ANADOLU ÜNİVERSİTESİ SOSYAL BİLİMLER DERGİSİ
ANADOLU UNIVERSITY JOURNAL OF SOCIAL SCIENCES
Cilt/Vol.:7- Sayı/No: 1 : 85-96 (2007)

THE BANKING STABILITY IN THE CZECH REPUBLIC BASED ON DISCRIMINANT AND CLUSTER ANALYSES

Liběna Černohorská* Jan Černohorský**
Petr Teplý***

ABSTRACT

Banking sector can have important effects on all economic units. Therefore stability of the banking sector is important for every economy. In the Czech Republic the banking sector has undergone profound changes after 1989. This study aims to develop a stability model for the banking sector in the Czech Republic using data for the period from1995 to 2005. According to the model developed in the study stability of banks is easily evaluated. In this study concerning 38 banks in the Czech Republic's banking sector 17 banks are found to be at a satisfactory level according to the model.

Keywords: *bank, stability, financial indicators, discriminant analysis, cluster analysis*

ÇEK CUMHURİYETİ BANKACILIK SEKTÖRÜNDE AYRIŞMA VE KÜMELEME ANALİZİNE DAYALI STABİLİTE ÖLÇÜMÜ

ÖZ

Bankacılık sektörü tüm ekonomik birimleri önemli ölçüde etkileyebilmektedir. Bu nedenle her ekonomi için bankacılık sektörünün stabilitesi önemlidir. Çek Cumhuriyeti'nde bankacılık sektörü 1989 sonrası önemli değişikliklere sahne olmuştur. Bu makale 1995-2005 dönemi verilerini ele alarak Çek Cumhuriyeti'nde bankacılık sektörünü için stabilite modeli geliştirmeyi amaçlamaktadır. Çalışmada ortaya konan modele göre bankaların stabilitesinin değerlendirilmesi kolaylıkla gerçekleştirilebilmektedir. Çek Cumhuriyeti bankacılık sektöründen 38 bankada yapılan uygulamada 17 bankanın modele göre yeterlilik düzeyinde olduğu belirlenmiştir.

Anahtar kelimeler: *banka, stabilite, finansal gösterge, ayrışma analizi, küreselleşme analizi*

* University of Pardubice Faculty of Economics and Administration e-mail: libena.cernohorska@upce.cz

** University of Pardubice Faculty of Economics and Administration e-mail: jan.cernohorsky@upce.cz

***Charles University in Prague Faculty of Social Science Institute of Economic Studies e-mail: petr.teply@gmail.com

1.Introduction

The banking sector significantly influences economic subjects and its stability is therefore crucial for each economy. The Czech banking sector has seen a sharp development since velvet revolution in 1989. For example, big banks funded manager's leveraged buy-outs and accepted company' s shares, usually over-priced, as collateral for their loans. On related note, small banks were sometimes founded for financing allied companies or even for financing bank's managers. For these reasons, the connection among Czech banks and enterprises was becoming stronger and stronger. Consequently, when a company went bust as a result of improper actions taken by bank' s managers, banks posted lower recovery rates from the loans because of value-Iess collaterals in their portfolios.

Clearly, such conditions did not support company' s restructuralization [26] and resulted in losses in bank' s books. Therefore plenty of banks went under in the Czech Republic in 1990' s and hence the stability of the banking sector deteriorated and the trust of customers in banks dropped (for example collapses of Agrobanka, Union Banka, IPB etc.). It is indisputable that the stabilized banking sector has been built in the Czech Republic in a relatively short period. Despite some pitfalls, the progress towards a higher stability has been made mainly due to better risk management, new IT technologies, higher-qualified staff and know-how brought by foreign investors.

The article deals with creating a bank stability model based on the discriminant analysis made on data obtained by the development of Czech banking sector in the period 1995-2005[1]. Cluster analysis is used for veryfing defined hypothesres. Both discriminant and cluster analyses have many applications in biology, market research, social network analysis and data mining.

2. The Selection of the Financial Indicators

The bank sector has seen fast development in the Czech Republic since1989. During the period some banks, for various reasons, finished their activities, while some banks are still operating today. Therefore we can suppose that the insolvent banks will show different values of financial indicators than the solvent (healthy) ones.

However, there is a slight difference between the term stability and solvency. For instance,

The bank is solvent if:

- it respects the rule of cautious banks entrepreneurships determined by the Czech National Bank (CNB);
- it has not received any financial or other help neither from the state nor the CNB;
- the value of relevant financial indicators will be moving around the values of the group of stable banks.

On the other hand, the bank is insolvent if:

- it was forced to finish its activity for reasons such as taking of the lieense or forced control or a bank which has received any he Ip from the state;

1 The Altman criteria for Czech banks cannot be used under original conditions, because these criteria were used for the U.S. environment that differs from the Czech one.

- the value of relevant financial indicators will be moving around the values of the group of the mean value insolvent banks.

2. 1. .Determination of Financial Indicators for Definition the Bank Stability Model [2]

When creating the bank stability model, it was necessary to choose the suitable financial indicators that are different for values of the solvent and insolvent banks and are uncorrelated at the same time. Using financial indicators varies both in the Czech (see Babou_ek [1] or Ziegler [27]) and the foreign literature (Golin [13]). Since data comes from the Czech banking sector, financial indicators have been chosen regarding the Czech market features, the Czech accounting standards and information disclosure of the Czech banks, and data availability.

The financial indicators were calculated for every bank in given years. Based on these calculations the median for each financial indicator was computed in each year, separately for solvent and insolvent banks (see Tables 2 and 3) This statistic indicator was selected based on its using by rating agencies such as Moody's and Standard & Poors when evaIuating bank performance (for instance return on average assets (ROAA), the bad loans volume etc.). The values of these indicators were calculated for last three years and then compared with the median of the classification group.

The main criteria for creating the bank stability model were the uncorrelated indicators and simultaneously values of the indicators differ for the group of solvent banks and the group of insolvent banks (verified by a graph showing time series of the financial indicators).

Based on the above-mentioned criteria the following indicators were selected:

- return on to average level of assets (ROAA);
- equity/liabilities;
- interest margin;
- profit margin;
- equity/total assets ratio.

Table 1 The Financial Indicators for the Solvent Banks in the Period 1995 - 2005 (Median, in %)

	1995	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
ROAA	0,69	0,79	0,52	0,33	0,02	0,13	0,58	0,66	1,60	1,55	1,72
Equity/Liabilities	18,35	18,41	37,10	34,93	19,92	8,35	18,31	11,26	20,68	19,32	20,50
Profit margin	5,07	8,18	4,80	2,84	0,23	8,24	6,71	12,31	21,56	21,63	21,88
Interest margin	3,54	2,89	2,00	2,52	3,47	5,31	2,34	1,97	4,05	3,96	4,12
Equity/Tota! assets	8,65	8,42	9,30	10,35	8,30	5,83	7,18	6,72	2,05	1,99	2,03

Source: own caleulation

2 See Tepla , L. The Evaiuation of Banking Stability on Discriminant Analysis. In Poloucek, S., Stavarek, D. (eds.) Future of Banking after the Year 2000 in the World and in the Czech Republic (Volume X Finance and Banking). Karvina: Silesian University, 2005, pp. 97 - 109.

Table 2 The Values of Selected Financial Indicators Period 1995 - 2000 (Median, in %)

	1995	*1996*	*1997*	*1998*	*1999*	*2000*
ROAA	-2.02	-1,30	0,91	0,35	0,00	0,13
Equity/Liabilities	9,76	11,28	8,73	7,30	8,62	8,35
Profit margin	-16,69	-7,26	-4,23	-4,38	0,00	8,24
Interest margin	4,69	4,06	4,84	5,48	3,79	5,31
Equity/Tota! assets	5,66	7,39	5,50	4,91	6,41	5,83

Source: own caleulation

2. 2. The Determination of Financial Indicators for the Cluster Analysis

We have done the selection of the banks as the first step. We will measure commercial banks because they substantial sight is to offer all types of commercial or investing products. The existence on a market of others types of the banks is quite different.

After that we counted an arithmetical average of the indicator when we count the values of conerete indicator through all the bank in the concrete group of the banks and through all the years and this count we divide with the number of values of the indicators (number 122 or 46). Than we get an average value of the indicator that characterizes existing banks in all the years or an average value of the indicator that characterize all non-existing banks (table 3).

Differences among the averages were counted for existing and non-existing banks in the next step of our analysis. These differences were divided with total average of concrete indicator for all the banks for all the years because we did not influence the selection of indicators by the total difference of solvent or insolvent banks. See the following table.

Table 3 The Selection of Suitable Financial Indicators for the Cluster Analysis

	Profitability and productivity				Liquidity			Assets quality	
	ROAA	ROAE	Profit per employee (CZK ths)	Operational profit/total assets	Quick assets/total assets	Receivables from clients/total assets	Bacic deposits/ total liabilities	Provisions charge/total assets	Provision charge/re-ceivables from clients
Average (solvent)	-0.0039	-0.0083	416	0.0173	0.1837	0.8053	0.3691	0.0254	0.1136
Average (insolvent)	-0.0644	0.1959	-916	0.3954	0.1299	0.7571	0.4828	0.0781	0.1993
Average for all banks	-0.0192	0.0433	179	0.1129	0.1701	0.7931	0.3978	0.0387	0.1349
Difference existing - solvent	0.0605	-0.2043	1332	-0.3781	0.0538	0.0481	-0.1137	-0.0527	-0.0857
(differece/average all) x 100	**315.6%**	471.9%	**743.7%**	335.1%	**31.6%**	6.1%	**28.6%**	**136.1%**	63.5%

	Market share			Income and expense		Activity	Structure of liabilities	
	Market share - balance sheet size	Market share - loans	Market share - deposits	Income/ total asset	Expenses per employee	Turnover ratio of loans	Liabilites to banks/total liabilites	Liabilites to clients/tota l liabilites
Average (solvent)	0.0416	0.0703	0.0666	0.1300	9430	3876	0.3230	0.4522
Average (insolvent)	0.0189	0.0279	0.0321	0.6641	35064	20050	0.1780	0.5607
Average for all banks	0.0359	0.0596	0.0579	0.2650	13995	7594	0.2864	0.4796
Difference existing - solvent	0.0227	0.0424	0.0346	-0.5341	-25634	-16174	0.4830	-0.1085
(differece/average all) x 100	63.4%	**71.1%**	59.7%	201.6%	**183.2%**	**213%**	0.4831	22.0%

Source: own calculation

We chose indicators where we will premise that we can distinguish between existing or bankrupt banks with he ip of this rate.

The aim of shown analysis was to choose the indicators that characterize differences between insolvent and solvent banks. We wanted to choose one suitable indicator from the group of all indicators to preserve the widest view on the bank as is possible:

The following indicators were selected from the group of all indicators:

- return on average assets;
- profit per employee;
- quick assets/total assets;
- receivables to clients/total assets;

- provisions charge/total assets;
- market share from the point of view of given loans;
- expenses per employee;
- liabilities to banks/total liabilities

3. The Creation of the Bank Stability Model

When applying the discriminant analysis, we calculate values $D_1, ..., D_k$ for the random quantity X. The investigated element belongs to the group that has the biggest value from values of D_j. Values μ_j and are usually unknown, hence we have used their estimates. The probability P_j is usually chosen as proportionally to the range of the j-group, if these ranges are unknown, one can choose $P_j = 1/k$. [17].

3.1. The Creation of the Model

Firstly, for building the bank stability model it was necessary to calculate the following values:

- values of medians $(\tilde{x}_i)$ and variances (μ_j) for all indicators for the solvent banks in the period 1995 - 2005;
- values of medians and variances for all indicators for the insolvent banks in the period 1995 - 2000.

We calculated the determinant of the inverse covariance matrix D_j. The value of D_1 for a particular bank is calculated as follows:

$$D_1 = -0{,}5 \cdot \ln\left[\det\left(\sum\nolimits_1\right)\right] - 0{,}5 \cdot \left(\tilde{x} - \mu_1\right)' \cdot \sum\nolimits_1^{-1} \cdot \left(\tilde{x} - \mu_1\right) + \ln p_1 \quad (1)$$

$$D_2 = -0{,}5 \cdot \ln\left[\det\left(\sum\nolimits_2\right)\right] - 0{,}5 \cdot \left(\tilde{x} - \mu_2\right)' \cdot \sum\nolimits_2^{-1} \cdot \left(\tilde{x} - \mu_2\right) + \ln p_2 \quad (2)$$

The final result is to build up a model that enables forecasting the classification of a particular bank to the concrete group of banks based on provided calculations (either into the first group of the solvent banks or into the second group of the insolvent banks). A particular bank will belong to the group of either solvent or insolvent banks in dependence on the value of D_j (the bank will be placed to the group where it reaches the bigger value of D_j).

3.2. The Verification of the Model

The bank stability model was verified through 38 banks based in the Czech Republic. It was necessary to exclude the chosen bank from the observe group for verification. Hence the new covariance of inverse and transposed matrixes was created for every of 38 researched banks. Furthermore, the number of measurement P_j for every bank was adjusted.

3.3. The Verification of Results by Monitoring Bank of the Model

The result of the model was verified that for every bank the value s of the testing criterion D_1 a D_2 were found.

Consequently, the bank was classified into the group of either solvent or insolvent banks according to the value of the testing criterion D_j. As a result, 17 banks were classified as solvent banks and 24 banks as insolvent.

Data from the CNB were used for the verification of the bank stability model. The CNB presents in the publication "The Bank Supervision 2005" the following overview of the Czech banking sector:

- banks with the valid bank' s license;
- banks in the forced administration;
- banks in liquidation;
- banks in bankruptcy proceeding;
- banks as stock companies without the bank license;
- banks in bankruptcy without liquidation;
- banks in bankruptcy with liquidation.

Based on obtained results the comparison between the results from the researchedmodel and the real development of the Czech bank sector was provided.

3.4. The Evaiuation the Bank Stability Model

As it comes from our research, the results from the proposed model completely correspond to the real development of the Czech banking sector. The model has classified 17 banks to the group of solvent banks and 21 banks to the group of insolvent banks. In comparison with real data, this classification fully matches with the real development of the Czech banking sector (see Table 4).

Table 4 The Comparison of the Bank Stability Model with the Real Development of the Czech Banking Sector

	Total number of banks in group	
Bank group	**Bank stability model**	**Real bank development**
Solvent banks	17	17
Insolvent banks	21	21

Source: own caZculation, *www.cnb.cz*

Based on results oudined above we can claim that the bank stability model is able to predict if the chosen bank belongs either to the group of the solvent banks or to the group of the insolvent banks. Since data used in the model is public available, the model can be used by any economical subject for its decision process when choosing a bank for its financial transactions.

4. Creation of Methods of the Cluster Analysis

It can be used a multidimensional statistic method of duster analysis for verifing a defined hypothesis. Sets of objects (group of banks in our case) could be better divide to some inside homogeny groups. Output is that' inside the groups are objects (banks) similar and on the contrary of objects of different dusters are different each other. We can create dusters of solvent banks and dusters of insolvent banks.

Starting values for every bank are the average values of every indicator for a 19952005 period or for a shorter period based on the existence of their dates. Following step was transformation of part of indicator by the way all indicators had same tendency. It means their higher value means a negative development and lower value means a positive development. We used following formula for transformation.

$$y_i = \max\{x_1, x_2, ..., x_n\} - x_i, \quad i = 1,...,n \tag{3}$$

We had to make the transformation of indicators to compare modules. We used following formula to make standardized magnitude.

$$x_{ik}^{*} = \frac{x_{ik} - \bar{x}_k}{s_k} \tag{4}$$

We will use these values in next steps. We can count the distance between single objects at this moment. We calculate this by force of Euclidean distance; this relation could count it:

$$d(X_i, X_j) = \sqrt{\sum_{k=1}^{n} \left(x_{ik} - x_{jk}\right)^2} \,. \tag{5}$$

Hence we can get a matrix of distances in this manner. We will make clustering of objects by method of average distances, distance of objects will be counted by this relation:

$$d(S_h, S_k) = \frac{1}{n_h n_k} \sum_{x_i \in S_h} \sum_{x_i \in S_k} d(X_i, X_j) \tag{6}$$

The diagram of representation of progression of clustering is a graph that represents the clusters of the banks.

We divided banks into six groups (Diagram n. 1) on the principle of selected indicators and the chosen distance 2.5. At every group is existing bank or bankrupt but there is one exception in this case (IPB). We can explain this exception in this manner. We do not have so long-term data, there were same nonstandard accounting procedures that resulted problems of this bank did not show itself in data of the bank

It can be said that selected indicators classified well differences between solvent and insolvent bank if we know that solvent bank is the bank existing and insolvent bank is bankrupt.

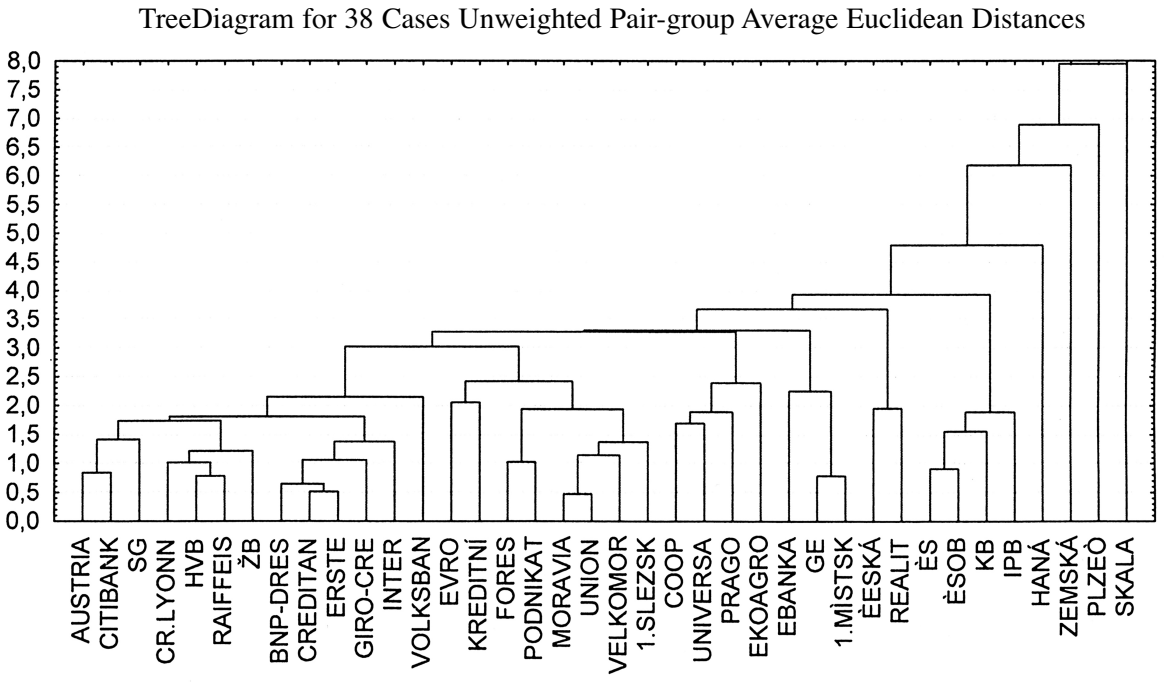

Diagram n. Tree Diagram For 38 Banks

5.Conclusion

The proposed bank stability model was verified on the selected banks doing business in the Czech Republic in the period 1995 - 2005. However, the verification could not be done on all the banks doing business in the Czech Republic in this period of time. The reason was data unavailability for an analysis of all needed financial indicators.

The bank stability model was created on the basis of the discriminant analysis. The discriminant analysis includes five financial indicators that help to classify a bank either into the group of the solvent banks or insolvent banks. The model was draw up by using 211 measurements, thereof 145 measurements were connected to the solvent banks and 66 measurements were connected to the insolvent banks. The classification of a bank to either the solvent or insolvent group fully corresponded to the facts published by the Czech National Bank

The choice of the financial indicators was partly influenced by its data availability. Our original intention included 11 financial indicators for providing the discriminant analysis.

However, we had to decrease the number of financial indicators because of correlation of financial indicators requirement. Therefore the number of indicators was cut from 11 to 5 indicators. The choice of these five financial indicators was also supported with the results of the financial analysis and through a graph describing time series of these financial indicators.

The verification of the model shows the practical usage for evaluation of the bank stability. The results verification was done for 38 banks in total, thereof 17 banks were clarified as the solvent banks and II banks as the insolvent banks. The used classification fully matches with the real development of the Czech banking sector.

We get to hypotheses during defining differences between solvent and insolvent bank. We confirm these hypotheses based on the results of the cluster analysis (we can say with respect to some conditions which influence information capability of the used method. However, the number of banks is not too extensive (38 banks), time series of indicator's value vary between 1 and 8 years (depending on period of data existence of a particular bank). The next reason is that banking went through complicated evolution during economic transition in the Czech Republic and also that the banks denoted as solvent had considerable problems in their activities. The Czech government even had to help big banks to hold their leading position on the market. The next factor is a purchase of banks by new owners and their financial recovery it means that before this operation the bank faced financial problems and was insolvent and after this operation the bank is solvent. Another aspect is credibility of accounting statements - we cannot suppose with a 100 % probability that all of data published in balance sheets and profit and loss accounts are true and correspond to accounting principles. We hope that this paper contributes to research in field of stability of banks.

Resume

The aim of this paper is to introduce the evaluation of banking stability based on both discriminant and cluster analyses. The model is built on the basis of financial indicators analysis of selected banking institutions in the Czech Republic in the 1995 - 2005period... The banks were divided into two groups - the group of operating banks and the group of bankrupted banks. Such a division was done according to the real development of the Czech banking sector based on data provided by the Czech National Bank. All banks providing services in the Czech Republic in the period of 1995- 2005 were analyzed in the model except for building societies (due to their different activities compared to commercial banks) and foreign bank's subsidiaries (strongly influenced by their foreign owners). Data for ca1culation of financial indicators were taken from bank's financial statements. Conclusions of our re search correspond to the real development of Czech banks in the examined period...

References

[1] BABOUČEK, 1. Analýza a hodnocení finanční situace banky na základě veřejně přístupných informací. Bankovnictví.1996, č. 13, roč. 4, str. 21-28. ISSN 1212-4273

[2] BLAHA, Z. S., JINDŘICHOVSKÁ, 1. Jak posoudit finanční zdraví firmy. Praha: Management Press, 1996. ISBN 80-85603-80-2.

[3] BORAK, N. Western Rules for Eastern Banking. In Post-Communis Economies. Abingdon, No. 3 (2000), Vol. 12, p. 293 - 306. ISSN 14631377

[4] CETORELLI, N. Analysis in Banking: Appraisal of the Methodologies. In E+conomic

Perspectives. Chicago, No. 1 (1999), Vol. 23, p. 2 -15. ISSN 1048115X

[5] ČERNOHORSKÁ, L. The EvaIuation of Banking Stability on Discriminant Analysis. In Poloucek, S., Stavarek, D. (eds.) Future of Banking after the Year 2000 in the World and in the Czech Republic (Volume X Finance and Banking). Karvina: Silesian University, 2005, pp. 97 - 109. ISBN 80-7248-342-0.

[6] ČERNOHORSKÝ, J. The Balance Sheet Structure as the Expression of the Economical State of the Bank. In Poloucek, S., Stavarek, D. (eds.) Future of Banking after the Year 2000 in the World and in the Czech Republic (Volume X Finance and Banking). Karvina: Silesian University, 2005, pp. 85 - 97. ISBN 80-7248-342-0

[7] ČERNOHORSKÝ, 1. Transformace bankovniho sektoru. In Hospodářská politika v tranzitivních ekonomikách III. Sbomík z mezinárodního semináře. Ostrava: VŠB- TU, 2002. str. 23-26. ISBN 80-248-0178-7

[8] ČNB. Zpráva o stabilitě bankovního sektoru. Výzkumná zpráva (leden 2004). Praha: ČNB.

[9] ČNB. Česká národní banka 1993 - 2003. Výzkumná zpráva (leden 2004). Praha: ČNB.

[10] ČNB. The Bank Supervision 1995 - 2005. Praha: Czech National Bank.

[11] ECB. Finandal stability review. Frankfurt am Main: European Central Bank 2007. ISSN 1830-2017

[12] GODDARD, J. A. - MOL YNEUX, P. - WILSON, O. S. European Banking: Technology and Growth. Hardcover, 2001. ISBN 0471494496

[13] GOLIN, J.: The Bank Credit Analysis Handbook: a guide for analysts, bankers and investors. Singapur: John Wiley & Sons, 2000. ISBN 0-471-84217-6.

[14] HALDANE, A. G., HALL, S., SAPORTA, V. Financial stability and macroeconomic models. Bank of England: Financial Stability Review, pp 80-88, June 2004.

[15] HOGGARTH, G., SAPORTA, V. Output costs of banking system instability: some empirical evidence", Bank of England: Financial Stability Review, pp 148-165, June 2001.

[16] KOTRBA, J., SVEJNAR, 1. Rapid and multifaced privatization, Experience of the Czech and Slovak Republic. Výzkumná prace. Praha: Univerzita Karlova - Cerge, 2002.

[17] KUBANOVÁ, J. Statistické metody pro ekonomickou a technickou praxi. Bratislava: Statis, 2003. ISBN 80-85659-31-X .

[18] MATOUŠEK, R. Finandal Analysis of Commercial Banks. Výzkumná práce č. 49. Praha: Institut ekonomie ČNB, 1996. 60 str.

[19] McLachlan, G.,J. Discriminant Analysis and Statistical Pattern Recognition. Wiley, 2004. ISBN 9780471691150

[20] MEJSTŘÍK, M. The Privatization Procec in East - Central Europe Evolunitionary Process of Czech Privatization. Dordrecht: Kluwer Academic Publisher, 1997. ISBN 0¬7923-4096-5

[21] MERV ART, J. České banky v kontextu světového vývoje. 1. vyd. Praha: Nakladatelství Lidové noviny, 1998. 162 str. ISBN 80-7106-236-7

[22] SEGER, J., et aL. Statistika v hospodárství Praha: ETC Publishing, 1998. ISBN 80¬-86006-56-5

[23] SEKERKA, B. Finanční analýza společnosti na bázi účetních výkazů. Praha: Profess,1996. 152 str. ISBN 80-85235-40-4

[24] ROMESBURG, H. Cluster Analysis for Researchers. North Carolina: Lulu Press, 2004. ISBN 1-4116-0617-5

[25] TEPLÁ, L. Problémy stabilizace bankovnictví v ČR. E+M Ekonomie a Management. 2001, roč. IV, s. 14-18.

[26] TETŘEVOVÁ, L. Alternative Approaches to Classification of Company Restructuring.Sci. Pap. Univ. Pardubice 9. Ser. D, 1. vyd., 2004, S. 177 - 180. ISBN 80-7194-716-4. ISSN 1211-555X

[27] ZIEGLER, K., et al. Finanční řízení bank. Praha: Bankovní institut, 1997. ISBN 80¬-902243-1-8