

# VERIFICATION OF A MODEL OF THE EVOLUTION OF THE ORGANIZATIONAL STRUCTURE OF RETAIL ENTERPRISES, BY USING REGRESSION ANALYSIS AND AUTOMATIC LINEAR MODELING

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## Abstract

The purpose of the study, examined in this article, is to create an econometric model that allows quantifying the growth of the organization's efficiency in the process of its development. The retail sector of the Czech Republic was chosen as the object of analysis. The financial and economic indicators of these organizations were obtained from the database Albertina Gold Edition of Bisnode Česká republika, a.s. for 2014. The computer program IBM SPSS Statistics was used for regression analysis in order to conduct the research. The analysis of the obtained results showed that the increase in the efficiency of retail organizations in the process of their development can be described by a linear model with acceptable accuracy. The main factors determining the increase in the efficiency of retail organizations were identified and the authors confirmed the model of the evolution of the organizational structure of commercial organizations. The analysis of the constructed model revealed the factors having the greatest impact on the growth of the efficiency of retail trade organizations.

**Key words:** retail trade organizations, efficiency growth, regression analysis.

**JEL Code:** L2, D21, C38

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## Introduction

Empirical studies to assess the effectiveness of companies in their development have been conducted since the mid-sixties of the last century. Thus, B. Henderson discovered a dependence that the efficiency of the company increases by about 25% with the doubling of production volumes (Stem and George Stalk Jr, 1998). Thereafter, such studies continued, as well in the Czech Republic. However, most of these studies concerned the construction of mathematical and statistical models using regression analysis based on the financial performance of organizations (Chandrapala, Knápková, 2013; Afonina, 2015). Since the authors of the article have previously conducted studies of the patterns of development of organizational structures of commercial organizations of various activities, which allowed to develop a theoretical model of the evolution

of the organizational structure, in this work an attempt was made to build a statistical model of the development of the company by using not only financial performance on the example of retail organizations in the Czech Republic.

Based on the results of previous studies of the authors, where, by using cluster analysis, there were disclosed regularities of the evolution of commercial organizations, consisting in the repeated change of sequential (vertical) and parallel (horizontal) organizational structure (Bobkov, Denisov, 2017; Bobkov, Denisov, Tsenina, 2018), and generally confirmed the developed model of the evolution of the organizational structure, the next task was to build a mathematical model that allows to quantify the growth of the efficiency of commercial organizations in the transition to the next level of development.

Therefore, in this article we will try to prove that the efficiency of organization increases (Hunter, 2015) when transiting at new level of development. The authors selected retail organizations of the Czech Republic presented in the database Albertina Gold Edition of Bisnode Česká republika a.s., as the object of study. The choice of this sector of the economy was conditioned by two main factors. Firstly, the statistical database of this sector was used by authors in the previous successful researches that proved the repeated change of sequential (vertical) and parallel (horizontal) organizational structures of retail entities in the Czech Republic. Secondly, the statistical database Albertina contains a large number of retail organizations in the Czech Republic in comparison to other sectors of the economy.

The most commonly used method of constructing statistical models describing the dependence of the dependent variable on several independent variables is regression analysis (Chatterjee, Hadi, 2015). The computer program IBM SPSS Statistics was used for regression analysis.

The research was conducted on the basis of statistical data of retail entities of the Czech Republic obtained from the database Albertina Gold Edition of Bisnode Česká republika. For the study, 2 250 retail organizations were selected based on the results of their economic activities for the 2014 calendar year (from 01.01.2014 to 31.12.2014). The choice of the year was conditioned by the completeness of the information and the positive results of previous studies on the verification of the authors' model of the evolution of the organizational structure. Financial indicators were calculated in the original currency – Czech koruna – CZK.

## **1. Research of efficiency growth of retail organizations in the process of their development, by using regression analysis**

In order to conduct research to assess the growth of efficiency of retail organizations in the process of their development, the authors attempted to build a statistical model describing the dependence of the efficiency of organizations on several independent variables (predictors) that characterize the size of the organization and the results of its financial and economic activities. As the summarized index characterizing growth of efficiency of the organization, the authors have chosen the indicator of value-added labour productivity. The choice of this indicator was stipulated by two factors. Firstly, a common approach to assessing the efficiency of business processes of the organization is to use indicator of labor productivity as a criterion for assessing the performance. Secondly, in the earlier studies on the verification of the model of organizational structure evolution, this indicator was one of the indicators that determine the patterns of structural changes in organizations. Due to the fact that multiple linear regression was used to construct the regression model, the logarithm of value-added labour productivity was chosen as the dependent variable (the distribution of the indicator corresponds to the normal distribution, the test was carried out using the Kolmogorov-Smirnov criterion, the significance level  $p=0.001$ ). As noted above, all calculations were performed in the IBM SPSS Statistics computer program.

As a result of the calculations, seven models using various independent variables (predictors) were obtained. Consolidated information about these models is given in Table 1.

**Tab. 1: Consolidated information about the models derived by using regression analysis**

N	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Standard error of estimate
1	0.508	0.258	0.257	0.86957
2	0.593	0.352	0.350	0.81313
3	0.631	0.399	0.397	0.78355
4	0.646	0.417	0.415	0.77183
5	0.652	0.425	0.422	0.76680
6	0.660	0.435	0.432	0.76024
7	0.663	0.440	0.436	0.75777

Source: own elaboration

As can be seen from the Table 1, the highest accuracy is provided by the model # 7. This model includes seven predictors:

- ✓ an amount of revenue per retail unit (thous. CZK);
- ✓ an average number of employees in one retail unit (pers.);
- ✓ profit (thous. CZK);
- ✓ an amount of depreciation (thous. CZK);
- ✓ an amount of revenue (thous. CZK);
- ✓ total assets (thous. CZK);

✓ an age of an organization (total number of years).

The values of regression coefficients for these seven predictors are presented in Table 2.

**Tab. 2: The results of the regression analysis**

N	Predictors	Unstandardized coefficients		Standardized coefficients	t
		B	Standard error of estimate	Beta	
1	Constanta	4.745	0.068		69.817
2	Amount of revenue per retail unit (thous. CZK)	0	0	0.625	19.502
3	Average number of employees in one retail unit (pers.)	-0.135	0.01	-0.338	-13.443
4	Profit (thous. CZK)	0	0	0.22	9.454
5	Amount of depreciation (thous. CZK)	0.001	0	0.119	4.674
6	Amount of revenue (thous. CZK)	-1.40E-05	0	-0,146	-4.641
7	Total assets (thous. CZK)	3.44E-05	0	0.118	4.098
8	Age of an organization (total number of years)	0.01	0.004	0.066	2.846

Source: own elaboration

Despite the fact that the results of the model revealed a list of indicators that determine the growth of efficiency of retail organizations, we should note a relatively low accuracy of the model: the value of the coefficient of determination  $R^2$  was 0.440 (adjusted  $R^2=0.436$ ), the standard error of estimate 0.7577. In this regard, the authors decided to consider other methods of constructing statistical models describing the influence of several independent variables on the selected dependent variable.

## **2. Efficiency growth analysis for retail organizations in the process of their development by using automated linear modeling**

For further efficiency growth analysis and construction of the appropriate model for retail organizations in the process of their development (Petrenko, Pritvorova, Dzhazykbaeva, 2018), the authors have chosen the method of automated linear modeling (Hox, Moerbeek, Van de Schoot, 2017). The choice of this method was determined by factors such as the simplicity of the model (this method also uses a linear model) and the possibility to build an adequate model by using independent variables with different distribution in the sample. This method is widely used

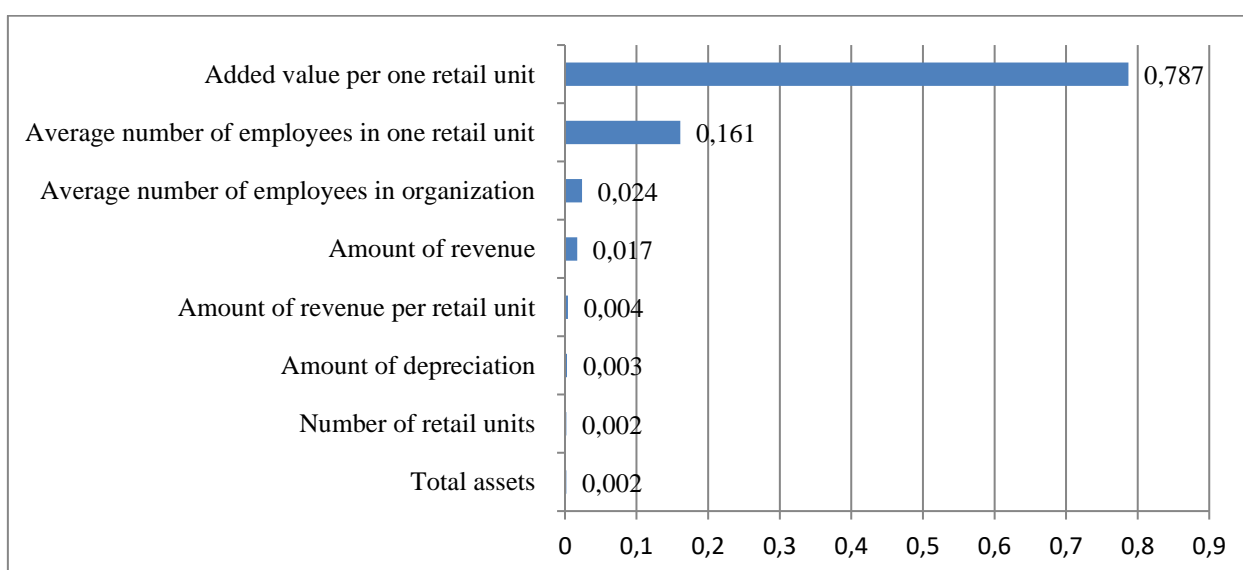
to predict quantitative response values for a selected target element. Forecasting is based on establishing a linear relationship between the target element and one or more predictors. At the same time, interval values of variables can be used as predictors; it distinguishes this method from the previously used regression analysis and it is better suits for analyzing data from the selected Albertina Gold Edition database. The use of the linear model in this study is explained by its comparative simplicity and the possibility to easily interpret the results.

As in the previous model, value-added productivity was chosen as the target element. The mathematical model constructed with the help of an automated linear modeling includes eight predictors:

- ✓ added value per one retail unit (thous. CZK);
- ✓ average number of employees in one retail unit (pers.);
- ✓ an average number of employees in organization (pers.);
- ✓ amount of revenue (thous. CZK);
- ✓ amount of revenue per retail unit (thous. CZK);
- ✓ amount of depreciation (thous. CZK);
- ✓ number of retail units (units);
- ✓ total assets (thous. CZK).

The values of the coefficients characterizing the importance of predictors for the selected target element are shown in Figure 1. The values of the coefficients of the constructed model are presented in Table 3.

**Fig. 1: Predictor importance for the selected target element**



Source: own elaboration

**Tab. 3: Coefficients values of the constructed model**

N	Predictor	Coefficients values
1	Absolute term	288.091
2	Added value per one retail unit (thous. CZK)	0.300
3	Average number of employees per retail unit (pers.)	-73.412
4	Average number of employees in organization (pers.)	-12.868
5	Amount of revenue (thous. CZK)	0.003
6	Amount of revenue per retail unit (thous. CZK)	-0.004
7	Amount of depreciation (thous. CZK)	-0.395
8	Number of retail units (units)	19.216
9	Total assets (thous. CZK)	0.001

Source: own elaboration

The value of the adjusted R<sup>2</sup> for the model constructed by using automated linear modeling is 0.538, which suggests the possibility of its use.

When analyzing the model (see Table 3) it becomes clear that some of the predictors are positive (i.e., increasing their values ensures the growth of the target element), and some – negative (i.e., increasing their values leads to a decrease of the target element). The predictors ensuring the efficiency growth of retail organizations include the added value per retail unit, the amount of revenue, the number of retail units and the value of total assets. Predictors that reduce the efficiency of retail organizations include the average number of employees per retail unit, the average number of employees in the organization, amount of revenue per retail unit and the amount of depreciation. It is noteworthy that the average number of employees has a significant and negative impact on labour productivity, (which is easily interpreted as a decrease in the efficiency of the use of workers with the growth of their number and / or the lack of business process automation). A significant positive impact on labor productivity, taking into account the importance of predictors, is provided by the value added per retail point, which can be interpreted as an increase in the efficiency of business processes in the relevant retail units.

Thus, the authors built a statistical model describing the increase in the efficiency of retail organizations in the process of their organizational development for the target element of value-added labour productivity, identified the main factors (predictors) influencing the growth of efficiency of retail organizations and determined their importance. However, it should be noted that the accuracy of the resulting model, although acceptable (adjusted R<sup>2</sup>=0.538), but not too high. This can be explained by the results of previous studies. The authors proved that in the transition from a parallel to sequential organizational structure the growth of the organization is

intense, and in the transition from a sequential organizational structure to a parallel growth of the organization is extensive. That is, in the transition to the next level of development, the increase in the efficiency of the organization depends on the type of change in the organizational structure. Consequently, the effect of independent variables on the selected target element is likely to be described by more complex nonlinear relationships rather than being linear.

### **3. Comparison of the results of evaluation of efficiency growth of retail organizations in the process of their development with the model of organizational structure evolution**

The results of the obtained mathematical model of evaluating the efficiency of retail organizations in the process of their development should be compared with the proposed model of the evolution (Blyton, Morris, 2017) of the organizational structure. In previous studies, the authors verified the theoretical model of organizational structure evolution. Verification was carried out by identifying a list of indicators that determine structural changes in the organization, grouping a sample of retail organizations of the Czech Republic by using cluster analysis and interpretation of the results. The results of the research are described in detail in the works of the authors; however, in order to compare the results of the constructed model of evaluating the efficiency of retail organizations in the process of their development, we consider them in this work.

When building a model of the evolution of the organizational structure of retail organizations it was discovered that the quantitative variables that determine the development of organizations are:

1. number of retail units;
2. the average number of employees total (pers.);
3. the average number of employees in one retail unit (pers.);
4. value-added labour productivity (thous. CZK / person);
5. amount of revenue per retail unit (thous. CZK);
6. total assets (thous. CZK);
7. amount of depreciation (thous. CZK);
8. age of an organization (total number of years).

As noted above, value-added labour productivity was chosen as the target element in the construction of the statistical model. Comparison of indicators obtained in the construction of a model for evaluating the efficiency of retail organizations (Table 3) with the variables used in the model of the evolution of the organizational structure shows their coincidence in five indicators

(excluding the target element). That is, in the model of the evolution of the organizational structure, and in the model of evaluating the efficiency of retail organizations, the following variables are used: number of retail units, the average number of employees total, the average number of employees in one retail unit, amount of revenue per retail unit, total assets. Thus, since the regularities of organizational development and the growth of their efficiency are determined by a close set of variables, the following conclusions can be derived:

- ✓ the growth of organizations and their transition to the next level of development in the framework of the model of evolution of the organizational structure of retail organizations is accompanied by an increase in their efficiency;
- ✓ the efficiency growth of retail organizations can be quantified by using the statistical model proposed by the authors;
- ✓ the statistical model developed by the authors uses two groups of indicators - indicators characterizing the size of the organization (the average number of employees in the organization, the amount of revenue, the number of retail units, the value of total assets) and indicators characterizing its economic efficiency (the added value per one retail unit, the average number of employees in one retail unit, the amount of revenue per retail unit).

## **Conclusion**

The results of the study of retail organizations of the Czech Republic allow the authors to conclude that it is possible to use a statistical model describing the increase in the efficiency of retail organizations in the process of their organizational development. The analysis of the constructed model shows that the growth of the efficiency of retail trade organizations (the target element – value-added labour productivity) is mostly influenced by the following factors: the added value per one retail unit, the average number of employees in one retail unit, the average number of employees in total and the amount of revenue. Along with this added value per retail unit and amount of revenue have a positive impact on efficiency growth, however such indicators as average number of employees per retail unit and the average number of employees in the organization have adverse effect.

The constructed model has an acceptable accuracy (adjusted R<sup>2</sup> value=0.538), which suggests confirmation of the hypothesis about the factors influencing the growth of efficiency of retail organizations in the process of their development and verification of the model of organizational structure evolution developed by the authors.



The question of the accuracy of the obtained model was discussed by the authors in the process of its analysis. According to the authors, this may be caused by different rates of efficiency growth in companies with different basic types of organizational structures, which was revealed in previous studies.

At the same time, the authors consider it necessary to conduct additional research, including on other time periods, in order to clarify the nature of the impact of various factors on the efficiency growth of organizations and to improve the accuracy of the model.

The result of the obtained statistical model was the verification of the previously developed model of organizational structure evolution, confirming the hypothesis of the sequential change of the two basic types of organizational structures at the new dialectical level of development and the growth of their efficiency. An important practical result of the study was the identification of a set of quantitative indicators that characterize the level of development of retail organizations. Knowledge of these indicators enables management of these organizations to make optimal decisions on their further development.

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