QUANTIFICATION OF FUNDING AND ANALYSIS OF THE FINANCIAL POSITION OF ENGINEERING COMPANIES IN THE SLOVAK REPUBLIC

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Abstract: The engineering sector is the backbone of industrial production in Slovakia. In recent years this sector has experienced record lows and highs nearly simultaneously. In Slovakia, it represents a kind of mother industry. Production for automotive vehicles is the strongest branch of engineering manufacturing, followed by the production of electrical and optical equipment. In summary, there is a view that engineering businesses in Slovakia have weak capital strength and financing their development is very risky. It is therefore necessary to look for other sources of financing, which would offer these businesses a competitive edge in a market economy, while adhering to legal requirements. The aim of the authors is to determine, using mathematical and statistical methods, for funding opportunities that engineering companies in the Slovak Republic can take advantage of. This paper deals with the analysis of financial metrics for the period 2007-2013.

Key words: engineering manufacturing, sources of funding, factor analysis, cluster analysis, assotiation

Introduction

The backbone of the Slovak economy is manufacturing, with the principal industry being engineering production (32.5% of total manufacturing), with it being 42.3% of the automotive industry (which is 20% of the overall industry SR). In 2008, the engineering industry in the European Union employed 6.8 million workers, representing almost 19% of the number employed in manufacturing. Engineering in the EU-27 accounts for nearly 18% of total industrial production in the EU.
The engineering industry, not only in Slovakia, but worldwide saw a decline due to the impact of the recent financial crisis. The production volume in 2009 decreased by almost 30% to 50% compared to 2008. The number of enterprises decreased by 187, from 715 to 528. The manufacture of machinery and equipment decreased by 37% and the manufacture of transportation equipment by 29%. Sales in 2009 (compared to 2008) decreased by 30% and amounted to 13,717 million euros. Exports fell by 26% and amounted to 13,480 million euros, and likewise for imports, which amounted to 9,691 million euros. The number of employees in the engineering industry fell by 18% in 2010, which amounted to 110,055 workers. The number of employees then rose to 120,887, but wages decreased by 27% (in 2009 labor costs amounted to 1,036 million Euros). In total this added to the value of industry by 27% (2,396 mil. EUR). Investment in machinery and

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equipment fell by 53%. The effective value added by the additional workers amounted to 21,767 million EUR. The added value to the engineering sector in 2009 was 90,686 million euros, with new revenues amounting to 15,889 million EUR. During the period between 2010- 2011 moderate growth was expected in investment in machinery. Stronger investment still was expected in 2011 – 2012, (Slovak Credit Bureau, 2011, 2012, 2014).

Total sales by Slovakian industries were 82,251 million euros. In the engineering industry it was 26,500 million (roughly 32% of total sales for all industries) and automotive sales were 29,689 million euros (roughly 36% of total sales for all industries) which is about 68% of total sales. Sales in engineering production in 2011 reached 29.5 billion euros. Manufacture of basic metals and fabricated metal products reported sales of 9.37 billion euros, manufacturers of machinery and equipment reported sales of 3.13 billion euros and manufacture of transportation equipment reported 17 billion euros.

This was due to positive developments in external demand and the growth in exports. Research and development in 2009 was allocated 16 million euros. Overall, Slovakia brought to research and development in the machinery sector more than 316.4 million Euros in 2008. In terms of euros, Slovakia's share for total industrial research is 5.1% and they employee 661 workers in research, which constitutes 2.1% of the total for the EU.

Slovakia, due to its open economy, was greatly affected by the economic recession, especially with regards to its affect on the engineering sector of the motor vehicle industry. The engineering industry, like other sectors, has its peculiarities regarding the circulation of capital, and consequently, finances. These include long production cycles with asymmetrical cost escalation on work in progress, as well as short sales of unfinished products. These particular businesses operate mainly on a variable volume, where structure and turnover time of current assets during the year and the overall composition of capital affect production. The mechanical engineering sector must constantly seek new and creative models of how to manage and withstand crisis and how to be competitive. Engineering production is one of the key areas of economic development in the European Union. In 2007, it employed 3,250,000 workers and constituted 9.78% of the EU's industrial basis. Research has shown there is only a two percent turnover rate for this sector. Development and production costs are strongly influenced by increasing technological complexity which has lead to the search for optimal solutions for the efficient management of the financial resources of companies. However, as Dima and Kot (2013) in their book chapter note, that it is always necessary to differentiate between an industrial company's production capacity (it shows the industrial company's maximum possible production in a time interval of one year), the production achieved by the industrial company, and industrial company's size (it is size in terms of production volume that it may achieve). Bucki and Chramcov (2011) focus on production process in more details in case of serial production system. They implemented heuristic algorithms in order to solve highly complex

mathematical task consisting in minimizing the total order realization time, maximizing the production output and minimizing the loss of unused tool capacity. Bucki and Suchánek (2012) further extended this idea to parallel system. Dalíková and Doležalová (2013) focus on Process management in general and possibilities of its implementation in small and medium enterprises. However, Dima et al (2011) specifically monitor the processes associated with the machine replacement policy, whereas Tabor (2014) analyzes the safety of work in the automotive industry through the study of environmental conditions.

In many engineering companies in Slovakia there are critical points in the production process:

- redundancy in machine capacities are not fully utilized and adapted to the real production process in some companies,
- a high degree of physical wear of machines,
- production technology that is not adaptable to new and frequently changing production processes,
- prevailing technological layouts of workplaces and existing provisions for the use of cell production structures that are outdated,
- persistent weakness of automation, continualization of material flow and a lack of compatibility with information systems,
- a lack of innovation or the capacity to be innovative.

To make the cased for investments in Slovakia, the following developments should be highlighted:

- production, technological and regional diversification, with a positive impact on employment and the development of small and medium enterprises,
- investment in emerging engineering processes, research and development, as well as the development of more sophisticated services (including shared service centers),
- the gradual transition from semi-automated production plants, characterized by a high degree of manual work, to a system with a more emphasis on robotic workstations, which is related to the upcoming problem of labor shortages in some sectors,
- constant pressure to improve the quality, productivity and flexibility of supply, because of the need to maintain and strengthen a competitive advantage (Sario, 2015, Kadłubek and Grabara, 2015).

External factors that positively impact the competitiveness of Slovakian businesses in the EU market are the exchange rate stability of the EU and support provided as a result of the absorption of Slovakia into the EU, whether from the state budget or EU funds. External factors which negatively impact the competitiveness of Slovakian businesses in the EU market are the heavy tax burden and the limited supply of skilled labor caused by many Slovaks choosing to work elsewhere in the EU. The main criteria sued to separate business entities into different types based on their activities is the Statistical Classification of Economic Activities or NACE. NACE is fully compatible with the classification of economic activities and has

remained unchanged regarding the distribution of enterprises by size, according to the value of assets and the sum of sales of goods, products and services. Slovakian enterprises classified under NACE as manufacturers of machinery and equipment increased from 569 in 2010 to 655 such businesses in 2013. In 2013, median liquidity, quantified by the sum of the financial assets and debts, reached the second degree, i.e. the one euro short-term liabilities coefficient reached 1.04, which compared with the previous year decreased by 2 cents. In 2011 it was 0.96, which meant a reduction in the ability of companies to pay short-term obligations by 6 cents compared with 2010. Total Current liquidity ratios for the last five years in Slovakia were not in the range of standard values (1.5-2), i.e. in 2010 one euro short-term liabilities accounted for 1.29 euro for current assets and in 2013 the median overall liquidity was 1:35. In 2013, the lower quartile value was 0.82 and the upper quartile value was 2.71. Median inventory turnover in 2013 was 16.61 days. The average time for the commitment of funds in stocks according to the median in 2010 was 25.21 days, which from 2011 began to decline to 23.16 days. Upper quantile maturity of liabilities was 300.85 and lower quantile was 66.90, with a median of 128.50 days. PTR Total Assets Turnover measured by the share of revenues in total assets of a firm in the machinery sector in the period of 2007-2010 had a downward trend in 2011. By contrast, the asset utilization coefficient increased in 2011 from 1.18 to 1.41, but then began to decline, so that in 2013 assets during the financial year turned to a utilization rate of 1.22.

In the area of financial indicators, total debt holdings in 2007 were 64.92% and in 2008 were 65.42%. In 2009 one euro total capital accounted for 0.6455 cents of foreign capital. And, in 2011 for a total of 524 businesses total indebtedness was 67.30%. In 2012, the median total debt for a total of 612 engineering companies reached 61.40%, and in 2013 one euro of total assets accounted for 65 cents of external resources. Interest coverage also reached a good level. Earnings Before Interest and Taxes (EBIT) exceeded interest expense in 2007-2013 eight times. Other financial metrics of profitability in this sector also have had positive values for Return on Equity (ROE). In 2013, every euro of equity accounted for 0.053 cents net profit EAT. Return on Sales (ROS) interprets how many euros of profit are generated for every € 1 in sales. It also denotes the profit margin or the rate of return on sales. This indicator is very interesting for the field of marketing and pricing policy. From 2010-2013 ROS rose from 2.7% to 2.99%. During the financial crisis it fell to a negative (-2.93%). Return on Assets (ROA) represents the output for power or Basic Earning Power, which is the earning capacity of an enterprise. One Euro of assets in 2007 accounted for 0.031 cents EBIT, and in 2008 it was 2.8%. In the period 2010-2013 there was a downward trend and by 2013 each euro managed to produce only 0.014 Equipment cent of operating profit before interest and taxes EBIT (Jenčová, 2011).

Characteristics of the Researched Object - Sources of Funding in the Engineering Industry in Slovakia

From the time series of economic indicators, it is already apparent that 2009 was the worst year of the current crisis. Data from 2009 forms, from a statistical point of view, a consistently negative picture. Our study was designed to obtain information on the use of financial resources by engineering companies in Slovakia immediately after the cresting of the economic crisis in 2009.
To find relationships and links on funding sources used by production engineering companies we used a questionnaire survey. Data collection in the field (Slovakia, 2013) yielded 57 replies. Respondents were generally managers of engineering companies. They were asked to fill out 17 items of the questionnaire in the presence of interviewers. Given the limited number of enterprises (there are 655 in total) and the reluctance of managers to cooperate, this number, combined with personal visits to the respondents and the maximum effort of the interviewers to obtain data, may be considered sufficient. The law of large numbers allows for valid statistical inferences using inductive statistics to be drawn from when there are more than 30 data points. Therefore, these respondents provide information that can be applied to their community. Randomness in the selection of respondents is required for the results to reflect the community at large. Due to the fact that the 57 respondents is small compared to the community at large and they responded voluntarilly, there is a real potential of a self-selection bias affecting the results of data analyzed from this survey. Due to this, data analyzed is limited to only two items on the questionnaire. Each contains within it subheadings for each source of funding (17 total resources), identifying on a four-step ordinal scale, the extent to which different external standard and alternative funding sources for financing major undertaking were utilized. The frequency distribution of these items is displayed graphically (Fig. 1). 55 questionnaires were determined to be valid.

Methodological Approach and Hypothesis

The research hypotheses were formed as follows:

1. *Assuming that it is possible to create, interpret and group sources of funding by the extent of their use,*
2. *Assuming that it is possible to break down machinery enterprises into clusters on the basis of a group of nearby sources of funding, and finally*
3. *Assuming that the breakdown of enterprises into clusters based on a group of nearby sources of funding is in relation to their financial performance.*

For descriptive statistics, data from the questionnaire pertaining to different funding sources were sorted by the extent of their use. Since it has been established that not all 17 sources were used, to verify the research hypothesis only data for the first 10 sources of funding were used (these areshown below in Tab. 2).

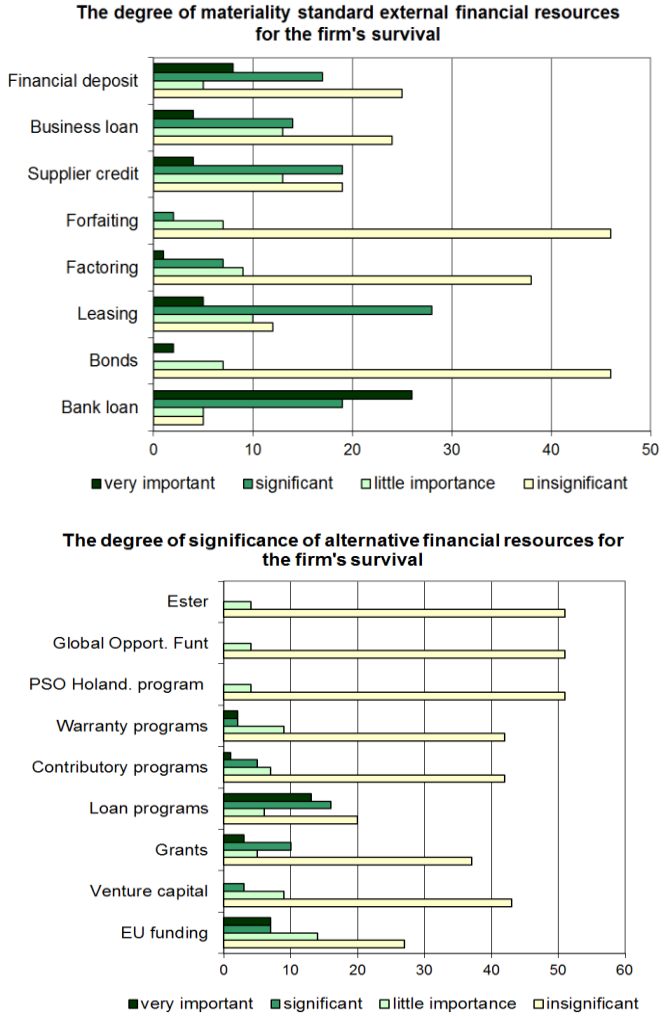

Figure 1. Distribution of selected items

These 10 funding sources were treated as explicit variables in factor analysis. They were combined into a new product of fewer variables, called latent variables, which are a linear combination of the original variables.

"Factor analysis allows one to find latent (indirectly observed) causes of variability in data. By finding latent factors it can reduce the number of variables while preserving maximum information and find a link between the observed variables and derived factors" (knowledgebase at www.spss.cz). Factor analysis by the SPSS knowledge base is "the best in determining interval variables, but also works well with ordinal, and dichotomic data". The final model explained the four extracted factors to 70.754% of the original variability of manifest variables (Tab. 1).

Table 1. Contribution of the factors to explaining the variability

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
1	3.391	33.909	33.909	3.391	33.909	33.909	2.476	24.760	24.760
2	1.592	15.923	49.832	1.592	15.923	49.832	1.821	18.212	42.972
3	1.225	12.247	62.079	1.225	12.247	62.079	1.603	16.034	59.006
4	.878	8.775	70.854	.878	8.775	70.854	1.185	11.849	70.854

A scree plot of eigenvalues (Fig. 2) shows the appropriateness of the choice of at least three of these factors in terms of the rate model in explaining variability. These were compared to four factors with a satisfactory percentage and were satisfactory to communalities. Findings communalities, we selected the 10-individual variables that were most communal. The lowest achieved communalita was 0.511, and others were > 0.6. Analysis of reliability applied to the 10-variables resulted in Cronbach's alpha equal to 0.753.

With 55 companies and 10 variables, we moderately satisfied Bryant and Yarnold's criterion (1995), the STV ratio: the ratio of the number of operators to the number of variables must not be less than 5. The best extraction method, levied by comparing the amount of variability in each of the manifest variables with that found in the latent factors, is the method of principal components (PCA). When PCA factors are generated as uncorrelated linear combinations of manifest variables. Their non-correlation will be determined in further analysis. (Verification of the assumptions of the factor analysis has been done.)

Prerequisites for the use of factor analysis were verified by the Keiser-Mayer-Olkin test that provided a value of 0.682 which confirmed the adequacy of the chosen set of variables. Bartlett's test of sphericity (chi2 = 158111; df = 45; sig = 0.000) confirmed that the correlation matrix of variables is not considered a unit. Consideration of factor loads (the correlation coefficient between variable factors) of the rotated solution provides a particular result (Tab. 2).

Table 2. Factor loadings

	Component			
	1	2	3	4
Bank loans	.204	.832	.082	.006
Leasing	.729	.040	.348	-.293
Credit programs	.079	.918	.101	.068
Advances	.095	-.007	.256	.814
Supplier credit	.113	.065	.847	.200
Business loan	-.084	.114	.807	.087
EU funds	.785	.021	-.032	.039
Subsidies	.719	.217	-.071	.309
Factoring	.427	.350	.136	.433
Subsidized programs	.744	.310	-.079	.316

In the selection of rotation, comparing how the various solutions are spun, confirmed that the most appropriate test by construction, is the Varimax rotation test. This test minimizes the number of variables having high factor load, and thus more factors. The rotation does not affect the explained variability as it only corrects the specification of factor loads to clearly assign the variable to the factor. The rotated solution with the Varimax rotation in Table 2 was used for the final interpretation of the rextracted factors in the next chapter.
The scree plot of eigenvalues (not reported here) shows the appropriateness of the choice of at least three factors. From the standpoint that both break the scree plot, this partly explains the extent to which the model variability of the selected four factors was equal to 70.854% (Tab. 1). Also, the choice of four factors is suitable in terms of the interpretation of the resulting factors.

Results

The sense of organising funding sources which are with its measure of use closer in individual factors can be interpreted as follows:

- *Factor1* is saturated: Leasing; EU funds; Subsidies; Subsidized programs. The proper interpretation of the first factor is the dynamics factor of financing a business entity.
- *Factor2* is saturated: Bank loans; Credit programs. The proper interpretation of the second factor is the loan burden factor of a business entity.
- *Factor3* is saturated: Supplier credit; Business loan. The proper interpretation of the third factor is the factor of supplier-customer lending.
- *Factor4* is saturated: Advances; Factoring. However, its assignment here is not entirely clear. This funding source has the same high weight as in the first factor.

Obviously it is derived from the position of in Figure 2. The proper interpretation of the fourth factor is the factor of advances and sale of business lending claims. It was useful to include this factor in the model from the interpretation point of view.
Groups of close sources of corporate financing were created and subsequently interpreted on the basis of the extent of their use by means of implementing the factor analysis method. The research hypothesis 1 is confirmed.
Orthogonal factors constitute, in terms of assumptions, appropriate input to the two step cluster analysis, which divided the 55 engineering companies to 3 clusters. They are a group of enterprises within each cluster that are the most similar, but the clusters themselves are the most different. The resulting division organized into: cluster 1 a total of 22 enterprises; in cluster 2, 10 enterprises; and in cluster 3, there are 23. The final cluster centers are reported in the Table 3.
Cluster 1 has a significantly higher average value in Factor 2 - the loan burden factor of business entities. Cluster 2 has significantly higher average values in one factor, i.e. the factor dynamics of financing a business entity, which is similar

in nature to the previous cluster in factor 2, and also has a significantly higher value in Factor 4 - the factor of advances and sale of business lending claims.

Table 3. Final Cluster Centers

	Cluster		
	1	2	3
FAC1	-.49408	1.54031	-.19710
FAC2	.67432	.61577	-.91273
FAC3	.50721	-.13581	-.42611
FAC4	-.41138	.68847	.09416

In contrast to the previous two clusters, Cluster 3 has a significantly lower value in factor 2. In Factor 3 - The factor of supplier-customer lending, the resulting clusters are much different. The F tests in Table 4 are used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. It merely confirms differences in the three clusters for every factor. Research Hypothesis 2 is confirmed, namely it is possible to segment the machinery enterprises in clusters on the basis of the use of the pool of sources of funding.

Table 4. F tests

	Cluster Mean Square	df	Error Mean Square	df	F	Sig.
FAC1	14.995	2	.462	52	32.475	.000
FAC2	16.478	2	.405	52	40.718	.000
FAC3	5.010	2	.846	52	5.924	.005
FAC4	4.333	2	.872	52	4.971	.011

To confirm the third hypothesis, it was necessary to show relationship between the resulting segmentation of the clusters and financial performance of the likelihood ratio test ($G^2 = 10.866$, $p = 0.028$). The contingency table of the two variables is shown in Table 5.

Table 5. Contingency table of cluster distribution and Earnings After Taxes

Earnings After Taxes:	Mostly unprofitable	Zero profit	Mostly profitable	Total
cluster 1	3 (13.6%)	7 (31.8%)	12 (54.5%)	22 (100%)
Std. Residual	1.1	**1.5**	-1.1	
cluster 2	0 (.0%)	0 (.0%)	10 (100.0%)	10 (100%)
Std. Residual	-.9	**-1.3**	.9	
cluster 3	1 (4.3%)	3 (13.0%)	19 (82.6%)	23 (100%)
Std. Residual	-.5	-.6	.4	
Total	4 (7.3%)	10 (18.2%)	41 (74.5%)	55 (100%)

From this it is clear that in cluster 1 resides 54.5% of profitable enterprises compared to the 13.6% which are largely unprofitable. And in cluster 3 are 82.6% of profitable enterprises and 4.3% largely unprofitable. The most successful are in 2 large cluster, where all businesses are mostly profit. Cells with the best contribution to significance are reported with bold standardized residuals.
However, the criterion of expected frequencies in this case is not fulfilled. 6 cells (66.7%) have an expected count of less than 5.
Therefore, we performed one more analysis: an adjusted pivot table type 2x2 (not reported there), which took into account only companies of cluster 1 and cluster 3 and counted frequency of unprofitability and zero profit. All expected frequencies in this case were greater than 5. Significance was established, with the value of G^2=4.229 and p = 0.040. Research hypothesis 3 of the context of sorting firms into clusters based on the use of funding sources and economic results is confirmed.

Conclusion

This research showed that profit affects the way companies benefit from funding sources. The best jointly managed companies were in cluster 2, which benefited the most from funding sources described in Factor 1 (the dynamics factor of financing a business entity), and also had positive and significant results in factor 2 (the loan burden factor of a business entity) and factor 4 (the factor of advances and sale of business lending claims). The least successful profit firms were in cluster 1, which significantly greater use of financial resources only in factor 2. Better results were obtained from cluster 3, which, on the contrary, had significantly less use of financial resources only in factor 2.
Poor quality and poor orientation and structure of educational institutions, underfunding of education, a large number of universities, dispersion and inefficient spending of state funds and insufficient linking schools to the needs of individual companies, resulted in a low level of interest in research and educational institutions on effective applied research. As a result, there is an acute shortage of vocational and technical education available to young people. The quality of any educational institution should be measured by the percentage of graduates actually working in their field of study.
Foreign direct investment (FDI) is the decisive factor in stimulating structural changes in industry, penetration of domestic companies to foreign markets, regional development, creation of new employment opportunities and the overall improvement of the domestic business environment in Slovakia. Unfortunately, with regards to Slovakia, FDI in industry is currently insufficiently channeled into sophisticated production with higher added value, employing high-tech workers, such as engineering.

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KWANTYFIKACJA FINANSOWANIA I ANALIZA SYTUACJI FINANSOWEJ FIRM INŻYNIERYJNYCH W REPUBLICE SŁOWACKIEJ

Streszczenie: Sektor inżynieryjny jest podstawą produkcji przemysłowej na Słowacji. W ostatnich latach sektor ten doświadczał niemal równocześnie rekordowych upadków i wzlotów. Na Słowacji sektor ten stanowi rodzaj przemysłu matki. Produkcja pojazdów samochodowych jest najsilniejszą gałęzią inżynierii produkcji, następnie wymienić należy produkcję urządzeń elektrycznych i optycznych. Podsumowując, istnieje pogląd, że firmy inżynieryjne na Słowacji mają słabą siłę kapitału i finansowanie ich rozwoju jest bardzo ryzykowne. Konieczne jest, zatem szukanie innych źródeł finansowania, które mogłyby zaoferować tym firmom przewagę konkurencyjną w gospodarce rynkowej, przy przestrzeganiu wymogów prawnych. Celem autorów jest określenie, za pomocą metod matematycznych i statystycznych, możliwości finansowania, które mogą wykorzystać firmy inżynieryjne w Republice Słowackiej. Niniejszy artykuł dotyczy analizy wskaźników finansowych w latach 2007-2013.
Słowa kluczowe: inżynieria produkcji, źródła finansowania, analiza czynnika, analiza skupień, stowarzyszenie

數量化資金和工程公司的財務狀況分析，斯洛伐克共和國的

摘要：工程領域是工業生產在斯洛伐克的中堅力量。近年來，該部門幾乎同時經歷了創紀錄的低點和高點。在斯洛伐克，它代表了一種母親的行業。生產用於機動車是工程製造的最強分支，接著是生產電學和光學設備。總之，有一種觀點認為，在斯洛伐克工程業務具有資本實力弱，資助他們的發展是非常危險的。因此，有必要尋找其他資金來源，這將提供這些企業在市場經濟中的競爭優勢，在堅持法律要求。作者的目的是確定，用數學和統計方法，為工程公司在斯洛伐克共和國可以利用的融資機會。本文涉及的財務指標為2007 – 2013年的分析。
關鍵詞：工程製造，資金來源，因子分析，聚類分析，協會