MEASURES OF HOSPITAL'S FINANCIAL CONDITION – EMPIRICAL STUDY

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Abstract. *The aim of financial condition analysis is to signal "early enough" unfavorable changes in selected business activity areas. The most popular, and largest group of signals, there are quantifiable financial signals, because most management decisions and changes in the company's environment is reflected in the financial data. In literature, and also practice, there are a lot of methods of financial condition's forecasting. Unfortunately, most of them, can't be applied in hospital industry. In this paper we have shown, that it is possible to analyse financial distress of hospitals, basing on financial ratios. The presented proposal use gradient method, which seems to be an interesting and effective proposition for forecasting financial difficulties, especially, for hospitals.*

Keywords: *synthetic measures; financial analysis; hospitals; financial distress forecasting.*

Introduction

Health system is crucial from the point of view of society's welfare. Health spending consume a significant share of gross domestic product. In the countries of Central and Eastern Europe health spending are generally lower than in the countries of Western Europe – but still, this is about 7% of GDP (OECD Health Data, 2014). A significant part of these resources are devoured by an inpatient care.

From the beginning of the 1990s, in the countries of Central and Eastern Europe, we can observe the ongoing process of health sector's reforming. The main direction designates moving away from the socialist model of health system, and adoption of a model based on universal health coverage, with bigger or lesser participation of the private sector. This change meant, from the point of view of hospitals, a new way of financing. In the period before the transformation, hospitals were funded on the basis of annual budgets - now hospital are forced to negotiate annual contracts, contract, determined the amount of provided benefits. This change meant, for hospitals, a drastic change, that essentially changed their business environment (Soltes & Gavurova, 2014).

Hospitals, in the countries of Central and Eastern Europe, are mostly public, owned by government or local-government units. On average, about 80% of the hospital beds are beds in public hospitals (HOPE,

2014). This means, in practice, that the public owner takes the responsibility for the bad situation of the hospital, which means often the need of financial support for indebted hospitals. It has an impact on the situation, also in the financial context of local governments, above all, those having smaller income potential. As a result, there is an emphasis on the implementation of the management tools, which allow monitoring, assessment and forecasting of the hospital's financial situation. Regardless of the issue of the owner's responsibility for hospital's debts, it should be highlighted, that hospitals, especially public, carry out a number of additional tasks, which go far beyond the provision of health services (Harrison & Sexton, 2004) – public hospital should assure the constant wide access to essential health care services (Michalski, 2008). The problem of financial health also has another aspect – many studies confirmed a link between the financial health of the hospital and quality of health benefits (Bazzoli & Andes, 1995; Gavurová et al., 2014; Bazzoli et al., 2007; Bem & Michalski, 2014; Bazzoli et al., 2008; Michalski, 2009). Financial problems often lead to necessary savings, which can not only lower the quality of the benefits, but may also limit access to benefits for part of the population.

For further research, it is necessary to define the concept of financial health, because the literature does not indicate one, generally accepted, definition (Michalski, 2010). The issue of financial condition is often interpret as the state associated with the problem of liquidity and solvency. In this context a good financial condition is defined as the possibility to meet, timely, the company's obligations. The financial condition may also be defined as some sort of the financial achievement, measured by cumulative changes in net assets, fund equity, or net cash flows (Wang, Dennis & Tu, 2007; Michalski, 2014).

Most of the research on the hospital's financial health bases on financial indicators, which are widely used in the corporate sector. These indicators can be applied directly, without any modification, or after a necessary modification, which aims to take into account the specificities of hospital industry (Watkins, 2000; Langland-Orban, Gapenski & Vogel, 1996; Pink et al., 2006; Gapenski, Vogel & Langland-Orban, 1993; Zeller, Stanko & Cleverley, 1997; Zeller, Stanko & Cleverey, 1996; Michalski, 2015).

Pink et al. (2006) pointed out six dimensions of financial performance that are essential for the assessment of the hospital financial health: profitability indicators, liquidity indicators, capital structure indicators, revenue indicators, cost indicators, and, finally, utilization indicators. Others researchers generally used different combinations of, enumerated above, indicators. Basing on those dimensions (indicators) we can built the synthetic measure of hospital financial condition, which should relatively easy to calculate, interpret and monitor (Raisova et al., 2014).

Since the 1960s, researchers looks for a synthetic measure of company' financial condition. Studies were initiated by Beaver (1966) and Altman (1968) and based on financial data from industrial enterprises. This study lead to creation a tool designed to forecast and measure the risk of bankruptcy. Synthetic indicators might be potentially created on the basis of selected financial and non-financial indicators. Literature studies provides only two synthetic indicators which was adapted for hospital industry (in financial distress' prediction): Z-score, based on Altman's model and Financial Strength Index (FSI). Altman's Z-score is widely known, due to applications in industrial firm. FSI, developed by Cleverley was designed especially for hospitals, and bases on four dimensions: profitability, liquidity, leverage, and the age of physical facilities (Cleverley, 2002, p.46).

Literature studies also suggest the need to create indicators which take into account the conditions arising from the location (countries, regions) and characteristics of the industry (Kitowski, 2013). This suggests, that the hospital financial health indicators, which were mostly built in the United States, even if they are adapted to the hospital industry, may not be directly implemented in the countries of Central and Eastern Europe, or even Western Europe, due to the differences in the organisation of the health system. These differences relate primarily to funding mechanisms and the degree of market regulation (Szczygiel et al., 2015).

This study correspond with current international research, leading to creation of a synthetic measure of financial condition's assessment in health care system. That's way this research is of exploratory character. During earlier research, we indicated, using taxonomic tools, the group financial indicators that had a significant impact on the assessment of the hospital's financial condition and most strongly

affect current, and also future, financial situation. Presented study is a continuation of previous research, as a result of which, we built three measures of the hospital financial condition (M1, M2, M3).

The study uses financial data coming from 333 hospitals from the Czech Republic, Poland and Slovakia. The purpose of the research is to test the effectiveness of the created measure in identifying hospitals with poor financial health, through the creation of a standard model of "*bankrupt hospital",* so the hospital in bad financial situation, that can be compared with chosen dataset of "*good*" and "*bad*" hospitals.

We have posed the following research hypotheses:
H1: it is possible to build a pattern of "bankrupt hospital" on the basis of a relatively small group of financial indicators;
H2: M1and M2 measures effectively indicate hospitals in good and bad financial condition.

The study used statistical, econometric and taxonomic tools. In order to build a synthetic indicator of hospital financial situation we have used discriminate and gradient method. The estimated model of "*bankrupt-hospital*" has been verified with the cross-validation method, using training and testing dataset. Statistical analysis has been conducted using Statistica 10 software.

Methods and data

Research sample covered 333 hospitals of Czech, Polish and Slovakia. Financial data were collected from databases: Amadeus and Emerging Markets, and, additionally, hospital's financial statement, collected by authors. We initially investigated 976 hospital, assuming that every entity qualified into research should fulfil several criteria:
- hospital activity should be a main area of overall activity;
- organizational structure - only hospitals having at least a admission room and two ward – in order to remove from the sample hospitals providing mainly one-day procedures;
- hospital size – only hospitals with income higher than 1 million euro have been included into research.

Significant part of hospitals were removed due to criteria presented above and certain part of observation were rejected as a results of the lack of all required data. Finally research sample covered financial data from 333 hospitals, coming from financial statement (balance sheet, profit and loss report, and cash flow statement) for the year 2012.

The study is based on the results of authors' previous research. We have created, using gradient methods, taxonomic measures of financial hospital health (M1, M2, M3)[1]. Basing on the developed measures, we have selected a group of good and weak hospitals, which were examined in this part of the study.

In order to verify previously built measures, we chose the gradient method, which is a taxonomic tool. The gradient method bases on determination of taxonomic distances between examined objects and defined reference points (bottom, top). This procedure allow to construct synthetic indicators of different nature, by combining values of, potentially, very diversified variables, including those denominated in different units, even dummy ones. This procedure makes result relatively easy to interpret, because the output takes the form of one value, usually from the range [0,1], what increases potential practical applications of constructed indicators (Siedlecka & Siedlecki, 1990; Siedlecki, 2014).

The gradient method assumes, that the matrix X comprises of stimulants. The transform into stimulants should be done according to the following formulas:
- for nominants: $x_{it} := -|x_{it} - median(x_i)|$
(1)

[1] Results during a publication process. Research were presented on the conference "Enterprises and the Competitive Environment" in Brno, 5-6 March, 2015.

- for destimulants: $x_{it} := -x_{it}$,.
(2)
Values of financial ratios (observations of the studied phenomenon) are denoted as: x_{ij}, where:
$i = 1,2, ..., m$, (a number of analysed indicator);
$j = 1,2, ..., n$, (a number of analysed observation);
and $x_{ij} \in R$.
In order to measure a taxonomic distance, two points must be determined:
Top: $P = [p_{1,0}, \dots, p_{m,0}]$
Bottom: $Q = [q_{1,0}, \dots, q_{m.0}]$
where: $p_{o,1} = max\ x_{i,j}$ and $q_{0,1} = min\ x_{ij}$
According, that QP segment describes the axes of synthetic indicator, PQ vector gradient takes a form of linear programming function:
$GR(X) = [P - Q]X^T$
(3)
and values of this function represent the value of synthetic indicator, according to formula:
$\varphi = (p_{i,o} - q_{i,0}) * x_{i,j}$
(4)
Obtained values of specific indicators, due to its construction, might take potentially very dissimilar values. In this situation, some indicators would potentially affect the constructed synthetic measure more strongly than other. To avoid this effect, obtained values are reduced to the range of [0-1] using the standardization method. Conversions should be made, from matrix X to Z, according to the following formula:
$z_{it} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})}$
(5)
As a result, points P and Q take the following form: $P = |1, \dots 1|$, $Q = |0, \dots 0|$:
$\varphi = \sum_{i=1}^{m} z_{it}$, and the measure of development (μ_t) is defined as:

$$\mu_t = \frac{\varphi}{m} \quad (6)$$

The procedure, applied in this study, covered several steps:
1) determination of μ-measure values for hospitals in poor financial condition, by specifying the minimum and maximum values of selected indicators;
2) determination of the values of μ_t and the minimum and the maximum of $x_{i,j}$ for bankrupt-hospitals training dataset
3) determination of the ranges of the $r_{i,t}$ measure, which define bankrupt-hospital financial condition (weak, good, unidentified), according to the following formula:

$$r_{it} = \frac{x_{it} - \min\ bankrupt(x_{it})}{\max\ bankrupt(x_{it}) - \min \text{bankrupt}(x_{it})} \quad (7)$$

in this case, the value of α_t indicator can be calculated as follows: $\alpha_t = \frac{\varphi(t)}{m}$,when:
$\varphi(t) = \sum_{i=1}^{m} r_{it}$
(8)
4) testing the results using testing dataset, containing "good" and "bad" hospitals.

We have analysed the linear relationship using Pearson correlation coefficient. Pearson's correlation coefficient indicates both the direction and strength of relationship. Due to the strength that can sometimes be questionable. The validation of the effectiveness of the financial health measures has been based on the cross-validation method. Hospitals characterised by the poor and very good financial health have been divided into two groups – training dataset and testing dataset. The cross-validation is a model validation technique which allow to assess, how the results of a statistical analysis generalize to an independent data set. Training dataset allows to build a econometric model fitted as good as possible. The estimated model is subjected to validation using testing data chosen from the same population.

Results and discussion

Based on previous research, we built three measures of hospital's financial measures - M1, M2 and M3. Using this measures we have created the ranking of hospitals, according, they may take values from the range [0,1]. Then we have assumed, that hospitals, for which the values of measures M1, M2 and M3 were lower than the mean minus one standard deviation had a difficult financial situation, and hospitals, for which M1, M2 or M3 values were higher than the mean plus one standard deviation had very good financial condition. By adopting this interpretation we qualified analysed hospital into three groups, characterised by, accordingly, difficult, average/good or very good financial conditions (Table 1).

Table 1. The assessment of hospital's financial health using the measures M1, M2 and M3

Financial condition	M1	M2	M3
Difficult	47 (17,1%)	43 (12,9%)	39 (11,7%)
Average/good	250 (72%)	251 (75,4%)	251 (75,4%)
Very good	36 (10,9%)	39 (11,7%)	43 (12,9%)

To the further research we selected hospitals, whose financial condition were rated as difficult, and hospitals whose situation were very good. The group of 57 "poor" hospitals (36 are recognize as difficult base on M1and M2 and M3, 11 only base M1, 7 only in M2 and 3 only in M3), was, then, divided, randomly, into two groups – the training dataset (30 hospitals) and the testing dataset (27 hospitals). A similar procedure was applied to hospitals characterised by very good (or good) financial situation – we created the training dataset of 30 hospitals and testing dataset of 50 hospitals from the best 100 hospitals.

In the first step, using training dataset of "poor hospitals", we built two indicators of financial condition for *"bankrupt-hospital"* by selecting 7 from 14 financial indicators for the B1 measure and 5 from 14 to B2 measure (see table 2). The selection of financial indicators based on:
- discriminatory methods,
- expert methods (measurability, availability, reliability, economy, types of characteristics);
- the analysis of the statistical significance of the average values between "poor hospitals" (training dataset) and "very good hospitals"
- the correlation analysis.

Table 2. Financial indicators chosen to construction of B1, B2 measures

Ratio	Formula	Character	Group	Measure
OPM	EBIT/Sales	stimulant	profitability	B1
CR	Current Assets/Current liabilities	nominant	liquidity	B1, B2
D%	Total debt/Total Assets	destimulant	debt	B1, B2
CF/Debt	(Net Profit + Depreciation)/Total debt	stimulant	debt	B1
TAT	Sales/Total Assets	stimulant	efficiency	B1, B2
CES	Employee benefit expense/Sales	destimulant	efficiency	B1, B2
ROCF	(Net Profit + Depreciation)/Total Assets	stimulant	profitability	B1

On the basis of the indicators, selected for the training group of *"poor hospitals"*, we built the measure of hospital financial condition (B*). In order to create B^* measure, all indicators have been transformed into stimulants and the gradient method was applied. In order to verify our training dataset of *"poor hospitals"* we calculated, again, the correlation coefficients and average values based on the group of 30 *"poor hospitals"* (training dataset) and the group of 30 *"very good hospitals"* - randomly selected from the best 100 "very good hospitals" (see table 3). We, finally, used 7 selected ratios for measure B1 and 5 ratios for B2 (eliminated ROCF and CFDebt characterised by the highest correlation coefficients), including indicators of profitability, liquidity, debt, and efficiency. Nominants and destimulants were convert to stimulant using formulas 1 and 2. The B1 and B2 measurements were built using formulas 3,4,5.

Table 3. The selected indicators for "bankrupt hospitals" (training group)

	Average value for "poor hospitals"	Aveage value for "very good hospitals"	t	p-value	N "poor hospitals"
OPM	0,069851	-0,090862	4,102293	0,000129***	30
CR*[1]	0,468621	1,775059	-3,40135	0,001220***	30
D%	0,601942	1,328344	-4,78014	0,000012***	30
CF/Debt	0,573273	-0,036921	2,406008	0,019336**	30
TAT	3,365505	1,528672	4,973887	0,000006***	30
CES	0,291515	0,554865	-8,24222	0,000000***	30
ROCF	0,234708	-0,084109	3,793178	0,000357***	30

[1] *Current Ratio calculated as deviation from the optimal value (median for 60 hospitals)*
* significance level α = 0.01, ** significance level α = 0.05 *** significance level α = 0.01

For further research both B1 and B2 measures were selected. It can be observed, that both group were actually different and correlation coefficients are less than 0,7 (see table 4) so we could built using this ratios ours B1 and B2 measurements.

Table 4. The correlation matrix for selected indicators

	OPM	CR*	D%	CFDebt	TAT	CES	ROCF
OPM	1,000000	0,023277	-0,230937	0,497041	0,204421	-0,670749	0,556652
CR*	0,023277	1,000000	-0,180390	0,094666	-0,354765	0,170516	0,011573
D%	-0,230937	-0,180390	1,000000	-0,265243	0,125297	0,323603	-0,414949
CFDebt	0,497041	0,094666	-0,265243	1,000000	0,243492	-0,357841	0,692628
TAT	0,204421	-0,354765	0,125297	0,243492	1,000000	-0,276694	0,186025
CES	-0,670749	0,170516	0,323603	-0,357841	-0,276694	1,000000	-0,429585
ROCF	0,556652	0,011573	-0,414949	0,692628	0,186025	-0,429585	1,000000

**we calculated distance from median value using data from 60 hospitals*

Then (step 2) we calculated minimum and maximum values of selected ratios (see table 5) and the value of α_t for the B1 and B2 measurements, using the training group of *"poor hospitals"* (the distance between the analysed hospital to the hypothetical *"best hospital"* from the group of *"poor hospitals"*).

Table 5. Minimum and maximum values of B1 and B2 (unitarized measures)

	OPM	CR	D%	CFDebt	TAT	CES	ROCF
Measure B1							
MIN	-0,58574	-9,3131	-2,72154	-0,29592	0,162815	-0,85657	-0,75409
MAX-MIN	0,729254	9,21694	2,627635	0,926257	5,334226	0,514318	0,897459
Measure B2							
MIN	-0,58574	-9,3131	-2,72154	-	0,162815	-0,85657	-
MAX-MIN	0,729254	9,21694	2,627635	-	5,334226	0,514318	-

During the third step we determined the ranges (intervals) of the B1 and B2 measures, which defined financial condition (weak, good, unidentified) of *"poor hospitals"*.

Table 6. Basic Statistic for measurement B1, B2 – training dataset of "poor hospitals"

	α_t – B1	α_t – B2
Average	0,556563647	0,573957798
Median	0,573242823	0,591716158
Standard deviation	0,114307484	0,086234203
Minimum	0,073698507	0,271523071
Maximum	0,703991206	0,693028658

Employing the minimum and maximum values of the B1 and B2 measures (see table 6), we have assumed the following interpretation of the α_t indicator:
for the B1 measure:
- if $\alpha_t < 0,71$ – *a strong warning signal - high probability of financial difficulties* – that means, that the values of financial indicators are lower than in the case of *"the best"* hospital from the group of *"poor hospitals"*;
- if $0,71 < \alpha_t < 0,81$ - *a warning signal, which indicate the average risk of financial difficulties*; hospitals from this range are a slightly better than *"the best"* hospital from the group of *"poor hospitals";*
- if $\alpha_t > 0,81$ - *lack of a clear warning signal – low probability of financial difficulties*, hospitals from this area are definitely better than *"the best"* hospital from the group of *"poor hospitals"*.
The analogous interpretation can be implemented for the B2 measure:
- if $\alpha_t < 0,7$ - a strong warning signal, high probability of financial difficulties;
- if $0,7 < \alpha_t < 0,8$ - a warning signal, the average risk of financial difficulties;
- if $\alpha_t > 0,8$ - lack of a clear warning signal – low probability of financial difficulties.

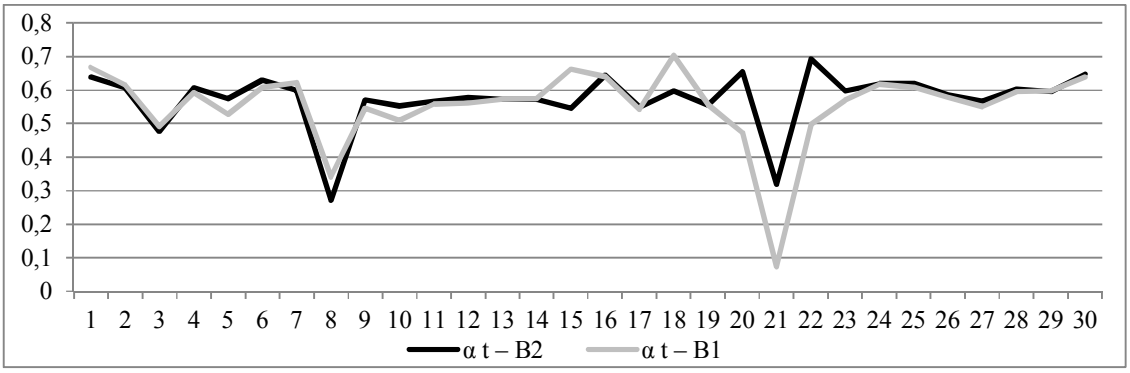

Figure 1. The value of measures for the training data of "poor hospitals"

Most of analysed hospitals was characterised by values of B1 and B2 from the range [0.5-0.7] what implied a strong warning signal. We could also observe the positive correlation between values of measures B1 and B2 (see figure 1).

In order to test, whether created measures - B1 and B2 - accurately identifies the financial condition of hospitals, we created warning forecasts for 77 hospitals (the fourth step in presented methodology). The aim was to test, whether hospitals identified as *"poor hospitals"* are, indeed, weak, and *"good hospitals"* are effectively in good condition. During this part of study, research sample covered the testing group of *"poor hospitals"* (27 hospitals) and the testing group for *"good hospitals"* (50 hospitals).
To test the new measures α_t for B1 and B2 we normalized financial ratios, according to formula 7, where we used the minimum and maximum values of B1 and B2 (see table 5) for testing ratios. Adopting this methodology, the value of α_t can be higher than 1 - some hospitals might have all ratios better than the best ratios from all poor hospitals. We have found, that both measurement B1 and B2 identified hospitals with weak financial situation very rightly, with 100% accuracy (see table 7 and figure 2).

Table 7. Effectiveness of the warning forecast (testing group of 50 "good hospitals" and 27 "poor hospitals")

	B1	**B2**
lack of a clear warning signal – low probability of financial difficulties	44	30
warning signal, the average risk of financial difficulties	6	19
strong warning signal, high probability of financial difficulties	27	27

It can be also observed, that for testing group of *"poor hospitals"* maximum value α_t for B1 and B2 is lower than in training dataset but the average value is higher, because the minimum value is higher also (see table 8).

Table 8. Basic Statistic for measurement B1, B2 – testing dataset of weak hospitals

	α t – B1	**α t – B2**
Average	0,622072	0,638323
Median	0,630388	0,635494
Standard deviation	0,039146	0,022472
Minimum	0,441175	0,59766
Maximum	0,654328	0,693713

We can also notice, that most of weak hospitals was classified as having the poor financial situation, regardless of the adoption of B1 or B2 measure. Only 1 hospital had the very low value of B1, while the B2 was as close to the average value from the group (see figure 2).

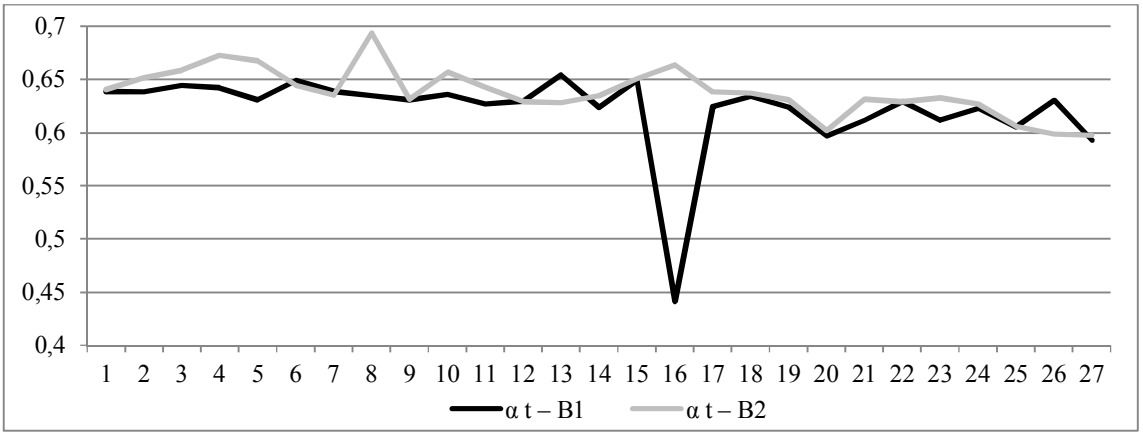

Figure 2. The value of measures for the training data for "poor" hospitals

We have found, that in the case of *"good hospitals"* some differences between values B1 and B2 occurred. Table 9 presented basic statistics for the testing dataset of 50 *"good hospitals"*. We see that average measurements are significantly higher than "poor" hospitals and the minimum is higher than maximum in poor hospitals (see table 9).

Table 9. Basic Statistic for measurement B1, B2 – testing dataset of "good" hospitals

	α t – M1	**α t – M2**
Average	0,865432	0,846479
Mediane	0,822106	0,838194
Standard deviation	0,238351	0,052292
Minimum	0,708314	0,77027
Maximum	2,470313	1,080809

It seems to be interesting that in measurement B1 one of hospital had very big value of α_t (2,5) and one is very close to financial difficulties area.

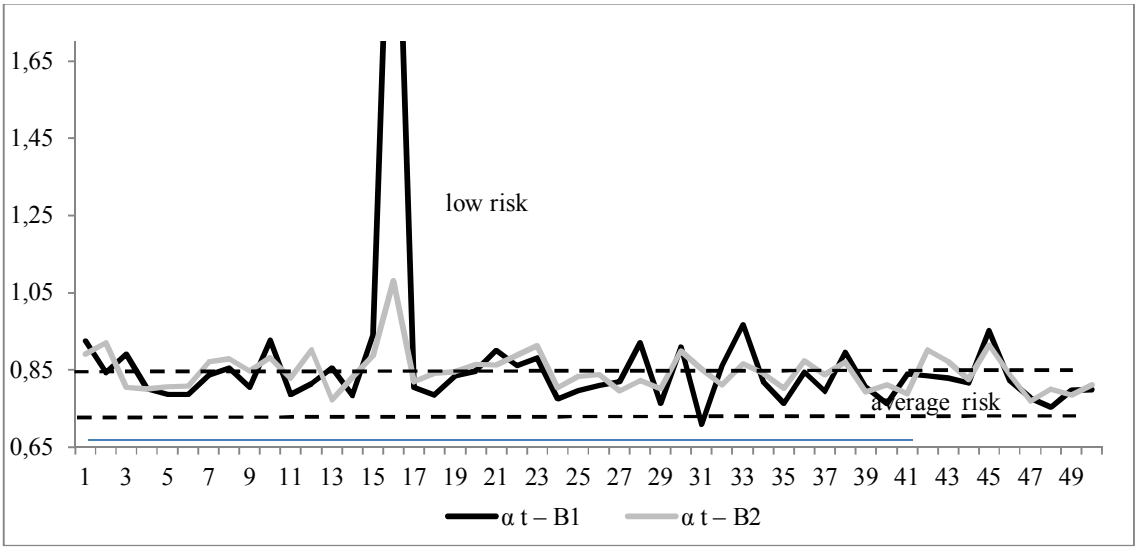

Figure 3. The value of measures for the training data for good and very good hospitals

Analyzing measurement B1 and B2 we can conclude, that the effectiveness of both measures in identifying financial difficulties is the same. We have observed, that the measure B1 is slightly better, because it recognised 44 from 50 good hospitals and only 6 classified to the grey area characterised by average risk of financial difficulties ($0,71<\alpha_t<0,81$), while the B2 measure classified 19 hospitals to the grey area (see table 7). We have also found, that the B1 measure is better to identify the best hospitals, where the sample is characterised by high volatility and extreme values (high robustness).

Conclusions

In this paper we have presented the simple and efficient method allowing the assessment of hospitals' financial health. Proposed indicators, based on the gradient method, are very simply to calculate and interpret. Both measures are built on financial indicators, what may be also interpret as their weakness, but, on the other hand, those data which comes from mandatory financial statements, are much easier to obtain, what is very important in the case of countries, like Poland, where there is no obligation to publish financial statements even in the case of public entities. This simplicity is also important, from the point of view of managers, because it doesn't require to calculate specific indicators.

Proposed measures demonstrated high efficiency, assuming that the test sample was representative. They have proved to be a very good tool for forecasting financial difficulties and determine the financial condition of hospitals. The results, presented in this paper, should be considered as conceptional ones and should be extended by including indicators specific market-based indicators.

References

Bazzoli, G.. and Andes, S. (1995). Consequences of hospital financial distress. *Hospital & Health Services Administration,* 40(4), 472-95.

Bazzoli, G.J., Chen, H.-F., Zhao, M., and Lindrooth, R.C. (2008). Hospital Financial Condition and the Quality of Patient Care. *Health Economics,* 17(8), 977–995.

Bazzoli, G.J., Clement, J.P., Lindrooth, R.C., Chen, H.F., Aydede, S.K., Braun, B.I., and Loeb, J.M. (2007). Hospital financial condition and operational decisions related to the quality of hospital care. *Medical Care Research and Review,* 64(2), 148-168.

Bem, A., and Michalski, G. (2014). The financial health of hospitals. V4 countries case. Zborník vedeckých štúdií. In *Sociálna ekonomika a vzdelávanie* (pp. 1-8). Banska Bystrica.

European Hospital and Healthcare Federation (2014). Retrieved from http://www.hope.be/03activities/1_1-facts_and_figures-web_tool.html.

Gapenski, L., Vogel, W., and Langland-Orban, B. (1993). The determinants of hospital profitability. *Hospital and health services administration,* 38(1), 63-80.

Gavurová, B., Šoltés, M., and Balloni, A. (2014) The Economic Importance of Using of ICT in the Health System. *Ekonomický časopis,* 62(1), 83-104.

Harrison, J.P., and Sexton, C. (2004). The paradox of the not-for-profit hospital. *The Health Care Manager,* 23(3), 192-204.

Kitowski, J. (2013). Metody dyskryminacyjne jako instrument oceny ryzyka upadłości przedsiębiorstwa. *Zarządzanie i Finanse*, 4(3), 197-213.

Langland-Orban, B., Gapenski, L., and Vogel, W. (1996). Differences in Characteristics of Hospitals with Sustained High and Sustained Low Profitability. *Hospital & Health Services Administration,* 41(3), 385-399.

Michalski, G. (2015). Full operating cycle influence on food and beverages processing firms characteristics. *Agricultural Economics - Zemědělská Ekonomika*, 61. Retrieved from http://www.agriculturejournals.cz/web/agricecon.htm?journal=AGRICECON&futureArticleId=4004923&type=futureArticleAbstract.

Michalski, G. (2014). Value maximizing corporate current assets and cash management in relation to risk sensitivity: Polish firms case. *Economic Computation and Economic Cybernetics Studies and Research,* 48(1), 259-276.

Michalski, G. (2010). Planning optimal from the firm value creation perspective levels of operating cash investments. *Romanian Journal of Economic Forecasting,* 13(1), 198-214.

Michalski, G. (2009). Inventory management optimization as part of operational risk management. *Economic Computation and Economic Cybernetics Studies and Research,* 43(4), 213-222.

Michalski, G. (2008). Corporate inventory management with value maximization in view. *Agricultural Economics,* 54(5), 187-192.

OECD Health Data (2014). Retrieved from http://www.oecd.org/els/health-systems/health-data.htm.

Pink, G.H., Holmes, G.M., D'Alpe, C., Strunk, L.A., McGee, P., and Slifkin, R.T. (2006). Financial indicators for critical access hospitals. *The Journal of Rural Health,* 22(3), 229-236.

Raisova, M., Buleca, J., Michalski, G. (2014) Food processing firms inventory levels in hard times. *Procedia Economics and Finance*, 12, 557-564.

Siedlecka, U., and Siedlecki, J. (1990). *Optymalizacja taksonomiczna*. Kraków: AE.

Siedlecki, R. (2014). Forecasting Company Financial Distress Using the Gradient Measurement of Development and S-Curve. *Procedia Economics and Finance*, 12, 597-606.

Soltes, V., and Gavurova, B. (2014). The functionality comparison of the health care systems by the analytical hierarchy process method. *E & M Ekonomie A Management*, 17(3), 100-117.

Szczygiel, N., Rutkowska-Podolowska, M., and Michalski, G. (2015). Information and Communication Technologies in Healthcare: Still Innovation or Reality?. In Nijkamp, P. (Ed.), *5th Central European Conference in Regional Science* (pp.1020-1029). Košice: Technical University of Košice.

Wang, X., Dennis, L., and Tu, Y.S. (2007). Measuring financial condition: A study of US states. *Public Budgeting & Finance,* 27(2), 1-21.

Watkins, A.L. (2000, Spring). Hospital financial ratio classification patterns revisited: Upon considering nonfinancial information. *Policy. Journal of Accounting and Public,* 19(1), 73–95.

Zeller, T.L., Stanko, B.B., and Cleverey, W.O. (1996). A revised classification pattern of hospital financial ratios. *Journal of Accounting and Public Policy,* 15(2),161–181.

Zeller, T.N., Stanko, B.B., and Cleverley, W.O. (1997). A new perspective on hospital financial ratio analysis. *Healthcare Finacial Management,* 51(11), 62-66.