Chapter 1
Correlational Research of Expenditure Spend on Slovak Armed Forces Participation in Peace Support Operations Led by NATO

Veronika Mitašová, Ján Havko and Tomáš Pavlenko

Abstract The expenditure which Ministry of Defence of the Slovak Republic spends on Armed Forces members' participation in peace support operations led by the North Atlantic Treaty Organisation is dependent on many factors. The main aim of this chapter is to find out the dependence level of this parameter from two selected factors, namely the level of defence expenditure and the GDP of the Slovak Republic. For this purpose the multifactor single-equation econometric model is created and tested. Based on the tests results, conclusions and proposals for further examination are formulated.

Keywords Peace support operation · Expenditure · Correlation · Econometric model

1.1 Introduction

Nowadays, peace support operations are an effective tool for conflict prevention and conflict resolution in problematic areas of the world. Mentioned type of operation is under the auspices of the international crisis management organizations. International organization of collective security, the North Atlantic Treaty Organisation ("NATO"), has undoubtedly a significant place among them.

V. Mitašová (✉) · J. Havko · T. Pavlenko
Faculty of Security Engineering, University of Žilina, Univerzitná 1, Žilina Slovak Republic
e-mail: veronika.mitasova@fbi.uniza.sk

J. Havko
e-mail: jan.havko@fbi.uniza.sk

T. Pavlenko
e-mail: tomas.pavlenko@fbi.uniza.sk

Š. Hošková-Mayerová et al., *Mathematical-Statistical Models and Qualitative Theories for Economic and Social Sciences*, Studies in Systems, Decision and Control 104,
DOI 10.1007/978-3-319-54819-7_1

This contribution is focused on the assessment of factors, which affects participation of the Armed Forces of the Slovak Republic in NATO peace support operations. It is necessary to identify and understand what influences the amount of finance spent on these operations from state budget of the Slovak Republic ("the SR"). Based on the input data the multifactor single-equation econometric model is created and tested. According to the results of each test, the hypothesis, that the amount of the expenditure which Ministry of defence ("MoD") of the SR spend on Armed Forces members' participation in peace support operations led by NATO is dependent on the defence expenditures and GDP of the SR, is confirmed or refuted.

1.2 Qualitative Analysis and Input Data

Before econometric model creation, it is necessary to do qualitative analysis, which means assessing relations between variables. In the contribution it will be verified, if the estimated correlation among the amount of finance spend on the Slovak Armed Forces members participation in NATO peace support operations, the defence expenditures and the level of GDP exists or not.

It can be assumed, that the amount of finance, which states spend on participation of their armed forces in peace operations, is affected by a lot of factors. Table 1.1 shows some of them.

For the purpose of creating and testing econometric model we should work with factors mentioned above, but because of many reasons, we will work only with data listed in the Table 1.2. First factor, variable x_1, is defence expenditure of the SR. This kind of data is publicly available on the official website of MoD of the SR, but only since 2001. Second factor, variable x_2—GDP of the SR, is available on the Eurostat portal. Third one, variable x_3, could be number of completed and ongoing peace support operations led by NATO. Although the information about number of

Table 1.1 Factors affecting the amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO

Variable	Factors
Amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO	Defence expenditure of the SR
	GDP of the SR
	Number of completed and ongoing peace support operations led by NATO
	Global security environment
	Number of military personnel in the SR
	Number of Slovak troops deployed in peace operations led by international crisis management organizations
	Costs of military personnel training
	Others

Table 1.2 Input data

Year	Amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO in million Euro (y)	Defence expenditure of the SR at current prices in million Euro (x_1)	GDP of the SR at current prices in million Euro (x_2)
2001	4.35943	632	23 572.9
2002	3.414446	662	25 971.7
2003	12.809034	762	29 489.2
2004	15.170682	762	33 994.6
2005	14.720513	848	38 489.1
2006	23.293318	898	44 501.7
2007	16.069106	929	54 810.8
2008	17.62134	994	64 413.5
2009	32.80862	967	62 794.4
2010	37.572209	853	65 897.0
2011	34.334504	763	68 974.2
2012	38.209909	790	71 096.0

Source Eurostat (2015), Ivančík (2013), SIPRI (2015)

completed and ongoing operations is available, it is difficult and also slightly mistakenly uses these data as a total number of peace support operations led by NATO in the individual year. Some operations are ongoing throughout the year, others only in certain months. More appropriate would be, in this case, to examine the correlation between the amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO and the number of peace support operations during particular months. However, because of other data distribution, it is not possible. The same problem is in the case of another factor, variable x_6—the number of Slovak troops deployed in peace operations led by international crisis management organizations. The number of troops in peace support operations may change through the operation, and this number is often slightly different from the mandate. Even though variable x_4, which is global security environment, affects the amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO, it is not a numerical quantity, so it would not be possible to use it in our econometric multifactor model. Other two variables, x_5—the number of military personnel in the SR and x_7—costs of military personnel training, would be appropriate to examine, but they are not available (Hošková-Mayerová 2017).

The small range of data is influenced by the fact, that the SR is relatively young country, but also a lot of needed information are confidential or they are not publicly available.

Based on the data in the Table 1.2, it is possible to notice a growing trend of expenditure for peace support operations led by NATO. The expenditure had increased in 12 years more than nine times. A similar trend is in the development of

GDP, which increased three times during the 12-year period. On the contrary, defence expenditures of the SR maintain approximately the same level.

1.3 The Construction of Econometric Model and Its Testing

It is possible to create and to test econometric model in different ways, from laborious and difficult calculation through different software. The results in this contribution were gained through MS Office Excel tools and STATISTICA software. Data sources were SIPRI database (Stockholm International Peace Research Institute) and Eurostat.

The particular regression equation, which expresses the relation between dependent variable y (expenditure of MoD on participation of the Slovak Armed Forces in peace support operations led by NATO in million Euro) and explanatory variables x_1 and x_2 (defence expenditure at current prices in million Euro and GDP of the SR at current prices in million Euro), can be written in the form:

$$y^{\wedge} = 4.1035 - 0.0199x_1 + 0.0007x_2 + u \tag{1.1}$$

The value of the parameter $b_1 = -0.0199$ indicates, that the increase of defence expenditure by 1 million Euro will reduce the amount of expenditure on the Slovak Armed Forces participation in NATO peace support operations by 19,900 Euro, while GDP remains unchanged. The value of the parameter $b_2 = 0.0007$ indicates, that increase of GDP by 1 million Euro will increase the expenditure on the Slovak Armed Forces participation in NATO peace support operations by 700 Euro, providing defence expenditure remained unchanged.

Multiple $R = 0.8949$ means, that there occurs a very strong positive correlation in the econometric model. The value of reliability $R^2 = 0.8008$ can be interpreted, that about 80% of the explaining variable variability is explained by the variability of explanatory variables. Remaining 20% of the explaining variable variability, which is amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO, is explained by other variables (Table 1.3).

Graphical representation of variables y, x_1, x_2 distribution is in the Figs. 1.1, 1.2 and 1.3. On the right side of these figures are values characterizing variables, namely minimum, maximum, standard deviation or median.

Table 1.3 Basic statistical values of the econometric model

Summary statistics	
Multiple R	0.8949
Multiple R^2	0.8008
Adjusted R^2	0.7566

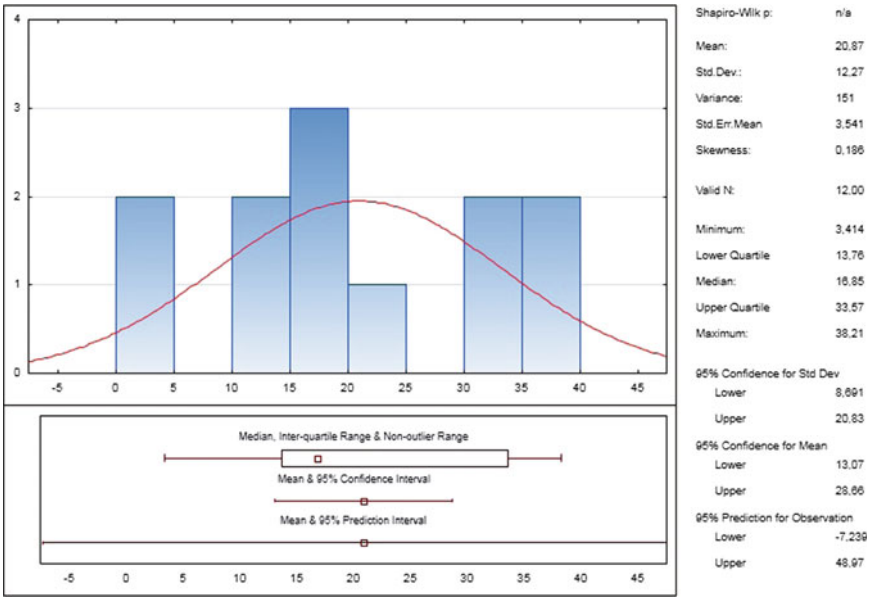

Fig. 1.1 Graphical summary for variable y

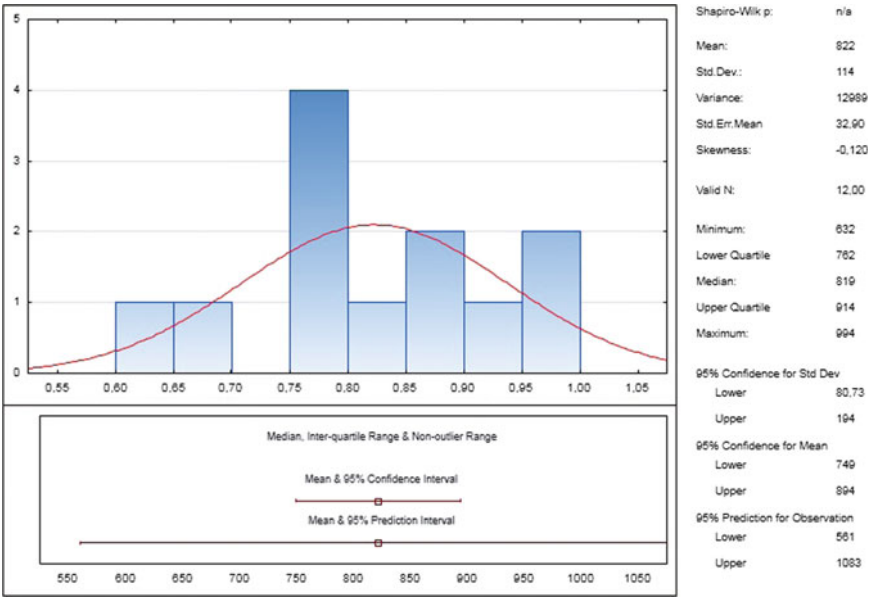

Fig. 1.2 Graphical summary for variable x_1

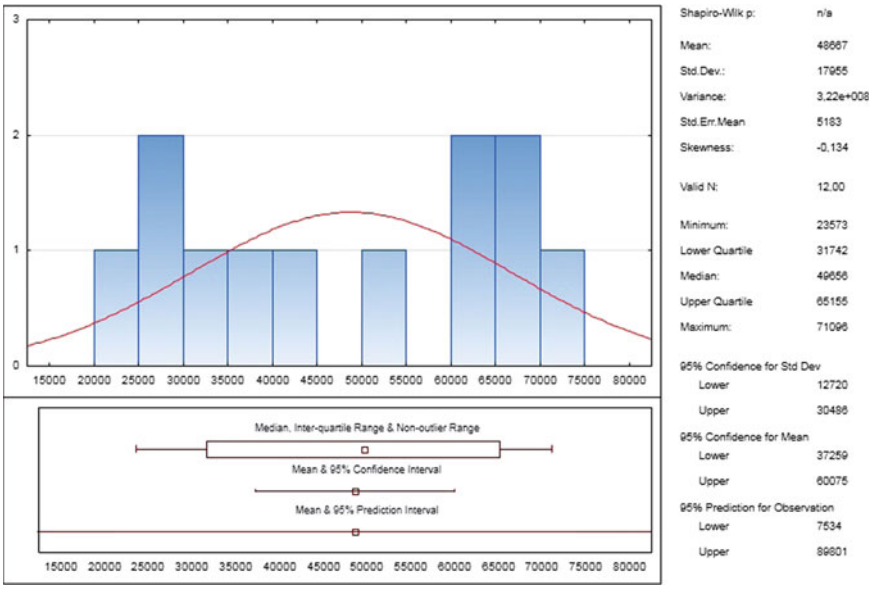

Fig. 1.3 Graphical summary for variable x_2

Econometric model must be tested after its creation, thus it is possible to conclude whether the model is applicable for practical needs. These tests are testing model as a whole through the coefficient of determination R^2 tested by Fisher's statistics (F-statistic), testing parameters of variables through Student's probability distribution (t-statistics), testing of residuals autocorrelation (we have <15 observations, so we will use Von-Neumann ratio and D-statistics). Verification of heteroscedasticity, respectively homoscedasticity, is made by Goldfield and Quandt test. The last test is used to find out the presence of multicollinearity in the model. For this purpose, we will use Farrar and Glauber method, where the correlation matrix is tested through Chi-square (Mikolaj and Vančo 2004; Ristvej and Kampová 2009).

Because of comprehensive testing procedures, there will be stated only particular resultant values of tests and conclusions related to them.

1.3.1 Testing of Econometric Model as a Whole

The value of determination coefficient R^2 is 0.8008. It means, that approximately 80% of the amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO variability is explained by the variability of defence expenditure and GDP in the SR. Remaining nearly 20% of the explaining variable variability is affected by other factors, which

are not included in the model. F-statistic test was performed at a significance level 0.05.

Therefore, if the model would be significant as a whole, the inequality (1.2) has to be valid.

$$F_r > F_{\alpha;k;[n-(k+1)]} \tag{1.2}$$

The value of $F_r = 18.0938$ and $F_{0,05,\ 2,\ 9} = 4.2565$, consequently, the determination coefficient of on the significance level 0.05 is considered as a significant and the model as a whole is considered as a statistically significant too.

1.3.2 Testing of Variables Parameters Through t-Statistics

Both of parameters, $b_1 = 0.0199$ and $b_2 = 0, 0.0007$, are tested at the significance level 0.05. To consider parameter as a statistically significant, the inequality (1.3) has to be valid.

$$|t_i| > t_{\alpha;[n-(k+1)]} \tag{1.3}$$

In the case of parameter $b_{1,}$ after substituting into inequality $0.9811 < 2.2622$, it does not apply. It means that the parameter b_1 at the significance level 0.05 is not considered as statistically significant. After substituting into inequality in the case of parameter b_2, inequality form is $5.2772 > 2.2622$. Based on it, we can formulate conclusion that inequality applies, therefore, the parameter b_2 at significance level 0.05 is considered as statistically significant.

1.3.3 Testing of Residuals Autocorrelation

Testing of residuals autocorrelation for <15 observations is carried out by Von-Neumann ratio. To autocorrelation verification the calculated value is compared to the tabulated one, while the inequality (1.4) has to apply.

$$D^+ < D < D^- \tag{1.4}$$

Value of $D^+ = 1.2301$, $D^- = 3.1335$ and $D = 2.0705$, therefore, the inequality applies. We conclude autocorrelation of residuals absents in our econometric model.

1.3.4 Testing of Heteroscedasticity

It is necessary to test heteroscedasticity for each variable x (x_1 and x_2). For the hypothesis "scatter of residuals is constant, there is homoscedasticity of residuals in the model" acceptation, inequality (1.5) has to apply, whereby the value v means degree of freedom.

$$F_{2,1} \leq F_{\alpha(v,v)} \tag{1.5}$$

It is calculated according to Eq. (1.6). The value v = 2 and tabulated value $F_{0.05;(2,2)} = 19$.

$$v = [\frac{(n-M)}{2}] - (k+1) \tag{1.6}$$

After substituting into inequality in the case of variable x_1, it is $1.6852 < 19$, in the case of variable x_2, it is $1.4757 < 19$. Therefore, the inequality applies in both cases, we conclude, that heteroscedasticity of residuals absents in our model. For better expression of values, in the Fig. 1.4 are shown predicted and observed values of variable y.

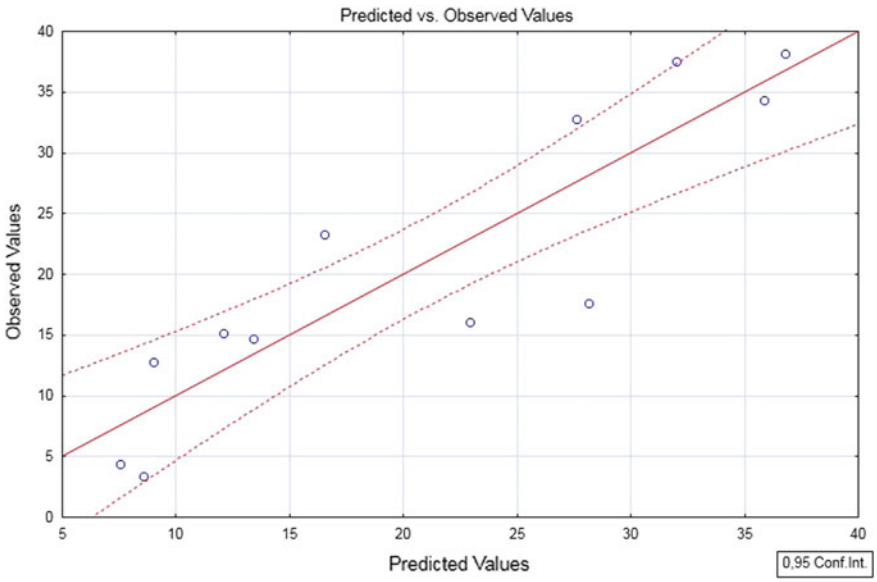

Fig. 1.4 Graph of predicted and observed values of variable y

Table 1.4 Matrix of correlational coefficients

	Defence expenditure of the SR at current prices in million Euro (x_1)	GDP of the SR at current prices in million Euro (x_2)
Defence expenditure of the SR at current prices in million Euro (x_1)	1.0000	−0.6167
GDP of the SR at current prices in million Euro (x_2)	−0.6167	1.0000

1.3.5 Testing of Multicollinearity

For testing a presence of multicollinearity in the model is used Farrar and Glauber method. This method allows to assess the overall multicollinearity in the set of explanatory variables and through determinant of correlation matrix testing by χ^2 (chi-square) test, it is possible to find out, which variables cause the multicollinearity (Table 1.4).

To prove that there is not multicollinearity in the model, the following inequality must apply:

$$\chi_R^2 \leq \chi_{\alpha(v)}^2 \tag{1.7}$$

After substituting tabulated value and value of determinant $|R|$ converted to empirical value, the inequality is $4.4550 > 3.8415$. However, the inequality does not apply. Therefore, the multicollinearity is in the model. We adopt the conclusion about interdependence of explanatory variables x_1 and x_2 at significance level 0.05.

1.4 Results and Discussion

The contribution is focused on multifactor single-equation econometric model creation. Through that we were able to fulfil stated objective and to find relations and dependencies among chosen variables. The aforementioned variables were the amounts of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO as explaining variable, defence expenditure of the SR and GDP of the SR as explanatory variables.

The prerequisite was that between mentioned explaining and the two explanatory variables, there will be a strong dependence. After creating and testing model as a whole, we concluded, that about 80% of the explaining variable variability is explained by the variability of explanatory variables. However, what is interesting and somewhat surprising, is fact, that parameter b_1 at the significance level 0.05 is not statistically significant. We expected that the amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support

operations led by NATO will certainly depend on defence expenditure of the SR. However, based on tests results, we ascertained our assumption was not correct.

Due to other tests we can comprehensively assess created model and its suitability for application. The first was residuals autocorrelation test. We found out, that there is not residuals autocorrelation, which is a positive finding. Another test confirmed that heteroscedasticity of residuals absents in the econometric model. But the last test, which is implemented in the case of multifactor econometric model testing, multicollinearity test, demonstrated an adverse finding. The explanatory variables are interdependent; therefore, multicollinearity is present in our model.

Based on the results of the individual tests, the created econometric model can be described as inappropriate for using in the present form. The main reason for this statement is fact, that one of the explanatory variables, the amount of defence expenditures in the SR, does not explain the variable y sufficiently. Another reason is the presence of multicollinearity, interdependence of explanatory variables.

Interestingly, we created one-equation econometric model from the input data again, but this time, it was only one factor econometric model. We wanted to ascertain, whether after a modification of the original model, in which the variable x_1 (defence expenditure in the SR) will not be, the new one will prove as reliable and useful. New form of regression equation is:

$$y^{\wedge} = -8.4932 + 0.0006x + u \tag{1.8}$$

The value of multiple $R = 0.8829$ indicates is a very strong positive correlation. The value of reliability $R^2 = 0.7795$ means, that about 78% of the explaining variable variability is explained by the variability of explanatory variable. This single-factor econometric model was tested; all results are in the Table 1.5.

The single-factor model successfully passed all tests. Their results confirmed that the model as a whole, and also the parameter b are at the significance level 0.05 statistically significant. There is not residuals autocorrelation; also the hypothesis about homoscedasticity was confirmed. Thereby was proven, that after removal statistically insignificant variable—the amount of defence expenditure in the SR, we created new model which is usable in practice.

Certainly, this claim would be justified in the context of further research in this field and original econometric model. It would be definitely appropriate to adjust or

Table 1.5 The results of single-factor econometric model tests

	Critical/tabulated value ($\alpha = 0.05$)	Comparative criterion calculated value (inequality)	
Testing of econometric model as a whole unit	$F_\alpha = 4.9646$	$F_r > F_\alpha$	$F_r = 35.3581$
Testing of variable parameter	$t_\alpha = 2.2281$	$\lvert t_i \rvert > t_\alpha$	$t_i = 5.9463$
Testing of residuals autocorrelation	$D^+ = 1.2301$ $D^- = 3.1335$	$D^+ < D < D^-$	$D = 1.7760$
Testing of heteroscedasticity	$F_\alpha = 9.2766$	$F_i \leq F_\alpha$	$F_i = 6.0031$

modify this model. Further research of dependence level with other variables could increase the percentage of the explaining variable variability explained by the variability of explanatory variable. In other words, it would be suitable to focus on this model and clarify the dependence. Despite of the model reliability, there are a lot of factors, which are logically more accurate to explain variable y, the amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO. This variable certainly depends on costs related to preparation of the Armed Forces members. Unfortunately, such data are not available.

In conclusion, it is necessary to mention, that our model was created from a relatively small range of data. It also could misrepresent and influence the results. Its reliability would increase if we could use wider range of variables data (Maturo and Hošková-Mayerová 2016; Ristvej and Kampová 2009). It is necessary to mention that because of the test results, the need of research a lot of other variables was highlighted. However, that is directly related to the processing dissertation thesis dealing with these issues.

1.5 Conclusions

Activities of international crisis management organizations are often the focus of media and public attention. That is why it is interesting to research factors which influence the amounts of financial sources spend on these activities.

The aim of this chapter was to reveal dependence among chosen variables. We expected strong correlation among them, so we created and tested econometric model. Based on test results, we have to definitely acknowledge that chosen explanatory variables are not able to adequately explain the dependent variable y—amount of expenditure spend by MoD of the SR on Armed Forces members' participation in peace support operations led by NATO.

Nevertheless, the scope for further research was created, thus it will be a part of processing dissertation thesis.

References

Eurostat. *Gross domestic product at market prices*. [on line]. Available at: http://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tec00001&language=en (2015).

Hošková-Mayerová, Š. (2017) Education and Training in Crisis Management. In: *The European Proceedings of Social & Behavioural Sciences EpSBS, Volume XVI*. Future Academy, 2017, p. 849–856.

Ivančík, R.: *Financovanie operácií medzinárodného krízového manažmentu (Financing of Operations led by International Crisis Management Organisations)*—lecture materials. General Staff of the Armed Forces of the Slovak Republic (2013).

Maturo, F., Hošková-Mayerová, Š. (2016) Fuzzy Regression Models and Alternative Operations for Economic and Social Sciences Recent Trends in Social Systems: Quantitative Theories and Quantitative Models, Decision and Control, Vol. 66, Maturo (Eds.), 235–248.

Mikolaj, J., Vančo, B.: *Ekonometria pre manažérov (Econometrics for Managers)*. Žilina: Fakulta špeciálneho inžinierstva ŽU (2004).

Ristvej, J., Kampová, K.: *Ekonometria pre manažérov—návody na cvičenia (Econometrics for Managers—exercises).* Žilina: EDIS- vydavateľstvo ŽU (2009). 140 pp. ISBN 978–80-554-0107-2.

SIPRI Military Expenditure Database. [on line]. Available at: http://www.sipri.org/research/armaments/milex/milex_database (2015).