason of technological and market synergy. Horizontal diversification is a source of positive effects in the use of reserves, growth and financial safety.
– Concentric diversification is going to new areas of activity, which have something in common with the current activity (e.g. technology, distributions). A new activity connected with old production generates the product-market synergy, which makes it possible to increase sale and/or decreasing costs.
– Conglomerate diversification is the idea of starting activities in completely new areas. It is often connected with the use of new technologies or finding new markets. This type of diversification is one of growth directions of contemporary, big enterprises from the high technology countries. The source of positive finance effects is finance synergy, which comes from the finance policy of the conglomerate. Moreover, the costs of management are relatively low. When it succeeds, it triggers possible fast growth of enterprise.

3. Entropy in economics and management

The entropy was previously defined in physics (statistical thermodynamics) by Clausis at the end of the XIX century. The realistic physical process decreases the order in a system and makes the entropy higher. In the XX century, analogous parameters were defined in the theory of information by Shannon and then in the theory of chaos by Kolmogorov.

The beginnings of application of the entropy-based parameters in economics and management started in 1967 and are connected with activities of Theil [15]. Since then, some authors have applied this idea to determine the level of diversification and to determine its type. A review of these methods was done by Raghunathan [13]. In quantitative analyses, the following parameters are used [13]: total diversification (TD), relative entropy (RE), distribution scale (DS), total diversification score (TDS), related scale (RS), related diversification score (RDS), unrelated scale (US), unrelated diversification score (UDS). The definition of these parameters are collected by Raghunathan [13] and are discussed by the authors [7].

Three estimators of entropy of a diversified firm will be applied in performed analysis – total diversification, diversification score and total diversification score.

The formula for total diversification is based on two classic formulations: weighed average of diversification between sectors [5] or weighted average of share between sectors [4]. The natural logarithm of reciprocal of part of share in each of segment is assumed as a weight [4]. The formal definition of entropy has the form of (1) [13], where P_i is a share for the i-th segment/sector, and n is the total number of segments. It is a useful parameter, which takes into account the number of segments/sectors and relative share each of segments. Unfortunately the same value of TD may be obtained for firms diversified in a different way.

$$TD = \sum_{i=1}^{n} P_i \ln\left(\frac{1}{P_i}\right) \qquad P_i \neq 0 \tag{1}$$

If the maximal value of entropy is assumed to be equal $\ln(n)$, the value of TD may be given in relation to this value, defined the distribution scale (2) [13]. The value of DS varies from zero to one. The zero value is obtained for activity in only one segment. Value one is obtained for the same distribution of shares for each sector, whose number is more than one.

$$DS = \frac{1}{\ln(n)} \sum_{i=1}^{n} P_i \ln\left(\frac{1}{P_i}\right) \qquad P_i \neq 0 \tag{2}$$

The total diversification score (3), which is the multiplication of DS by the number of segments [13], is another useful parameter.

$$TDS = \frac{n}{\ln(n)} \sum_{i=1}^{n} P_i \ln\left(\frac{1}{P_i}\right) \qquad P_i \neq 0 \tag{3}$$

4. Example of estimations

In the machinery industry, product diversification is connected with different consumers, representing factories from different machinery sectors: mining, steel, building, agricultural and food. In the machinery sector, the products include machines of general application, factory machines, their elements and parts of mechanisms. Product diversification in the machinery industry is connected with a broad spectrum of the production offer, from the point of view of innovation and quality.

As an example of estimation of distribution scale of machinery type firms, let us consider five enterprises who may working maximally in three segments. Not so high number of segments is typical for machinery industry. Some of them work in two segments and action of others is diversified in segments on sectors (related diversification). The characteristics of their activities are given in Table 1.

Table 1

Characteristics of diversified enterprises

ENTERPRISE	SEGMENT 1		SEGMENT 2	SEGMENT 3
	SECTOR 1	SECTOR 2		
I	1	0	0	0
II	0	0	1	0
III	0.3	0.2	0.5	0
IV	0.4	0	0.6	0
V	1/6	1/6	1/3	1/3

In Table 2, calculated values of entropies TD, DS and TDS for the analyzed enterprises are given. The actions of enterprises I and II are connected only with one sector of one segment. Therefore, the value of DS is equal to zero. The action of enterprise V is evenly distributed in three segments, and in segment 1 in two sectors. Therefore, the value of DS is maximal and equals one. The actions of enterprises III and IV are diversified in two active sectors. Hence, the values of DS for them are relatively high. However, the value of DS for enterprise IV is higher than for enterprise III, the values of TDS are in opposite order for them. It is due to the fact that firm III is active in two sectors of segment 1.

Parameter TD cannot be so easily interpreted as parameters DS and TDS.

T a b l e 2

Estimated parameters of diversification of enterprises

ENTERPRISE	TD	DS	TDS
I	0	0	0
II	0	0	0
III	0.447	0.937	2.812
IV	0.292	0.971	1.942
V	0.602	1	4

5. Conclusions

Application of the entropy is a useful form of quantitative analysis of diversification level of firm or production process. The well-known different parameters based on entropy concept makes possible application for different types of firms/diversifications.

Activities of firms can be compared each other. Moreover dynamics of diversification can be analyzed quantitatively for the given firm. Scale of distribution can be compared with parameters of economic growth of firm in considered country/region or area of activity.

Product diversification for machinery industry increase range of activity of enterprise and leads to change technology, create new knowledge, growth co-operation between suppliers and consumers and open a new markets.

Analysis of process of diversification by applying the entropy parameters show, that if analyzed enterprises makes decisions of diversification, it is reduced to two or maximal three segments. Due to characteristics of machinery industry, enterprises usually applied horizontal diversification, which is good for stability and growth of firm and concentric diversification. These two types of diversifications are not so high in risk than the conglomerate one, when effects coming from finance synergy may be not enough. Realization of innovation projects, which realize the market requirements may has positive influence of growth of machinery industry.

The advantage of diversification of production in machinery industry is distribution of risk of firm activity. It is very important for enterprise to define the main area (product/products) of activity, and then start process of diversification.

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