ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LX 30 Number 2, 2012

RATING CALIBRATION

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Received: November 30, 2011

Abstract

MYŠKOVÁ, K., HAMPEL, D.: *Rating calibration.* Acta univ. agric. et silvic. Mendel. Brun., 2012, LX, No. 2, pp. 223–230

In this work we deal with the question of whether the evaluation of selected rating agencies is equivalent in some sense or not and whether it is possible to find a relationship between assessments. The fact that rating agencies affect not only financial market participants (by publication of companies or states ratings) is undeniable. On the one hand, these agencies are criticized for the rating changes, which have influence for example credit conditions for rated entity. On the other hand, ratings have a growing number of users for which ratings have become one of the few clues in today's complicated conditions powered by global financial crisis.

For this purpose we use the calibration problem techniques, because calibration finds a relationship between two measurements, in our case between two independent assessments of rating agencies. Due to the nature of the data we assume that the relationship can be described by linear or quadratic function. So we use estimates derived for the one-dimensional linear calibration model with quadratic calibration function. This all we illustrate by the real ratings. The situation is complicated by the ordinal type data of the examined variables. Among other things, we discuss relations between ratings coming from particular rating agencies and evolution of this relation over time.

linear calibration model, sovereign ratings

By the "rating", we mean a type of evaluation of particular economical subject, i.e. state, company or a security. It is obvious that each rating must have certain criteria and must serve a specific purpose. For this reason, there are more ratings of serving different users.

History of the rating services is closely related to the development of the United States of America financial market. The beginning of rating can be considered the year 1909, when John Moody started to evaluate the bonds of railway companies (which were a very important sector of the economy). Soon after he started using this type of bonds assessment for utilities and industrial companies. Among the first agencies also belonged Poor's Publishing Company, which issued its first ratings in 1916, the Standard Statistics Company and the Fitch Publishing Company, whose ratings followed in 1922. Rating market gradually evolved so that today there are three leading global rating agencies.

Originally, ratings were developed primarily as ratings associated with a particular issue of securities (the issue rating), and later began to enjoy themselves rating actors (so-called issuer rating). At first it was mainly business entities, most recently, however, ratings of municipalities and countries (so-called sovereign ratings) were developed. Ratings of countries appear in the 90's of the 20th century mostly.

Rating is not a recommendation to buy, sell or hold any security, nor shall not consider the suitability of investments for a particular investor. External rating provides important information for the financial market and helps to orient to the financial market investors, who often do not have options and time to find out detailed information. Over the years rating gained recognition among investors and is accepted as a tool for differentiating credit quality.

In this paper, we focus on so-called sovereign ratings, i.e. ratings of the countries, particularly on agencies providing such ratings. This ratings can be labeled as external ratings, because agencies providing ratings not for own need, but for different users. In this context, rating means the international

standard measurement tool (evaluation) the creditworthiness of countries to assess their credibility. Rating reflects the degree of business risk for foreign companies and quantifies the probability that the country will honor its commitments. The award is an expression of the quality of the state as a debtor and its economic ability to meet its own issued liabilities and pay on time and in full amount of principal and interest owed.

Ratings are primarily used by investors, issuers, investment banks, brokers and government institutions. Credit rating agencies extend investment opportunities for the investors and provide independent and user-friendly assessment of the relative credit risk. This substantially increases market efficiency and reduce costs to investors (the costs associated with the analysis of issuers, etc.), investment banks and brokers use the ratings when calculating the risk of its portfolio.

Rating directly affects mainly bonds, namely the difference between yields with very low risk (AAA rating), and bond yields with a given lower ratings. Rating accumulates parameters important for bond investors, such as government debt and its development, and general status and outlook for the local economy. However, the rating also affects the overall view of investors in a given state, which can also changes the behavior of the currency. Deterioration of the rating may negatively affect the taste of foreign investors to bring new capital.

This ranking is also reflected in the fact that the state has for the difference between the reference rating valuation and its worse rating to pay to its creditors the credit surcharge when issuing new bonds, which balances the lower quality of debtor. Practically, this means that the state has more expensive credit because of worsened rating. In the case of ten-year yield of the Czech Republic is a premium roughly 0.3 percentage point against the European reference level.

External rating is characterized by the usage of expert methods. It is different to the scoring methods, which – after developing – can be used to perform an evaluation of many subjects rather quickly. The basis is already scoring achievements entity (results of the company), a past data and then evaluation is objective in the sense that the evaluator does not intervene to set algorithm evaluation. This method of assessment is a transparent, of course, faster and less demanding, but is generally less informative.

In addition to the requested rating which the company pays, there are so-called unsolicited ratings (called "public information"). Unlike the official rating, independent agency processes unsolicited ratings of its decision and at its own expense. These ratings are based on publicly available sources such as financial statements, annual and press releases, etc. This kind of rating is not so meaningful and it cannot be used as an indicator of extras between individual companies.

Actually, the role of the credit rating agencies is contested significantly. During the financial crisis, some investors in the United States of America attempted to blame the rating agencies that have recommended investments that were not stable. Many claims have been bought off and therefore agencies should be responsible for the crisis. The greatest part of economists believe that agencies are only riding on a wave of enthusiasm and their evaluation came in a bubble, it did not correspond to reality. Agencies resist by the fact that rating is only estimate of the future and estimate just came out. The fact ratings were ordered by companies, not by those who wanted to invest in bodies, can cause that ratings were more positive than the actual situation. The agencies are also often criticized for not acceding to all the companies evaluated independently and not included in the evaluation all known risks. Finally, rating is an estimate, but may have an active impact on the rated entity: a downgrade of its rating deteriorates its situation on the market in general and can act as a "self-fulfilling prophecy".

In this paper we focus on comparability of credit rating agencies outputs. We introduce three biggest agencies, methodology of assigning a credit rating, rating scale and linear calibration technique. Numerical calculations are based on two samples of worldwide sovereign ratings. The main hypothesis is that all the agencies produce identical ratings in terms of linear calibration problem.

MATERIAL AND METHODS

Credit rating agencies

Usually, ratings are determined by independent rating agencies. According to the Basel Committee on Banking Supervision (2000), it exists nearly 150 credit rating agencies around the world. Some, however, have significance only on a national level (such as those being developed in Sweden) or regional, only a few agencies operating globally. For the activities of these agencies are the most important independence and credibility. In order to become a recognized agency, it must be able to respond to changing market demand internationally.

In global world-renowned rating agencies are currently considered only three entities in principle, Standard & Poor's, Moody's Investors Service and Fitch Ratings. Each of these agencies employ roughly about a thousand analysts and the rating assigned to the order of thousands of subjects. These agencies, reside in the United States of America, operate worldwide, and their evaluation is internationally recognized. Information about these three agencies is obtained from Vinš (2005).

Standard & Poor's

The history of this credit rating agency began the year 1860, ratings are provided since 1916. It was an independent publicly traded company until 1966,

when it was bought by a large publishing company McGraw-Hill Inc. Standard & Poor's Rating Services (S & P) is now one of its units, but in terms of ratings, it operates independently.

Besides a large range of ratings, this agency provides further assessment of subjects with related services, such as various studies and analysis, statistical information, educational services. The Risk Solutions division provides services to banks especially in the building of internal rating systems (including model approaches) and in the field of credit risk. Financial analysts use some indexes introduced by the S & P, such as S & P 500.

The process of granting S & P rating is highly standardized, rating shall be granted only if they are available all necessary information and after the quantitative, qualitative and legal analysis. S & P appoint a team of analysts led by leading analyst who researches information related to the rating. Team members study all the documents and meet with representatives of the rated entity to verify the necessary facts.

After studying all the information analysis team shall submit their documents with the draft decision on the credit committee, which acts on them, discussed and finally voted upon. Rated entity is informed of the outcome evaluation and the factors that led to it, and it can express its disapproval of any proposed assessment even before it is published, or may even provide additional important information.

Moody's Investors Service

Moody's Investors Service (Moody's) has been incorporated as a CRA in 1914. John Moody founded the company in the year 1900, when he has published the Manual of industrial and other securities. This manual provided information and statistics about securities. Later, Moody began to improve the analytical methodology and in 1909 published analytical evaluation principles, which quickly found their place in the market in the hands of investors.

European issuers are evaluated by Moody's since 1920 and the rapid expansion of its credit rating was mainly from the 80th years in connection with the development of the "eurobond" market. In Europe, Moody's has offices in London, Paris, Milan, Madrid, Frankfurt and Limassol. It currently provides evaluations (ratings) of about 100 countries, 10 000 businesses and almost 300 000 securities issues, which coincides with the order of the agency S & P. Moody's share of the market is now estimated at 40%, as well as the agency S & P. The company has approximately 4 000 employees in 27 countries.

The ownership structure is as a parent, Moody's Corporation, both of its two subsidiaries: Moody's Investors Service (ratings) and Moody's KMV, which provides products from the processing and credit risk management for banks and investors. Among the managers of credit risk is known the KMV model, which is one of the approaches to model credit risk. The rating process applied by Moody's is very similar to the S & P, its length is estimated by agency at about 3 months with the fact that it is possible to agree on a shorter term.

Fitch Ratings

Like the aforementioned competitors, the agency has an American origin, though today it operates globally. Fitch Ratings was founded by John Knowles Fitch in New York in 1913 as the Fitch Publishing Company. In 1924 Fitch introduced the rating scale with degrees from "AAA" to "D", which is generally used so far. Greater development of the agency has undergone roughly from the 90's, especially in the area of structured finance.

In 1997 Fitch IBCA merged with the IBCA Limited (based in London), which increased coverage of ratings in the fields of banks, financial institutions and states. The merger led Fitch Ratings to be owned by holding company Fimalac S. A. The company continued on this way – provision of global services – by takeover of two credit rating agencies, Duff & Phelps Credit Rating Co. (based in Chicago) in the year 2000 and Thomson Bankwatch agency in the year 2001.

Fitch ratings now cover over 7 000 entities (financial institutions, companies, states), in addition to providing ratings of about 10 000 transactions of structured finance and other 45 000 transactions of municipal financing. Fitch Ratings is the third largest rating agency, its market share is estimated at about 16%.

The methodology of determining a country credit rating

The rating in the state case focuses on two broad areas, namely the political risk, which reflects the willingness to repay debt, and the economic risk, reflecting the ability to repay debt.

In drawing up the rating, agency collaborates with the key state institutions (central bank, ministries, government agencies, trade unions, etc.). Based on information obtained, agency shall mark the appropriate state, which corresponds to the riskiness of the country – on a scale from A (highest quality bonds) to C or D (very risky bonds, which have hardly a chance to become an investment opportunity).

In long term perspective, the highest rating receives the most advanced countries in the world. They offer to investors stable economically growing economy with low inflation, unemployment, an educated population and good infrastructure. Foreign investors currently have a level playing field with domestic trading companies and entrepreneurs. At the opposite pole is a country with high debt, the economy faces serious problems and total insolvency.

Now we describe Moody's agency sovereign rating methodology more deeply (see Cailleteau 2008). There is no quantitative model that can adequately capture the complex web of factors that lead a government to default on its debt. The task of

rating sovereign entities requires in Moody's agency case an assessment of a combination of quantitative and qualitative factors whose interaction is often difficult to predict. In addition, by the nature of sovereignty, a government may decide not to repay its debt despite having the resources to do so.

For these reasons, a mechanistic approach based on quantitative factors alone is unable (according to Moody's) to capture the complexity of the interaction between political, economic, financial and social factors that define the degree of danger, for creditors, of a sovereign credit. This methodology therefore provides a conceptual framework in which both quantitative and qualitative parameters are used in a disciplined fashion, and where risk scenarios are combined with comparative metrics. This step-by-step approach produces a narrow rating range. In some instances, however, the final rating may diverge from this range – in other words, the unusual characteristics of a sovereign credit may not be fully captured by the approach. Generally, we can divide Moody's rating process into three steps.

The first step consists of determining the shock-absorption capacity of the country, based on the combination of two key factors. The first one is the country's economic strength, captured in particular by the GDP per capita – the single best indicator of economic robustness and, in turn, shock-absorption capacity. The second factor is the institutional strength of the country, the key question being whether or not the quality of a country's institutional framework and governance – such as the respect of property right, transparency, the efficiency and predictability of government action, the degree of consensus on the key goals of political action – is conducive to the respect of contracts. Combining these two indicators helps determine the degree of resiliency, and position of the country in the rating scale: very high, high, moderate, low or very low.

The second step focuses directly on debt matters, and especially the combination of two other factors. The first thing is the financial strength of the government. The question is to determine what must be repaid (and how "tolerable" the debt is) and the ability of the government to mobilize resources: raise taxes, cut spending, sell assets, obtain foreign currency etc. Following matter is the susceptibility to event risk – that is the risk of a direct and immediate threat to debt repayment, and, for countries higher in the rating scale, the risk of a sudden multi-notch downgrade. The issue is to determine whether the debt situation may be (further) endangered by the occurrence of adverse economic, financial or political events. Combining these two indicators helps determine degrees of financial robustness and refine the positioning of the country on the rating scale.

The third stage consists of adjusting the degree of resiliency to the degree of financial robustness. This results in the identification of a rating range. The determination of the exact rating is done on the basis of a peer comparison, and weighting additional factors that may not have been adequately captured earlier.

Credit rating scale

To express the degree of rating, the rating agencies use a rating scale. Levels are expressed through alphabetic characters followed by digits or signs + and -. Levels of low-risk are referred to as an investment (grades from AAA to BBB), a high degree of risk is referred to as speculative (degrees from BB). Table of the global rating scale for long-term ratings is shown below, see Tab. I. In addition to a rating, agencies state "view" (negative, stable, positive), i.e. the direction in which the rating is likely to evolve. Local credit rating agencies tend to have their own rating scale. For short-term rating is taking a different, simpler scale, with 5 degrees usually.

Linear calibration

Using this approach we obtain quadratic calibration function, which parameters present information about relation of ratings given by particular agencies. To calculate the parameters of the calibration function we use the theory of calibration, because both measurements we have burdened by a certain degree of inaccuracy. This inaccuracy, or variation, we set by experts. Specifically, our task can be understood as one-dimensional linear calibration with quadratic calibration function.

If we suppose that $\mathbf{X}$ is realization of random vector (first measurement) with mean value $\boldsymbol{\mu}$ and covariance matrix $\sigma_x^2 I_n$, $\mathbf{Y}$ is realization of random vector (second measurement) with mean value $\boldsymbol{\nu}$ and covariance matrix $\sigma_y^2 I_n$ and calibration function

I: *Global rating scale for long-term ratings, three biggest agencies*

Moody's	S&P	Fitch	Interpretation
Aaa	AAA	AAA	The highest quality
Aa1	AA+	AA+	High quality
Aa2	AA	AA	
Aa3	AA-	AA-	
A1	A+	A+	Medium quality – higher
A2	A	A	
A3	A-	A-	
Baa1	BBB+	BBB+	Medium quality – lower
Baa2	BBB	BBB	
Baa3	BBB-	BBB-	
Ba1	BB+	BB+	Speculative
Ba2	BB	BB	
Ba3	BB-	BB-	
B1	B+	B+	Highly speculative
B2	B	B	
B3	B-	B-	
Caa1	CCC+	CCC+	Considerable risks
Caa2	CCC	CCC	Extremely speculative
Caa3	CCC-	CCC-	With a very low Perspective
Ca	CC	CC	
C	C	C	Very high probability of decline
	CI	D	
	D		

in quadratic form $\mathbf{v} = a\mathbf{1}_n + b\mu_0 + c\mu_0^2$, than calculation of the unknown parameters of the calibration function is based on the relationship

$$\begin{pmatrix} \hat{a} \\ \hat{b} \\ \hat{c} \end{pmatrix} = -(\mathbf{A}^T\mathbf{W}^{-1}\mathbf{A})^{-1}\mathbf{A}^T\mathbf{W}^{-1}(\mathbf{D}(\mathbf{X} - \boldsymbol{\mu}_0) - \mathbf{Y}),$$

where
$\mathbf{W} = diag(\sigma_x^2(b_0\mathbf{1}_n + 2c_0\boldsymbol{\mu}_0)^2 + \sigma_y\mathbf{1}_n)$,
$\mathbf{D} = \mathrm{diag}(b_0\mathbf{1}_n + 2c_0\boldsymbol{\mu}_0)$,
$\mathbf{A} = (\mathbf{1}_n, \boldsymbol{\mu}_0, \boldsymbol{\mu}_0^2)$ and subscript 0 denotes the initial estimate of unknown parameter. More details of derivation and description are set out in Myšková (2011). Confidence intervals for individual parameters are obtained as a linear combination of the vector $(\hat{a}, \hat{b}, \hat{c})^T$, about which we assume the following:

$$\begin{pmatrix} \hat{a} - a \\ \hat{b} - b \\ \hat{c} - c \end{pmatrix} \approx N(0, (\mathbf{A}^T\mathbf{W}^{-1}\mathbf{A})^{-1}).$$

The case of identical ratings given by particular agencies would be if the calibration function was linear (i.e. parameter c equal to zero), with the slope equal to 1 and zero shifting, which will be based on 95% confidence intervals tested. All practical calculations were made in Matlab computational system.

Data

The data were obtained from the websites http://www.finance.cz/ekonomika/rating/ and http://www.cnb.cz/cs/mezinarodni_vztahy/rating/ (functional 17. 11. 2011). For our purposes, we assign numbers to individual assessments, namely the highest AAA rating we assigned 1, and then we follow using the natural numbers. By this manner we obtain equal distance between neighboring ratings, what is unrealistic according to ordinal character of the data. We resolve this difficulty by having considered four options for the values of variances: 1, 10, 1, 10 for the first measurement and 1, 10, 10, 1 for the second one. This should induce the ordinal character of the data and more, we can explore situation with different accuracy of particular agencies. Stability of the results can be judged by comparison of analyzed rating values from 24. 3. 2011 and 19. 10. 2011.

RESULTS AND DISCUSSION

All the results are summarized in Tab. II and III. These tables contain estimates of the calibration function parameters, where a is the shift, b is the slope parameter and c is the parameter of quadratic member in the equation $y = a + bx + cx^2$. Analysis was carried out for all agency couples (the first measurement corresponds to the agency designated as x, the second measurement corresponds to the agency designated as y). Below the parameter estimates are given their 95% confidence intervals. Roman numerals identify the individual choices of variances: for I variances 1 and 1, for II variances 10 and 10, for III variances 1 and 10 and for IV variances 10 and 1.

As the first step we tested individual parameters. Specifically, we tested the equality to zero for parameters a and c and equality $b = 1$. This would

II: *Calibration parameters estimate for data from 24. 3. 2011*

24. 3. 2011	I	II	III	IV	I	II	III	IV
	MOODY'S x STANDARD & POOR'S				STANDARD & POOR'S x MOODY'S			
a	**0,0206**	**0,0206**	**–0,0146**	**0,0563**	**0,1808**	**0,1808**	**0,1060**	**0,2196**
	–0,8228	–2,6464	–1,9644	–1,9058	–0,6349	–2,3985	–1,8943	–1,5351
	0,8640	2,6877	1,9351	2,0185	0,9964	2,7600	2,1063	1,9744
b	**1,1628**	**1,1628**	**1,1971**	**1,1223**	**0,7342**	**0,7342**	**0,7973**	**0,6949**
	0,8966	0,3208	0,5403	0,5345	0,4182	–0,2652	0,0947	–0,0649
	1,4291	2,0049	1,8538	1,7101	1,0502	1,7336	1,4998	1,4546
c	**–0,0155**	**–0,0155**	**–0,0185**	**–0,0120**	**0,0239**	**0,0239**	**0,0182**	**0,0276**
	–0,0324	–0,0689	–0,0613	–0,0485	0,0005	–0,0499	–0,0311	–0,0314
	0,0013	0,0378	0,0243	0,0246	0,0472	0,0976	0,0675	0,0866
	MOODY'S x Fitch-IBCA				Fitch-IBCA x MOODY'S			
a	**–0,0251**	**–0,0251**	**–0,0189**	**–0,0571**	**0,0862**	**0,0862**	**0,0954**	**0,0828**
	–0,9031	–2,8016	–2,0373	–2,1550	–0,7816	–2,6580	–1,9703	–1,8870
	0,8529	2,7514	1,9996	2,0408	0,9540	2,8304	2,1611	2,0526
b	**1,1151**	**1,1151**	**1,1476**	**1,0897**	**0,8524**	**0,8524**	**0,8907**	**0,8163**
	0,8058	0,1369	0,4108	0,3636	0,5074	–0,2386	0,1132	–0,0246
	1,4245	2,0934	1,8845	1,8159	1,1974	1,9434	1,6681	1,6573
c	**–0,0112**	**–0,0112**	**–0,0149**	**–0,0077**	**0,0140**	**0,0140**	**0,0093**	**0,0184**
	–0,0327	–0,0791	–0,0669	–0,0582	–0,0121	–0,0686	–0,0478	–0,0479
	0,0103	0,0568	0,0370	0,0427	0,0401	0,0966	0,0665	0,0847

24. 3. 2011	I	II	III	IV	I	II	III	IV
	MOODY'S x STANDARD & POOR'S				STANDARD & POOR'S x MOODY'S			
	STANDARD & POOR'S x Fitch-IBCA				Fitch-IBCA x STANDARD & POOR'S			
a	**0,2134**	**0,2134**	**0,2231**	**0,1830**	**–0,1942**	**–0,1942**	**–0,1270**	**–0,2286**
	–0,6410	–2,4884	–1,8728	–1,7440	–1,1270	–3,1438	–2,2104	–2,5361
	1,0678	2,9153	2,3190	2,1100	0,7385	2,7554	1,9564	2,0788
b	**0,8036**	**0,8036**	**0,8317**	**0,7899**	**1,1832**	**1,1832**	**1,1781**	**1,1683**
	0,4568	–0,2929	0,0230	–0,0461	0,8563	0,1497	0,4147	0,3735
	1,1503	1,9001	1,6404	1,6259	1,5100	2,2166	1,9416	1,9631
c	**0,0167**	**0,0167**	**0,0133**	**0,0190**	**–0,0154**	**–0,0154**	**–0,0161**	**–0,0132**
	–0,0101	–0,0680	–0,0475	–0,0477	–0,0384	–0,0882	–0,0711	–0,0687
	0,0435	0,1015	0,0741	0,0856	0,0076	0,0574	0,0389	0,0424

III: *Calibration parameters estimate for data from 19. 10. 2011*

19. 10. 2011	I	II	III	IV	I	II	III	IV
	MOODY'S x STANDARD & POOR'S				STANDARD & POOR'S x MOODY'S			
a	**0,1691**	**0,1691**	**0,2038**	**0,1186**	**–0,1327**	**–0,1327**	**–0,0964**	**–0,1448**
	–0,5923	–2,2388	–1,6205	–1,6546	–0,9491	–2,7143	–1,9632	–2,1167
	0,9305	2,5770	2,0282	1,8918	0,6837	2,4490	1,7704	1,8271
b	**1,0025**	**1,0025**	**1,0046**	**1,0055**	**0,9793**	**0,9793**	**0,9836**	**0,9662**
	0,7831	0,3087	0,4612	0,5083	0,7274	0,1827	0,4309	0,3249
	1,2220	1,6964	1,5481	1,5027	1,2313	1,7760	1,5363	1,6075
c	**–0,0029**	**–0,0029**	**–0,0037**	**–0,0024**	**0,0043**	**0,0043**	**0,0033**	**0,0059**
	–0,0159	–0,0440	–0,0362	–0,0316	–0,0115	–0,0457	–0,0308	–0,0354
	0,0101	0,0382	0,0289	0,0268	0,0201	0,0543	0,0373	0,0472
	MOODY'S x Fitch-IBCA				Fitch-IBCA x MOODY'S			
a	**0,0106**	**0,0106**	**0,0466**	**–0,0520**	**0,0694**	**0,0694**	**0,0940**	**0,0606**
	–0,7893	–2,5189	–1,7972	–1,9933	–0,7403	–2,4909	–1,8470	–1,7912
	0,8105	2,5402	1,8905	1,8893	0,8790	2,6297	2,0350	1,9123
b	**1,1106**	**1,1106**	**1,1121**	**1,1179**	**0,8473**	**0,8473**	**0,8585**	**0,8317**
	0,8824	0,3891	0,5575	0,5888	0,5661	–0,0420	0,2255	0,1380
	1,3387	1,8320	1,6667	1,6469	1,1285	1,7366	1,4915	1,5253
c	**–0,0103**	**–0,0103**	**–0,0111**	**–0,0101**	**0,0138**	**0,0138**	**0,0121**	**0,0157**
	–0,0240	–0,0535	–0,0454	–0,0407	–0,0057	–0,0479	–0,0302	–0,0343
	0,0033	0,0328	0,0232	0,0205	0,0333	0,0755	0,0544	0,0658
	STANDARD & POOR'S x Fitch-IBCA				Fitch-IBCA x STANDARD & POOR'S			
a	**–0,1658**	**–0,1658**	**–0,0952**	**–0,2191**	**0,1303**	**0,1303**	**0,1715**	**0,0734**
	–1,0002	–2,8044	–1,9671	–2,2905	–0,6667	–2,3902	–1,7614	–1,7598
	0,6686	2,4728	1,7767	1,8524	0,9274	2,6509	2,1044	1,9067
b	**1,1070**	**1,1070**	**1,0943**	**1,1112**	**0,9069**	**0,9069**	**0,9079**	**0,9138**
	0,8645	0,3401	0,5403	0,5090	0,6465	0,0833	0,2849	0,3030
	1,3495	1,8738	1,6483	1,7134	1,1674	1,7305	1,5310	1,5247
c	**–0,0074**	**–0,0074**	**–0,0073**	**–0,0070**	**0,0066**	**0,0066**	**0,0058**	**0,0068**
	–0,0225	–0,0552	–0,0424	–0,0443	–0,0110	–0,0490	–0,0356	–0,0351
	0,0077	0,0403	0,0279	0,0303	0,0241	0,0621	0,0471	0,0488

occur if the ratings of particular rating agencies were identical in mean value to each other. This can be formulated as a statistical hypothesis, with reject rule given by 95% confidence intervals listed below parameter estimates in Tab. II and III. We cannot reject hypotheses about zero shift parameter *a* and quadratic member parameter *c* as well as hypothesis about unitary slope parameter *b* in any case. The only exception is nonzero parameter *c* in

relationship "STANDARD & POOR'S x MOODY'S", situation I (see Tab. II).

Now we can conclude that linear calibration function is sufficient to describe relationship between ratings from particular rating agencies in any case. Further, we cannot reject that all rating agencies rate in the same way with the exception of a few individual countries. However, we can use the estimated parameters for following conclusions.

Different situations with set variances (I–IV) did not affect parameter estimates visibly. In the case of pairwise equal variances parameters remain the same. This setting significantly affects width of 95% confidence intervals for all parameters. Relation "MOODY'S x Fitch-IBCA" remains stable in time. It is possible to say that Fitch-IBCA ratings are more stringent especially for countries with speculative or worse ratings. Relation "MOODY'S x STANDARD & POOR'S" changed in time. STANDARD & POOR'S ratings were more stringent for countries with worse ratings in the March 2011, but in the October 2011 it seems that STANDARD & POOR'S ratings are stricter than MOODY'S ratings systematically. The most dramatic changes appears in relation "STANDARD & POOR'S x Fitch-IBCA". S & P was more stringent for countries with worse ratings in the March and more benevolent for AAA and AA+ rated countries. In the October the situation turned vice versa. As a total conclusion we can state presumption that S & P ratings were the strictest ones in March, but in October we can see them more benevolent than before.

SUMMARY

In this work we deal with the question of whether the evaluation of selected rating agencies is equivalent in some sense or not and whether it is possible to find a relationship between assessments. Actually, the role of the credit rating agencies is contested significantly for many reasons. Rating is an estimate, but may have an active impact on the rated entity: a downgrade of its rating deteriorates its situation on the market in general. On the other hand, ratings have a growing number of users for which ratings have become one of the few clues in today's complicated conditions powered by global financial crisis. In this paper we focus on so-called sovereign ratings, i.e. ratings of the countries, particularly on agencies providing such ratings. This ratings can be labeled as external ratings, because agencies providing ratings not for own need, but for different users. In this context, rating means the international standard measurement tool (evaluation) the creditworthiness of countries to assess their credibility. Rating reflects the degree of business risk for foreign firms and quantifies the probability that the country will honor its commitments. For this purpose we use the calibration problem techniques, because calibration finds a relationship between two measurements, in our case between two independent assessments of rating agencies. Due to the nature of the data we assume that the relationship can be described by linear or quadratic function. So we use estimates derived for the one-dimensional linear calibration model with quadratic calibration function. Everything we illustrate by the real ratings. The situation is complicated by the ordinal type data of the examined variables. We introduce three biggest agencies: Fitch-IBCA, MOODY'S and STANDARD & POOR'S. Given is methodology of assigning a credit rating, rating scale and elements of linear calibration technique. Numerical calculations are based on two samples of worldwide sovereign ratings. The main hypothesis is that all the agencies produce identical ratings in terms of linear calibration problem. Among other things, we discuss relations between ratings coming from particular rating agencies and evolution of this relation over time. For example, relation "MOODY'S x STANDARD & POOR'S" changed in time. STANDARD & POOR'S ratings were more stringent for countries with worse ratings in the March 2011, but in the October 2011 it seems that STANDARD & POOR'S ratings are stricter than MOODY'S ratings systematically.

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