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PREDICTION POWER OF SOVEREIGN RATING MODELS IN TIME OF DEBT CRISIS

The case of Slovak Republic, Czech Republic and Hungary

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ABSTRACT:

The objective of this paper is to analyze the prediction power of the econometric sovereign rating models in the time of the debt crisis. Through econometric testing for period 1997-2007 we found out that the model - developed by Cantor and Packer (CPM) - is systematically underestimating the sovereign rating of the Standard & Poor's for Slovakia, Czech Republic and Hungary. We obtained significantly better results by including some soft variables in the CPM model, and also eliminating the multicollinearity between the exogenous variables. By testing the prediction power of our models for period 2008-2010 we also find bigger difference between S&P and model ratings compared to 1997-2007. At the end the paper discusses the possible explanation of these findings.

Key words: Sovereign Rating, Econometric Model, Bond Yields.

1. Introduction

According to a well-known efficient market hypothesis, or defenders of opinion on development of financial assets in the form of "random walk", the forecasting possibilities for future development of financial markets are limited. Nevertheless, country *sovereign rating* published by credit rating agencies represents an important information for many private or public investors in their investment decision-making. "The logic underlying the existence of credit rating agencies is to solve the problem of the informative asymmetry between lenders and borrowers regarding the creditworthiness of the later"[2]. Yet, there are some studies supporting the hypothesis on possibilities of games by setting the prices of financial assets[3]. On the other hand and based on the primary finding of study Hill, Faff

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[2] Elkhoury (2008)

[3] According to Cantwell's research on the specimen of 309 issuers 90% of issuers stated that they were able to change the rating of the rating agency before its publishing on the basis of appeal. Source: Fight (2001)

(2007) „re-ratings which follow watch procedures are neither more nor less informative, and we conclude therefore that the credit watch procedure does not impact upon the private information of credit rating agencies".

Traditional criticism of credit rating agencies *(CRA´s)* as important financial players influencing inter alia also the government bond market, concentrates mainly on potential *rating agencies' conflict of interest*, their *oligopolic character or transparency of the rating process*.

Conflict of interest is perceived mainly in connection with possible offer of further consulting services from the side of *CRA´s* in the requested rating[4], with consulting on discrete internal information between *CRA* and the issuer, and also with regard to possible pressure on the issuer through unasked rating. Oligopolic character of *CRA´s* market and restricted access to the market is supported particularly by legal regulations.[5] For many financial institutions rating evaluation by nationally recognised agencies became an investment criterion by law.[6] Transparency of *CRA´s* is perceived by experts mainly because a detailed methodological procedure for awarding sovereign rating *(SOR)* is not published by the *CRA´s* , what creates potential space for rating games on financial market.

Despite objections of several experts[7] and politicians[8] against the status of rating agencies in the system of world financial markets, it is obvious that rating assessments have still an important information power in forming the expected development on financial markets.

After the end of 2007 *Standard & Poor's (S&P)* decreased *SOR* of several central European countries, during which time there were changes in the spreads of government bonds *(SGB)* of these countries. In connection with these changes, we have followed up with research of setting *SOR* using Cantor, Packer's[9] *(MCP)* econometric model and its modification *(MMCP)* for the selected middle European countries. The presented paper thereafter analyses:

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[4] Rating can be requested by the issuer or not requested, when the agency itself decides carry out the rating.

[5] For example The Office of the Comptroller of the Currency in the USA in 1931 introduced a standard for appraisal of debenture bonds' accounts kept in the national banks on the basis of ratings and finally banned investment in securities from non investment zone. See more in Partnoy (1999). Another barrier in entering the sector is the regulation of the US Securities and Exchange Commission, which in 1975 established a category Nationally recognised statistical rating organizations.

[6] U.S., Senate Committee on Governmental Affairs, Financial Oversight of Enron: The SEC and Private-Sector Watchdogs: Report of the Staff to the Committee on Governmental Affairs (8 October 2002) states that as of October 2002 minimum 8 US federal laws, 47 federal regulations and more than 100 various US state laws required reference criterion standard for ratings from the Nationally recognised statistical rating organization.

[7] For example Prof. Pierre-Henri Conac, Frank Partnoy, Charlie McCreevy, American Senator C. Lieberman.

[8] Charlie McCreevy (European Commissioner for internal market and services)presented these proposals in Brussels on November 13, 2008. For details see also: McCreevy (2009)

[9] Cantor and Packer (1996). Overview of other macro variable based approach of SOR see also in Sy (2003)

- reaction of model SOR estimation using (MMCP) compared with the change of ratings of the Slovak Republic, Czech Republic and (SCH) by (S&P),

- causality or time lag between the changes and SOR for the analysed countries SCH.

2. Methodology of the Sovereign Ratings

Sovereign rating methodology is in comparison with rating of companies, credits, securities or municipalities a scientifically relatively little researched issue. One of the objective reasons is also the fact that there are few empirical examples of state defaults, or they have a hidden form.[10].

In the case of rating procedures for micro subjects and their financial assets, an important part of methodological procedures is derived from the ex post assessment of an enormous number of observations. These observations enable statistical methods to relatively reliably assess both the probability of default of particular micro subjects in certain time horizon, as well as evaluate the factors and their values, which were ex post verified as significant in real defaults of selected specimen of subjects.[11].

For the stability and investor's future prospects, the comparison of rating migration in longer time horizon is of great value. In the past two decades rating migration was the subject of several researches. It was generally assumed that the rating migration bears the characteristics of Markov's process. That means that the past of rating assessment is irrelevant, as soon as we know the current rating. In other words, the probability of transition from one rating group into another depends only on the initial and final rating group and not on extraneous variables. However, the existence of a certain motive force in transition from one group into another was empirically proved, which contradicts this assumption[12].

Research work has proved that there is higher probability that lowering of the rating will be followed by further lower rather than higher rating. The rating migrations also show

[10] In the theory is obviously the most investigated story the gradual disintegration of the Spanish kingdom empire during the reign of Philip II from 1556-1598. Many authors, e.g.. Conklin (1998) analysed 4 stories of bankrupts in Spain during the above reign of Philip II. They made an effort to explain mainly the natural amount of fine (risk Premium) for not paying off the kingdom loans, then the way of setting expenditure and debt ceilings on fluctuation in expenditures particularly of military character and in the style of their „correct" setting, and in the light of modern economic theory. See details in Conklin (1998). Already Smith (1950) acquired a key knowledge that as soon as certain limit of debt is exceeded, a particular economy is able to pay off the debts in full amount only exceptionally. At the same time he distinguished two forms of solving state bankruptcies: by rather sporadically and officially admitted state bankruptcy, when for example the tax collateral was released in favour of creditors. Generally but only seemingly by paying off the debt. According to Smith, in both case it was a real bankruptcy of the state, whose general solution for paying off the debt was the increase in nominal value of the coins, made from precious metals.

[11] Nick Willson, Altman and many others.

dependence on duration, sequence of correlations and dependence on direction of move.[13]

E.I. Altman's research[14] has proven that newly assessed firms show lower probability of rating migration during the first few years than the implanted companies from the same rating group. He also drew the attention to the effect of the rating taken away and the importance of dependence between the economic conditions and rating migrations. By his research Figlewski[15] has also proven the effect of ageing for the probability of failure – the longer time elapsed from the first rating assignment, the higher was the probability of a particular company's default.

Rating agencies do not, however, publish their whole methodology, whether it is for sovereign rating, or for other subjects[16] and know-how for setting the rating, but they often present statistical data and economic indicators in their publications. Recipient of the rating has therefore possibility to at least partially know the factors that will be assessed and reasons that led to assigning the respective rating. Rating agencies started to publish their procedures and criteria for assigning rating only in the past 6-7 years. In the past was nearly all their methodology unavailable for the investor.

Rating methodology on macro and micro levels comes out from generally existing financial statements, whereas in the past rating agencies carried out also comparisons of audit results in the form of *assurance*. For rating assessment they use their own accesses oriented on judging the future development of the assessed subject[17].

There are several basic procedures for assigning the rating to a selected subject as an expression of their capability to pay off their liabilities. Majority of the used procedures is based on the appraisal of the condition and development of selected economic indicators. On their basis it is consequently possible to create certain groups of subjects with collateral values of characteristics - benchmarking. Other, a more prevalent way is the ex post setting of transition probability of a certain subject in certain concrete time horizon into a real default, usually through using econometric and statistical models.

For restrictions in these methods is deemed the fact that the rating scale is a cardinal

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[12] Hamilton and Cantor (2004)
[13] Altman and Kao (1992), Carty and Fons (1993), Lando and Skodeberg (2002)
[14] Altman (1998)
[15] Figlewski and Frydman and Liang (2006)
[16] For example Fitch rating agency assesses in setting SOR the following areas: (i) Demographic, educational and structural factors. (ii) Analysis of the labour market. (iii) Structure of output and trade. (iv) Dynamics of private sector. (v) Balance of supply and demand. (vi) Balance of payment. (vii) Analysis of medium-term growth constraints. (viii) Macroeconomic policy. (ix) Foreign trade and foreign investment policy. (x) Banking and finance. (xi) External assets. (xii) External liabilities. (xiii) Politics and state. (xiii) International ranking. For detail see: Sovereign Ratings Methodology, Fitch Inc. and Fitch Ratings, Ltd, New York, 2002.
[17] See more in Elkhoury (2008)

variable (it can gain on the whole values). In econometrics the *Probit* type analysis can be used for such case. Second group comprises econometric models, where dependent variable is the rating scale transformed into the form of the cardinal variable.[18]

Although some methodological bases for *SOR* and micro ratings have some common features, the setting of sovereign rating has its own particularities. According to Cantor and Packer the approach using econometric model on the national level is the only possible. The reason is that the specimen data is relatively small and on the other hand there exist a great number of values of dependent variable (rating categories). The best results, mentioned below, were achieved by the cited authors through using the linear dependence of the rating scale in comparison with logarithmic or exponential functions.[19]

Ratings from agencies are an effective method for predicting issuer's failure or credit quality of obligations or securities.[20] Data from the historical databases provide information on degrees of default for individual rating groups, as well as on the probability of rating migration. Country rating is an indicator of assurance that the respective country will pay off the government bonds, treasury bonds, credits and other liabilities in time and in full amount. Country default has a negative impact not only on its ranking, but also on the ranking of financial institutions and business subjects in this country.

Rating agencies highly appraise observance of deadlines for remittance of liabilities in the past. Payment default in the past will generally be reflected in a country's ranking in the speculative zone. *Country payment default can be defined* as *the incapability or unwillingness of* an obligor, in this case the *central government,* or *governments of lower territorial units, to pay off the debt sum and the agreed interest to the creditor* in full and on time. In general, we cannot presume that a country will get into the situation when it has to declare payment default and is not be able to pay off its liabilities to the creditors, who will consequently assert their creditor rights through the sale of the relevant country's assets.

In the history it was proved that many times a state was incapable to pay some of its liabilities, namely debt in domestic currency, incapability to pay government bonds issued in foreign currency, inability to pay back the government loans in foreign currency.

[18] L. Ederington' research, dealing with company ratings, comes to conclusion that results of Probit analysis are quite similar, or slightly more precise than those achieved through the least square method. The condition is however, the availability of a greater scale of input data. Authors R. Kaplan and G. Urwitz, are of contradictory opinion, and on the basis of their research they dispute that estimations by Probit method achieve worse results. See more in Ederington (1985), Kaplan and Urwitz (1972)

[19] Transformation of the rating scale used by Cantor and Packer and also by us is included in Annex 5.

[20] As for the current mortgage and financial crises, rating agencies are exposed to pressure and criticisms because their ratings of structured finance product seems to be the conflict of interests. This product of rating is the subject of special interest for institutions carrying out financial market.

According to Standard & Poor's[21] data in the period from 1970 – 1995 countries were in default 42 times. Out of it 9 cases applied to debt in domestic currency and the rest of cases were related to liabilities in foreign currency (from that 4 times to government bonds and 29 times to government loans). In all 29 government loans in foreign currency was the bank debt restructured and this was qualified as a default by the rating agency. As far as liabilities in domestic currency - in two cases there was a coup and change of the country's political system[22], the remaining cases were related to drastic economic reforms targeted on stopping hyperinflation[23].

3. Cantor Packer model and its Modifications

The model authors came out of the specimen of 49 countries from the scale with the highest rating assigned by the agencies Standard & Poor's and Moody's (Aaa or AAA) as far as the level B3 or B minus. Rating scale variable *(RS)*[24] was the dependent variable. Factors, which should clarify the rating variability were selected with regard to their high probability. to influence the ability and willingness of the government to pay back their liabilities.

3.1 Model CPM

For their research Cantor and Packer developed a *CPM* model in the shape[25]:

$$RS = a_0 + a_1 . IP + a_2 . GR - a_3 . P + a_4 . FS + a_5 . PB - a_6 . DF + a_7 . ED - a_8 . IN + u \qquad (1)$$

where

IP – income per capita,

GR – GDP growth,

P – inflation,

FS- fiscal discipline (as percentage share of the average annual state budget balance by GDP),

[21] Beers (1995)

[22] This applied to the change of regime in Vietnam in 1975 and political crisis in Russian in 1993.

[23] It pertained to measures in two South American countries – Argentina (default to pay some liabilities in domestic currency occurred in years 1982, 1989 and 1990) and Brazil (similar situation in years 1986, 1989 and 1991).

[24] Variable RS used also in our model contains Annex 6.

[25] Cantor and Packer (1996)

PB - balance of foreign account (average percentage share of the annual balance of current account by GDP), DF – foreign indebtedness (debt in foreign currency on export),
ED – level of economic development (discrete variable 0 or 1),
IN – payment default in the past (discrete variable 0 or 1).

Selection of the above indicators came from determinants of default in assessment of country credit risk.[26] In setting individual factors the authors reasoned as follows.

Income per capita is an essential factor for tax collection that in the future impacts the country's capability to pay back the debt. It can also be a certain measure of a country's political stability. Higher economic growth rate in a country indicates higher country's ability to pay the debt. At a high rate of inflation the government can, according to the authors, turn to inflation financing of the debt. Higher rates of inflation can be linked with structural problems in the state budget management. Public dissatisfaction with the growing inflation can also lead to political instability.

In case of high deficit, also this factor indicates that the government might not be able or willing to use the tax revenues to cover its expenditures. With regard to the availability of data, the authors use the central government debt, although it would be more exact to calculate with consolidated accounts of the lower territorial units, or the government's debts of individual states in the case of federal countries. Higher deficit of the current account indicates, according to the authors, the existence of great dependence of public as well as private sector on foreign sources. From the long-term view, this can lead to a default. Higher debt burden corresponds to higher risk of default. The weight of burden increases with the growth of country debt in foreign currency in comparison with the country's export. Creditors, let us say investors, are interested in the total country debt burden, and also the rating agencies emphasize the importance of foreign indebtedness in the rating process.

For evaluation of economic maturity the author used value 1 for mature category according to IMF classification and value 0 for other countries. Although the above mentioned indicators measure the economic maturity, according to the authors, the rating agencies take into consideration the country's openness for the relation of economic development and country risk.[27] Therefore the authors take as reference the IMF classification.

[26] Saini and Bates (1984), McFadden (1985)
[27] For state debt creditors an important condition is the possibility of direct sanctions in case of non payment the debt. Developed countries are in general integrated in the world economic system and for a creditor it is relatively simple to apply legal rights, for example in the form of confiscation of assets. For details see Bulow and Rogoff (1989)

The last variable gains value 1 when the country was in default in the past, and value 0 if not. This factor is very important for the rating, as the theory admits a significant role of the country's reputation with regard to the sovereign rating. Payment default in the past means a high credit risk.[28] So does the empirical evidence imply that the countries affected by default have distinctly worse position for creditors.[29]

It is obvious that in reality the *CRA´s* assess also social and political factors, or expectations, which could be included in the *soft processes* group. However, they cannot be quite objectively measured and compared. Yet, it is evident that the soft process type factors are different for individual countries or their grouping. E.g. as shown on the case of the selected *SCM* states, application of *CPM* model to these countries has the tendency to systematically under estimate the real *SOR* rating by *S&P* but also by *Moody's.*

3.2 MCPM Model

At modification of *CPM* for selected countries we have therefore tried to modify the model *(1)* and explain this difference. For objectivity reason, an additional and joint „soft" variable was included into the model *index*, published by *Heritage Foundation*[30] and the *Wall Street Journal.* This index is published annually and evaluates the level of economic freedom in 180 countries. It is comprised of ten sub indexes and is based on the economic thinking and *approach* of *Adam Smith*.

According to their definition, economic freedom should comprise all rights and freedoms of the production, distribution and consumption of goods and services. The highest form of economic freedom should provide an absolute right of property ownership, fully realized freedoms of movement for labour, capital, and goods and services. State measures should be pushed in order to ensure such economic freedom and not to confine it. The influence of the government should not be enhanced above the minimum needed level.[31]

According the non-governmental organization *Freedom House,* that evaluates the level of the political freedom in individual states worldwide, the results of their political freedom rating statistically strongly correlates with the results of economic freedom measured by an

[28] Eaton (1996)
[29] Ozler (1991)
[30] Heritage Foundation (a conservative research institute (think tank), is aiming at „...on the basis of expertness support suitable measures based on conservative principles of free trade, minimum interference of the state and individual freedom." Quoted from www.heritage.org.
[31] Miller and Holmes (2009)

index.[32]

Index of economic freedom is created from ten sub indexes, which determine economic freedom. Individual indexes as well as cumulative index are quantified in the scale from 0 – 100 points, where the values nearing zero mean a very low level of economic freedom and are negatively rated. In the overall score the same weights are allocated to ten sub indexes and their average determines the final value. The sub indexes are as follows: *(i) index of freedom of enterprise*[33]*, (ii) index of free international trade*[34]*, (iii) index of fiscal freedom*[35] *(iv) government size index, or the volume of government expenditure*[36]*, (v) index of monetary freedom*[37]*, (vi) index of free investment*[38]*, (vii) index of financial freedom*[39]*, (viii) index of right to property ownership*[40]*, (ix) index of corruption elimination rate* [41]*, (x) index of freedoms on the labour market.*[42]

[32] Karatnycky (2001)

[33] Measures the possibility to start, operate and terminate enterprising from the point of total demandingness and the barriers from the legislative view, as well as the effectiveness of the government regulatory system. The index is computed by means of 10 factors with the same weight, it uses data from the World Bank study Doing Business.

[34] Reflects openness of economy towards import of good and services from abroad; higher score reflects the absence of customs and other barriers, which influence import and export. Its value is determined by means of two variables: 1.) extent of customs burden defined by weighted average 2.) barriers of non-customs character.

[35] It measures tax and other burdens, which the government inflicts on individuals and companies. The index includes the tax burden using the highest rate of income tax (natural persons and corporate bodies) and also the total share in all tax revenues in GDP.

[36] According to authors it „condemns" excessive state interventions into the market mechanism as external influences, which interfere in market equilibrium and effectiveness, cause pushing effect and divert sources and may even cause growth of interest rates and inflation.

[37] Includes the rate of price stability and evaluation of price control. Index setting is base on the fact, that inflation as well as price control deform business environment. Authors consider price stability without microeconomic interventions as ideal condition.

[38] It is determined on the basis of quantitative evaluations. It refers to questions such as: existence of the law or regulation on foreign investment, just and unbiased approach of the government to domestic and foreign investors, existence of any restrictions of access to foreign currency and possibility of exchange, legislatively defined approach to foreign and domestic companies, existence of government limitations to payments, transfers and capital transactions, inaccessibility of specific sectors for foreign investors.

[39] It reflects the rules for prudential enterprising of banks and financial institutions and their supervision. Index evaluates the rate of bank sector security and also the rate of independence of this sector form the government. Authors perceive state ownership of banks and other financial institutions as a non-effective burden, which reduces competition and decreases the level of the provided services.

[40] Evaluates the possibility of an individual to gather private property, ensured by transparent laws, which are fully protected by the state. It measures the level of protecting the rights to private property, which is rendered by the country laws as well as the level of enforcing this right, which is ensured by the government. It also evaluates the probability of private property expropriation and analyses the independence of jurisdiction, existence of corruption in the judiciary system and possibility of physical persons and corporate bodies to enforce execution of the contracts.

[41] It expresses the extent of freedom from corruption in country environment, or the rate of corruption elimination in the countries systems. Corruption damages economic freedom, because it bring uncertainty into economic relations and jeopardizes the feeling of safety. The score of this index is derived from Corruption perception index CPI, which is compiled by Transparency International.

[42] It takes into consideration several aspects of legislative and regulatory framework for labour market in a given country. It reflects mainly demandingness of recruiting, non-standard working time, severance pay, rules for terminating redundant employment and its costs.

The same weight is allocated to each *sub index* in fixing the cumulative index of economic freedom *(IEF)*, so that none of them has a more significant influence. Apparently, there are links among the above sub indexes and they are mutually influencing, but the authors do not define the mechanism of their mutual relations. The authors state that the "*Index* objective is to depict the economic environment of each country in the most balanced way". The individual sub index data or also the cumulative index may be used by other authors in the size and extent according to their own discretion".[43]

After including *IEF*, or its factor sub indexes (IEF_1, $IEF_{2...}$ IEF_{10}) into the *CPM* model, a model for assigning *SOR* is developed, marked as *MCPM*:

$$RS = a_0 + a_1 . IP + a_2 . GR - a_3 .P + a_4 .FS + a_5 . PB - a_6.DF + a_7 .ED - a_8 . IN + a_9 . IEF + u \quad (2a)$$

$$RS = a_0 + a_1 . IP + a_2 . GR - a_3 .P + a_4 .FS + a_5 . PB - a_6.DF + a_7 .ED - a_8 . IN + \sum_{j=1}^{10} \beta j \cdot IEFj + u \quad (2b)$$

4. Pricing of Sovereign Bonds

Economic theory provides several explanations for changes in sovereign bond yields. Majority of them is based on development of economic fundamentals, particularly on fiscal variables. In Baldaci, Kumar's (2010) survey several approaches and studies are introduced, and a great part of them is concentrated "on specific aspects of the relationship between the fiscal variables and bond yields". The result of studies is mainly the knowledge that basically it is a combination of nonlinear effects, initial conditions, institutional features, and spillovers, potentially imparting some bias to the empirical findings[44].

The authors designed and tested an econometric model for sovereign bond yields analysis for a panel of 31 advanced and emerging market economies in the following form:

$$r^{10Y}_{i,t} = \alpha i + \beta_1 r^{M}_{i,t} + \beta_2 \pi_{i,t} + \delta_1 b_{i,t} + \delta_2 D_{i,t-1} + \delta_3 D_{i,t-1} + \rho_1 z_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

[43] Miller and Holmes (2009)

[44] Baldaci and Kumar (2010) compare how episodes of large fiscal deficit led to significantly higher nominal and real long-term yields on government bonds (in proportionate terms) than episodes where the deficit rose more modestly. Also differences in structural and institutional features may play significant role: countries with structural high domestic savings and financial systems that rely on bank financing more than capital markets for funding investment, may be more readily able to absorb an increase in public bond supply. Accounting for the

where

r^{10Y}_{t} denotes nominal yields on 10-year government bonds for country *i*, period *t* (1980–2007), r^{M} is the short-term nominal interest rate (to control for the effects of monetary policy on the term structure), π is CPI inflation, *b* is the fiscal balance in percent of GDP, *D* is the level of gross general government debt in percent of GDP, *z* is output growth (to control for the country's cyclical position) and ε is the error term.

Several other studies further investigated for example how markets take into account macroeconomic fundamentals (external debt to GDP ratio, the degree of openness, the ratio of amortizations to reserves, and the ratio of the current account to GDP) when pricing sovereign risk - Ferrucci (2003). Ferrucci in his study finds that also *nonfundamental factors play* an important role. He finds a strong empirical relationship between sovereign spreads and external factors such as global liquidity conditions and U.S. equity prices.

Belllas, Papaioannou, Petrova (2010) extend the Ferrucci approach (2003) and incorporate a financial stress index in the model. The model reflects also the condition of country's financial health and other factors.

5. Sovereign Ratings and Sovereign Bonds Yields

From a brief comparison of the rating methodology and pricing of government bonds it is apparent, that there exist several joint groups of factors, which influence the rating as well as risk premiums of government bonds. This refers to the fiscal variables and selected macroeconomic indicators. The expression of fiscal sustainability is the key different factor between *SOR* models (*share of the state budget balance on GDP*) or *GBY* pricing (*share of gross general government debt on GDP*). Yet, the factors of non-fundamental character[45], as well as media information apparently play a more significant role in the short-term fluctuation of the government bond prices. In terms of games on financial markets, a question emerges 'what is the causality between the market signals in pricing the government bonds and changes (SOR) in individual countries?'

impact of capital inflows and spillovers from global sovereign bond markets can be important too.

[45] Other research Works focused also on crisis-related determinants of sovereign bond spreads. Ebner (2009) findings are for example significant differences in government bond spreads in Central and Eastern Europe during the crisis and noncrisis periods. Volatility, political instability or uncertainty, and global factors explain the rise in spreads during the crisis periods, bud the macroeconomic variables led to lover importance. Dailami, Masson, and Padou (2008) proposed and examined and showed how U.S. interest rate alone is not a sufficient explanation of the spread level. The debt dynamics, global liquidity conditions, the appetite for risk, and shock indicators are also important factors for different influence in the crisis and noncrisis periods.

In this part we will come back to the fundamentals of our study, where we present the analysis of: *(i)* ex post and ex ante results of *SOR* model estimation and their comparison with the change in the Slovak Republic, Czech Republic and Hungary's ratings *(SCM)* by *S&P*, *(ii)* causality between the changes in government bond prices and *SOR* for the analysed countries *SCM.*

5. 1 Prediction power of SOR based on CPM and MCPM during the debt crisis

After ex post testing of *CPM* and *MCPM* models in pre-crisis period 1997-2007 for *SCM* countries we have used the original values of parameters and the same factors as the authors of CPM model. [46] Using the model *(1)* model *SOR* values were estimated for countries *SCM.* As follows from Annex 1, model estimation of *SOR* obviously underestimated the real *S&P's* rating by several degrees. At the same time there was an indubitable correlation of changes in model rating and rating of the above mentioned *CRA.*

Due to systematic underestimation of *SOR* by means of the original model *(1)*[47] in the subsequent research we have estimated parameters for both the *CPM* as well as *MCPM (2)* models. Because of strong multicollinearity between the individual variables, several models were tested in successive steps. The best results of estimations we provided ex post by three models (Annexes 2-4).

All three models provided more exact estimations than the original *CPM* model. For model no.1 the average value of difference between the real rating and model estimation for *SCM* countries was 0,000 with a standard deviation 0,908 of rating notch. For model no.2 the average difference was -0,0014 with a standard deviation 0,699. For model no.3 the difference between real and model rating was in average -0,0328 with standard deviation 0,700 of rating notch.

Prediction ability of individual *MCPM* models for years 2008-2011 was significantly influenced by the global economic crisis, when economic recession occurred in each of the investigated countries. Year-on-year drop in *GDP* in the SR in 2009 was more than 4% and in Hungary nearly 7%. This was manifested in 2009 results of the each model. In years 2009 and 2010 indicators for the individual country's fiscal health were significantly deteriorated.

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[46] Computed model values are compared with real rating with a time slip by 1 period, i.e. for example values for 1997 are compared with real rating for 1998. It should reflect assumption that country's economic efficiency in year 1997 will be reflected in rating for year 1998. As awarding of the rating is a dynamic process, which is not limited by a calendar year, for assigning a rating for specific year we have chosen the date of its awarding.

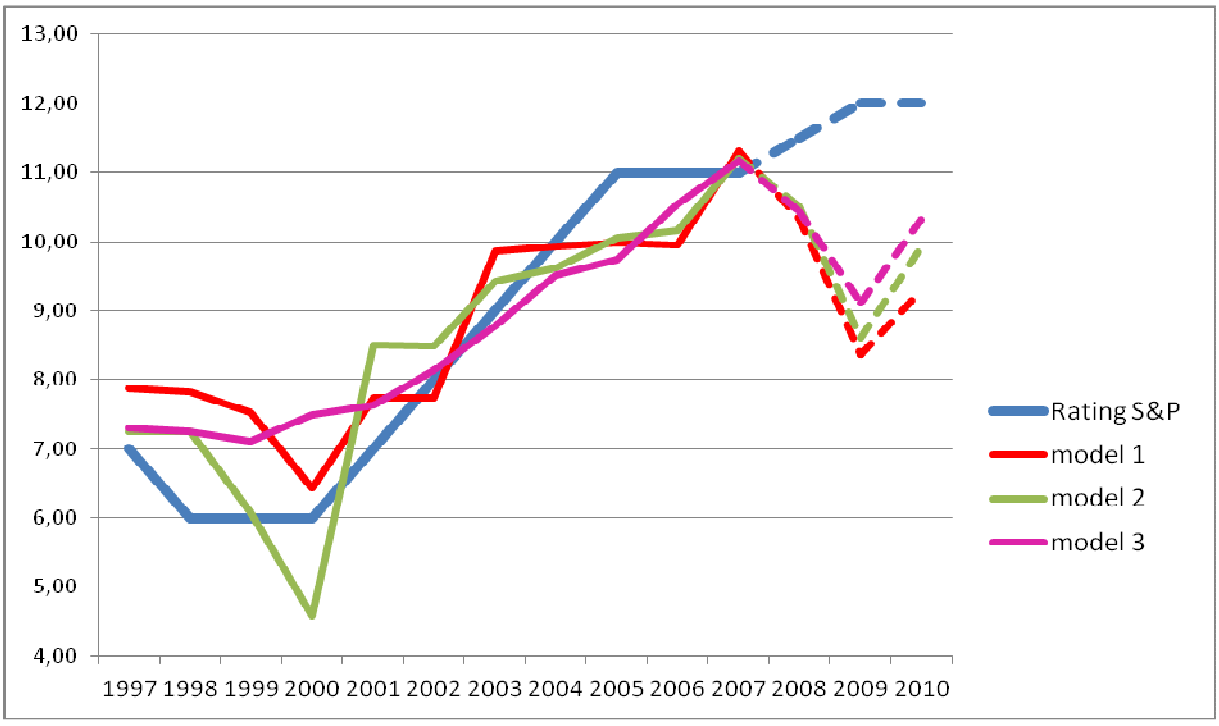
[47] But also for statistically not quite reliable estimation of parameters of the original CPM model.

Other investigated variables, used by the model did not show changes in comparison with the previous periods. Variable such foreign indebtedness did not appear to be statistically significant in our model. Yet, the foreign indebtedness significantly deteriorated particularly in Hungary.

Using rating parameters of individual models and the respective fundaments for years 2008-2010 the model results showed more significant deviations in comparison with *SOR* by *(S&P)*. The first models underestimated the rating grade of the Slovakia and Czech Republic. In case of Slovakia the difference was more striking – the real rating was in average higher by 2.5 rating notches than the estimation of the model. In case of the Czech Republic it was less than 1 rating notch. Model estimations for Hungary overestimated its rating in average by more than 2.5 rating notches.

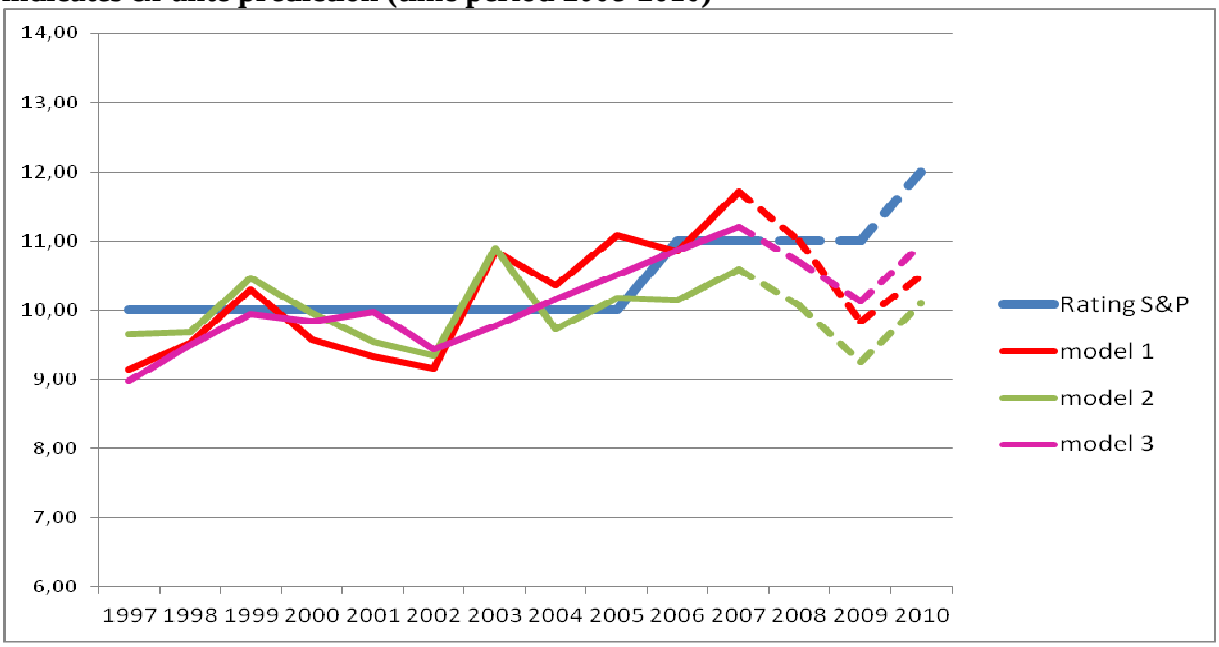
Other two models which included also qualitative variables achieve similar results. In case of Slovakia and Czech Republic the real rating was higher than estimation of the model, and in the case of Hungary it was vice-versa. Model, which included overall index of economic freedom estimated the results with the lowest deviation from the real rating. In general, model results for the Czech Republic were the closest to real values of country's rating.

Graph 1: Slovakia – comparison of S&P rating with model estimates. Dashed line indicates ex-ante prediction (time period 2008-2010)



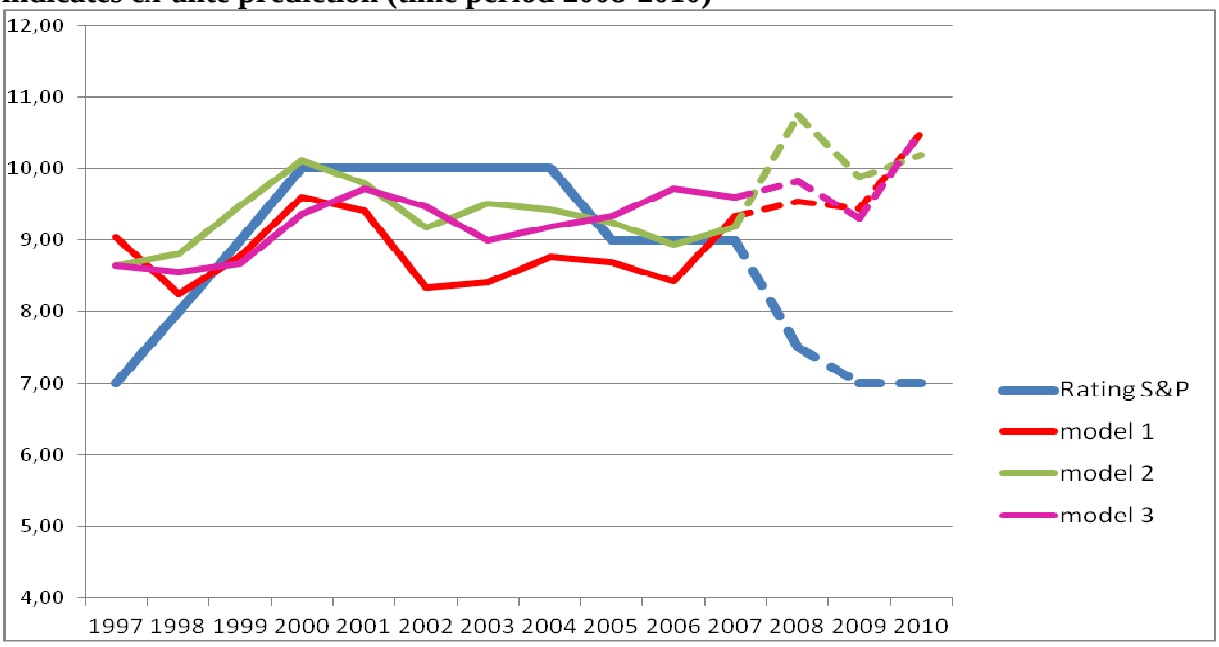
Source: Own estimation

Graph 2: Czech Republic – comparison of S&P rating with model estimates. Dashed line indicates ex-ante prediction (time period 2008-2010)



Source: Own estimation

Graph 3: Hungary – comparison of S&P rating with model estimates. Dashed line indicates ex-ante prediction (time period 2008-2010)



Source: Own estimation

Comparison of S&P rating grade and prediction of *SOR´s* by using *MCPM´s* and *RS* variable is included in Annex 7.

5.2 Causality between SOR and Government Bond Yields (GBY) in the time of the debt crisis

The question or hypothesis which has been under examination of several studies and is in our focus is: do credit rating changes contain any new information which is not available for the private investors or other market subjects? Lonely by *CPM* authors Cantor, Packer (1995) came to conclusions, that "market yields on selected sovereign debt issues indicates that the investor community not only frequently disagrees with the agencies over the rank-ordering of credit risks, but also shows considerably more pessimism in its absolute assessment of the level of credit risk in the sovereign sector".

Following results of study Block, Valler (2004), the credit rating agencies downgrade ratings of developing country more often in election years. The authors also examined the time lag between election date and the bond spreads movement: "the bond spreads are higher in the 60 days before an election compared to spread in the 60 days after an election; spreads trend significantly downward in the 60 days before an election. The spreads flatten out in the 60 days after an election".

Hill and Faff (2007) in a comprehensive study examined in way of econometrical testing if credit watch procedures affect changes of *SOR*. The findings of Hiff and Faff support the argument, that re-rating which follows watch procedures is informative for the private investors.

In our subsequent testing of causality between *SOR* and *GBY* for the SCH countries in 2008-2010, a technical analysis was used due to the shortness of observations[48]. The very graphic scheme[49] of *GBY* changes and dates of *SOR* changes by *(S&P)* and also the findings of Hill, Faff and Cantor, Packer allow us to state that it is not the financial market that reacts to changes in ratings. On the contrary, the increase in *GBY*[50] risk premium leads in a relatively short time to a change of a respective country rating. But after re-rating of the *SOR*, the *GBY* come back to the initially level in a few months. The best individual example shows the case of Hungary in the Annex 6.

[48] Application of VAR model, or Granger's causality testing was not possible on the given small set of observations.
[49] But also consultations with experts from the Slovak Agency for Debt and Liquidity Management..
[50] But also CDS and spreads.

6. Conclusions

The results of this paper suggest that there are limits to the prediction power of the econometric models in the times of turbulences on the financial and other markets. Firstly we found out that econometric model of sovereign rating – originally developed and tested by Cantor and Packer (CPM) – ex post systematically underestimates the sovereign rating of the Standard & Poor‘s for Slovakia, Czech Republic and Hungary. The model was using standard macro fundaments as explanatory variables.

Significant improvement of the CPM model results were obtained by including some soft variables in the model. Based on multicollinearity testing we have excluded some of the fundamental variables (originally used in PCM) from our three models. All modified models significantly decreased the deviation between models estimation and S&P sovereign ratings for the three countries.

By testing the prediction power of our models for period 2008-2010 for Slovakia, Czech Republic and Hungary we observed increase in differences between S&P's and models' ratings. In our opinion there are two main reasons for these findings.

First of all, the level of public debt was not a significant factor (proved by econometric testing) by sovereign rating setting in the period of relatively stable economic development in the years 1997-2007. But in the time of economic, financial or debt crisis the increase of the public debt or its share on GDP starts to be one of the most important signals for pricing the government bonds and also for sovereign rating.

The second possible reason we describe as the game on the financial markets between governments and the main private financial players. Our findings as well as findings of others allow us to say that no rating agencies are giving the first signals for the pricing of the sovereign bonds. It is rather other way around. The rating agencies incorporate the signals from financial markets and other soft or qualitative indicators into their ratings at the time of public debt crisis.

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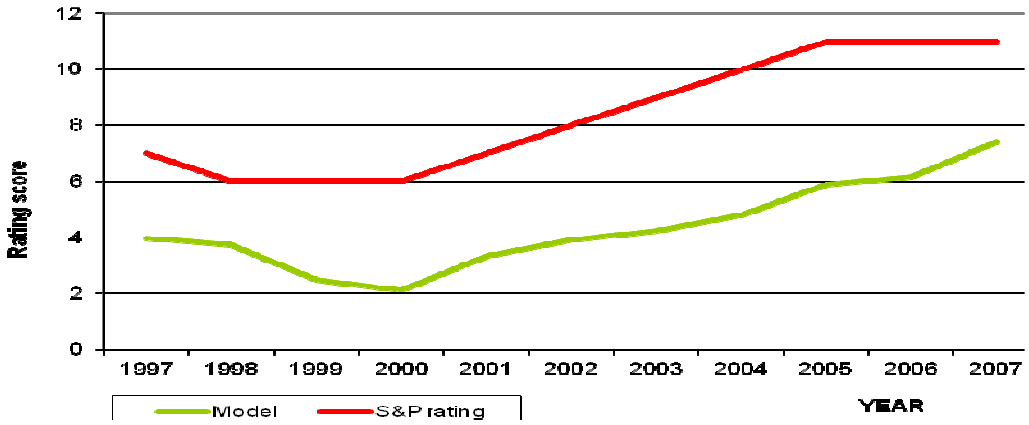
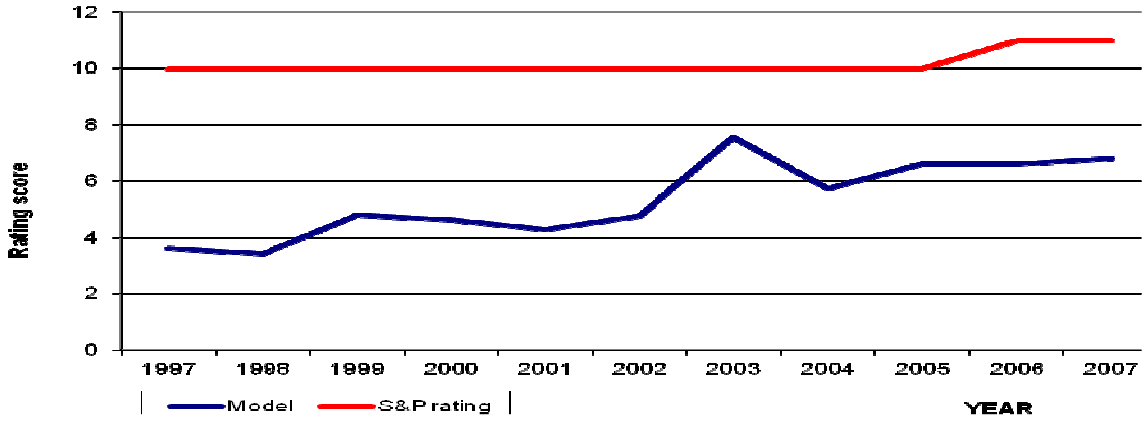
Annex 1:

Slovak Republic



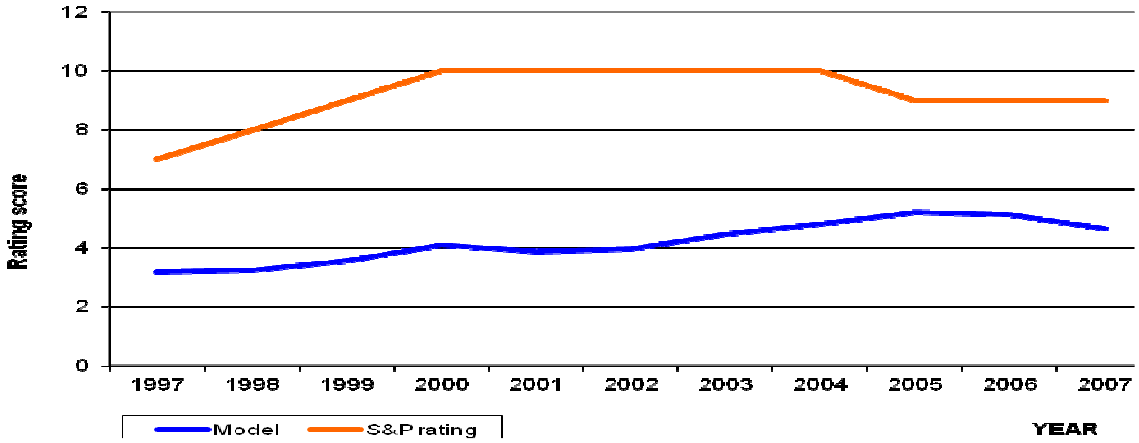
Source: Standard & Poor's rating, own estimation.

Czech Republic



Source: Standard & Poor's rating, own estimation.

Hungary



Source: Standard & Poor's rating, own estimation.

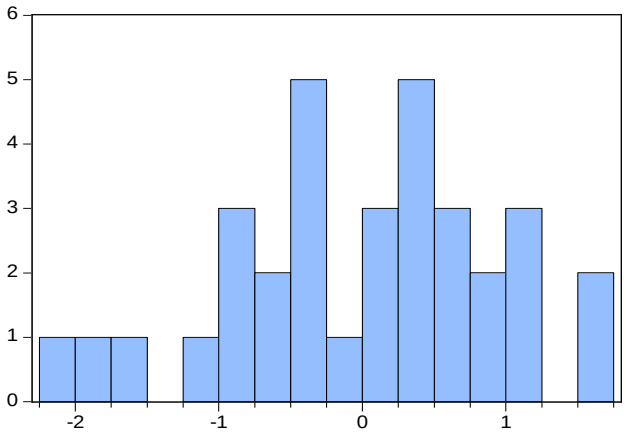
Annex 2

Model S&P with macro-economic variables

Dependent Variable: S_POORS
Method: Least Squares
Date: 02/06/10 Time: 16:19
Sample: 1 33
Included observations: 33
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

	Coefficient	Std. Error	t-Statistic	Prob.
C	11.17361	0.451303	24.75854	0.0000
GROWTH_GDP	0.102878	0.062666	1.641694	0.1118
INFLATION	-0.340224	0.161808	-2.102642	0.0446
FISCAL_BALANCE	0.299064	0.070194	4.260534	0.0002
FOREIGN_ACCOUNT	0.145686	0.082814	1.759194	0.0895

R-squared	0.632592	Mean dependent var	9.242424
Adjusted R-squared	0.580105	S.D. dependent var	1.521313
S.E. of regression	0.985800	Akaike info criterion	2.948002
Sum squared resid	27.21047	Schwarz criterion	3.174745
Log likelihood	-43.64202	Hannan-Quinn criter.	3.024294
F-statistic	12.05238	Durbin-Watson stat	0.880962
Prob(F-statistic)	0.000008		



Series: Residuals
Sample 1 33
Observations 33

Mean	1.55e-16
Median	0.156211
Maximum	1.671425
Minimum	-2.033581
Std. Dev.	0.922132
Skewness	-0.288425
Kurtosis	2.563778
Jarque-Bera	0.719187
Probability	0.697960

	GROWTH_GDP	INFLATION	FISCAL_BALANCE	FOREIGN_ACCOUNT
GROWTH_GDP	1	-0,184521	0,193977	0,120015
INFLATION	-0,184521	1	-0,1817	-0,158451
FISCAL_BALANCE	0,193977	-0,1817	1	0,239261
FOREIGN_ACCOUNT	0,120015	-0,158451	0,239261	1

MATRIX DETERM	0,840885327
k =	4
CHI SQUARE TEST	5,170116113
DEGREE OF FREEDOM	6
CHI SQUARE 0,05	12,59158724
CHI SQUARE 0,025	14,44937534
CHI SQUARE 0,01	16,81189383

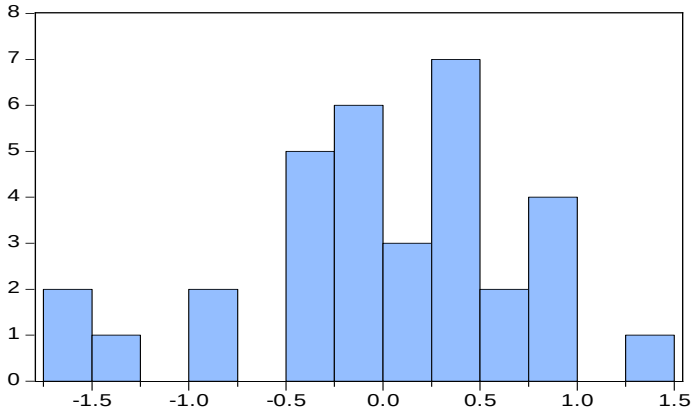
Annex 3

Model S&P combining macro-economic variables and individual factors of Index of Economic Freedom

Dependent Variable: S_POORS
Method: Least Squares
Date: 02/07/10 Time: 00:26
Sample: 1 33
Included observations: 33
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

	Coefficient	Std. Error	t-Statistic	Prob.
GROWTH_GDP	0.129735	0.046384	2.796966	0.0092
INFLATION	-0.367827	0.173800	-2.116383	0.0433
FISCAL_BALANCE	0.212501	0.053255	3.990224	0.0004
INVEST_FREEDOM	0.117409	0.017104	6.864617	0.0000
NO_CORRUPT	0.052798	0.027193	1.941602	0.0623

R-squared	0.782172	Mean dependent var	9.242424
Adjusted R-squared	0.751054	S.D. dependent var	1.521313
S.E. of regression	0.759052	Akaike info criterion	2.425234
Sum squared resid	16.13247	Schwarz criterion	2.651978
Log likelihood	-35.01636	Hannan-Quinn criter.	2.501526
Durbin-Watson stat	1.824885		



Series: Residuals
Sample 1 33
Observations 33

Mean	-0.001408
Median	0.036991
Maximum	1.427659
Minimum	-1.647067
Std. Dev.	0.710027
Skewness	-0.439726
Kurtosis	2.947042
Jarque-Bera	1.067332
Probability	0.586451

	GROWTH_GDP	INFLATION	FISCAL_BAL	INVEST_FREEDOM	NO_CORRUPT
GROWTH_GDP	1	-0,184521	0,193977	0,193484	-0,388685
INFLATION	-0,184521	1	-0,1817	-0,222935	0,304416
FISCAL_BALANCE	0,193977	-0,1817	1	0,427824	-0,044591
INVEST_FREEDOM	0,193484	-0,222935	0,427824	1	-0,128797
NO_CORRUPT	-0,388685	0,304416	-0,044591	-0,128797	1

MATRIX DETERM	0,562360608
k =	5
CHI SQUARE TEST	16,9805535
DEGREE OF FREEDOM	10
CHI SQUARE 0,05	18,30703805
CHI SQUARE 0,025	20,48317735
CHI SQUARE 0,01	23,20925116

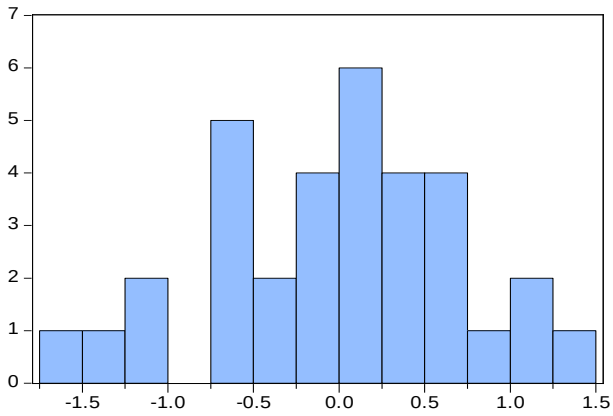
Annex 4

Model S&P combining macro-economic variables and overall score of Index of Economic Freedom

Dependent Variable: S_POORS
Method: Least Squares
Date: 02/06/10 Time: 16:48
Sample: 1 33
Included observations: 33
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

	Coefficient	Std. Error	t-Statistic	Prob.
GROWTH_GDP	0.134388	0.062166	2.161779	0.0387
FOREIGN_ACCOUNT	0.143069	0.048825	2.930221	0.0064
OVERALL_SCORE	0.142532	0.004775	29.84951	0.0000

R-squared	0.780877	Mean dependent var	9.242424
Adjusted R-squared	0.766269	S.D. dependent var	1.521313
S.E. of regression	0.735490	Akaike info criterion	2.309947
Sum squared resid	16.22835	Schwarz criterion	2.445993
Log likelihood	-35.11413	Hannan-Quinn criter.	2.355723
Durbin-Watson stat	0.724014		



Series: Residuals
Sample 1 33
Observations 33

Mean	-0.032778
Median	0.051378
Maximum	1.255286
Minimum	-1.643552
Std. Dev.	0.711356
Skewness	-0.439848
Kurtosis	2.741728
Jarque-Bera	1.155784
Probability	0.561080

	GROWTH_GDP	FOREIGN_ACC	OVERALL_SCORE
GROWTH_GDP	1	0,120015	0,112814
FOREIGN_ACCOUNT	0,120015	1	0,368472
OVERALL_SCORE	0,112814	0,368472	1

MATRIX DETERM	0,847075546
k =	3
CHI SQUARE TEST	5,006622793
DEGREE OF FREEDOM	3
CHI SQUARE 0,05	7,814727764
CHI SQUARE 0,025	9,348403568
CHI SQUARE 0,01	11,34486668

Annex 5: Comparison of real rating and prediction of models (the quoted rating according to the rating scale):

Slovak Republic

Year	Rating S&P	Model 1	Model 2	Model 3
2008	A / A+	A-	A- / A	A- / A
2009	A+	BBB	BBB +	BBB +
2010	A+	BBB+	A-	A-

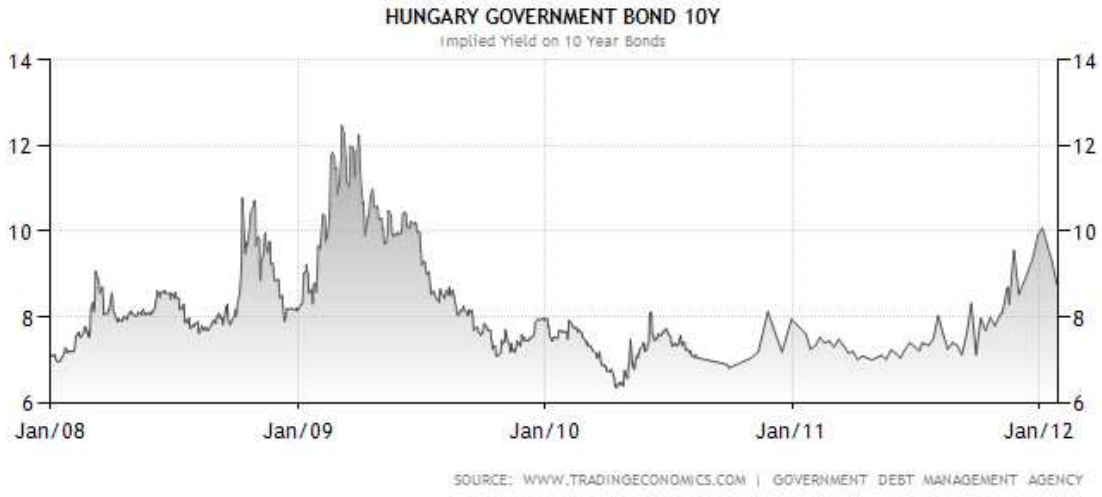
Czech Republic

Year	Rating S&P	Model 1	Model 2	Model 3
2008	A	A	A-	A
2009	A	A-	BBB+	A-
2010	A / AA-	A- / A	A-	A

Hungary

Year	Rating S&P	Model 1	Model 2	Model 3
2008	BBB / BBB-	BBB+ / A-	A	A-
2009	BBB-	BBB+ / A-	A-	BBB+
2010	BBB-	A- / A	A-	A- / A

Annex 6.



▲ ▲ ▲

BBB+ BBB BBB- BB+

Annex 7.

RS	S & P
1	B -
2	B
3	B+
4	BB -
5	BB
6	BB+
7	BBB -
8	BBB
9	BBB+
10	A -
11	A
12	A+
13	AA -
14	AA
15	AA+
16	AAA