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The Transparency of Credit Ratings – Reconstruction of Hungary's Sovereign Rating*

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After the crisis that commenced in 2008, the observed procyclicality and the slow responses of the credit rating institutions to credit risk events cast strong doubts on the justification of the major role of the credit rating agencies in the financial markets and the reliability of their ratings. Therefore, this case study examines the extent to which the reconstruction of the foreign currency denominated debt ratings of Hungary, as a sovereign issuer, can be implemented accurately under the present transparency of the credit rating processes, i.e. to what degree the indicative rating range, obtained on the basis of the credit rating agencies' methodology, explains the actual credit rating. Using the publicly available methodological documentation of Moody's, Standard and Poor's and Fitch Ratings, we performed the model calculation of Hungary's credit rating at the three institutions. Although the level of transparency of the three rating agencies has improved, ratings for Hungary could only be reconstructed with some uncertainty. Major progress could only be achieved if the rating agencies calculated the input indicators of the model from known data sources with known calculation at all times.

Journal of Economic Literature (JEL) codes: F34, G15, G24

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1. Introduction

Structured credit products, which were downgraded after the financial crisis that erupted in 2008, and the downgrading of sovereign issuers facing severe funding difficulties as a result of the crisis brought the activity of the credit rating agencies into the focus of experts. With regard to the development of the crisis, many questioned the justification of the major role of credit rating agencies in the market, as well as the reliability of their ratings (*Benmelech – Dlugosz 2009; Crotty 2009; White 2010;*

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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Iyengar 2012). In December 2008, structured products accounted for roughly 35 per cent of the US bond market, with a magnitude of USD 10^{13}, more than half of which received AAA rating from Moody's; then one third of them was shortly subject to significant downgrading (*Benmelech – Dlugosz 2009*). Such events signalled that this was a complex problem. On the one hand, it was known already before the crisis that the business model of the rating agencies generates conflicts of interest, where the rated entity is the user of the rating service, i.e. the source of the rating agency's revenues (*O'Sullivan et al. 2012*). At the same time, the crisis made it clear: the models of the rating agencies also contain methodological errors *(Utzig 2010).* With a view to improving the quality of the credit ratings and mitigating the uncertainties surrounding the activity of the rating agencies, the regulatory authorities significantly expanded the regulation of the sector (*IMF 2010*; *European Council 2009, 2011*). Owing to these regulatory efforts, the credit rating agencies have rendered their decision-making processes more transparent and published more detailed methodologies than before. In addition, in the rating action reports accompanying their credit rating decisions, they publish several pieces of information that reveal the criteria and economic developments they consider upon the classification of issuers.

This paper, as a case study focusing on Hungary, examines the accuracy – with the present transparency of the credit rating processes – of the reconstruction of the ratings of Hungary, as a sovereign issuer, i.e. to what extent the indicative rating range, obtained on the basis of the credit rating agencies' methodological documentation, explains the actual credit rating. Due to length constraints, emphasising the character of a case study, we perform the analysis only for one of Hungary's ratings, i.e. for foreign currency-denominated debt. This choice ensures the comparison of our conclusions with similar results in the Hungarian technical literature. (See later in more detail the comments on the 2016 work of *Ligeti – Szőrfi*.)

To answer the research question, on the one hand we review in detail the publicly available methodological documentation of the three dominant credit rating agencies, i.e. Moody's, Standard and Poor's, and Fitch Ratings, and then, based on the methodological documentation, we examine the accuracy of the possible modelling of Hungary's sovereign debt rating at the three institutions. In addition, the research takes account of the credit rating reports published following the respective review by the institutions, the information content of which also contributes to the more accurate model calculation of the real credit ratings. We performed the reconstruction of the model calculation for all three institutions for the date of the latest available credit rating review, which was 4 November 2016 in the case of Moody's, 16 February 2018 in the case of S&P and 9 March 2018 in the case of Fitch. This paper solely examines the extent to which the ratings are reconstructible accurately, and we do not examine the "correctness" and forecasting capacity of the models. Beyond length constraints, such an analysis would be limited

by the fact that the possibility of reconstructing the model of the three rating agencies – as is seen later – remains still limited.

The colleagues of the Magyar Nemzeti Bank have already dealt with the methodological issues of the credit ratings and the reconstruction thereof with regard to Hungary within the framework of a series of technical articles; however, since then more detailed methodological documentation has been published, which calls for a repeated analysis and facilitates the understanding of the credit rating agencies' decision-making processes even more accurately. This is particularly true for the methodological documentation of Fitch Ratings, which had not yet published a methodology suitable for reconstruction at the time when the earlier papers were written; however, the present description is already detailed enough for us to attempt a reproduction of the rating. In addition to the foregoing, we deem it important to emphasise that this paper relies substantially on the results of the relevant research published earlier.

In the following, we first briefly describe the role of credit rating institutions in the financial markets, and then review the preliminaries of our research in the literature. Thereafter, we describe the general methodology of the credit rating of sovereign issuers, followed by a review of the three rating agencies' methodologies. Finally, we model the calculation of Hungary's credit rating at the three institutions. The paper is closed with a summary and conclusion.

2. Functions of the credit rating agencies in the financial markets

In its October 2010 "Global Financial Stability Report", the International Monetary Fund (IMF) paid special attention to the issues of credit rating institutions affecting financial stability, and – with reference to the relevant international literature – discussed the fundamental functions of credit rating agencies in detail. According to the IMF paper, credit rating agencies have essentially three functions in the financial markets: (1) to provide information on the entities they rate; (2) to encourage borrowers to take corrective measures; and (3) to provide issuers with certificates (*IMF 2010*). In the following paragraphs, we briefly review the performance of these three functions.

In the case of external financing, e.g. borrowing, there is an information asymmetry between the party in need of financing and the party that provides the financing. The party providing the external financing does not know in full the potential success of the project and activity to be financed, or the efforts of the party raising the capital as to whether it focuses on the maximisation of the full value of the project or only on its private benefit. This information asymmetry gives way to moral hazard, i.e. the financed project owner becomes inclined to maximise its own utility in the absence of proper incentives. Accordingly, in a lending situation, credit rationing can be observed:

projects with positive net present value are either not implemented at all, or they are implemented in a smaller than optimal volume (*Tirole 2006*).

The rather complex risk appearing in a lending situation is generally referred to as credit risk. *Jorion* (*1999*) refers to it as the risk when the borrower fails to fulfil the interest due and/or principal instalment in part or in full, or does not fulfil on the due date. He also considers it to the part of the credit risk when the probability of these events increases. MNB Recommendation 1/2017 states as follows: "Credit risk is a risk, jeopardising the profitability and capital position, arising from partial or complete non-fulfilment (or from fulfilment not in compliance with the conditions of the contract) of the contracting parties' obligation, i.e. from the partial or complete non-fulfilment of (on-balance sheet or off-balance sheet) obligations outstanding vis-à-vis the financial institution." (*MNB 2017:3*). Of the credit risk types detailed in the MNB Recommendation, sovereign risk[1] is the one that is forecasted by the rating agencies' sovereign models. Non-fulfilment by sovereign issuers is closely related to the notion of sovereign default, a topic which we only mention briefly due to length constraints. For example, *Vidovics-Dancs* (*2013, 2014, 2015*) deals with this topic in her papers. We only cite one definition of sovereign default by the author: "sovereign default is usually defined as the failure of a sovereign state to discharge its payment obligations related to its credit liability or discharging it not in accordance with the original conditions, and thereby causing a loss to the lender" (*Vidovics-Dancs 2014:264*). This definition corresponds to the definitions used in the international literature, but more importantly it also corresponds to the approach of Fitch, S&P and Moody's.

This is the point where the credit rating agencies have a role in a lending situation. The market assumes that the rating agencies usually have an informational advantage compared to an average investor in the assessment of the payment ability and payment willingness of the inspected issuer, and of its credit risk resulting from these two parameters (*Melnick 2008*). Since the rating agencies primarily measure the relative risk of the non-fulfilment of the borrowers' financial obligations, their primary role in the financial markets is to provide accurate and reliable information, thereby mitigating the informational asymmetry existing at the two ends of the credit relation (*IMF 2010; Ligeti – Szőrfi 2016*). Elimination of the informational asymmetry is mutually advantageous for lenders and borrowers: lenders can invest with a more accurate knowledge of the credit risk, while borrowers can raise funds at lower costs (*Fennel – Medvedev 2011; Ligeti – Szőrfi 2016*). Thus, the information provided by the rating agencies may also increase the number of potential borrowers, which contributes to the establishment of liquid markets (*IMF 2010*). All of this leads to a decrease in credit rationing, the projects not financed

[1] "it is a sub-type of country risk, and means the risk arising from the default of the country vis-à-vis which the financial organisation has an exposure" (*MNB 2017:3*)

or financed at higher cost earlier can be implemented or realised at lower cost, i.e. the activity of the rating agencies also enhances social welfare (*Tirole 2006*).

Another major role of the rating agencies manifests itself in a kind of monitoring activity; with this they motivate the borrower to perform adjustments with a view to preventing downgrading (*IMF 2010; Ligeti – Szőrfi 2016*). The means of this include the warnings related to potential downgrading, communicated in the credit rating review. A positive credit rating assessment is of crucial importance, because a potential downgrade may generate additional negative impacts for the borrowers, since most institutional investors are not allowed by regulations to keep low-graded securities in their portfolio (*IMF 2010*).

Although the positive effects of the rating agencies' monitoring activity are unquestionable, potential downgrades may entail spillover effects, which can also destabilise financial markets (*IMF 2010*). This problem stems from the rating agencies' third basic function, i.e. from the issue of certificates, since rating categories have now become integral parts of a number of regulatory requirements and financial contracts (*IMF 2010*; *Ligeti – Szőrfi 2016*). *Utzig* (*2010*) also emphasises that the use of credit ratings for regulatory purposes makes a huge contribution to the procyclical effect of ratings.

However, the rating agencies perform the aforementioned functions in the knowledge of the occasionally contradictory requirements of the stakeholders. The most evident requirement is that the models of the rating agencies should be representative of the issuer and the securities, and provide a good forecast of credit risk events. In addition to the precise description of the credit risk related to the issuer/securities, stability is also an issue: how "sensitive" a good model should be to the momentary, potentially temporary, changes in the circumstances of the rated entity. Timeliness is also in important issue, but perhaps it can be handled better than the previous one. Accordingly, accuracy, stability and timeliness are all justified requirements concerning the ratings; however, from time to time they can only be enforced at the expense of each other (*Ligeti – Szőrfi 2016*). Let us consider market participants' expectations with regard to the stability of the ratings, as an example. The stability of ratings may be a realistic requirement of investors making decisions on the basis of such ratings, since it would be expensive to restructure their portfolio upon each minor market movement. The institutions in charge of the oversight of the market, traditionally also deem the stability of the ratings to be advantageous, since a rating that responds quickly to negative market movements puts additional pressure on the market. The interest of the issuers in a stable rating is self-evident; for them each change in the rating means a new price negotiation with the providers of external finance. In addition, if the rating changes too often, it also questions the reliability of the rating agency. Based on all of these motivations, the stability of the ratings may be an acceptable objective for all stakeholders. Thus, this simple example also illustrates well that even under normal market circumstances, rating

agencies face a number of expectations, pondering which they have to perform, as far as possible, objective rating over and over again (*Melnick 2008*).

However, after the 2007–2008 crisis, investors started to voice their concerns more loudly that the rating agencies follow market changes too slowly – many of them blamed this for "surprises" such as the Enron case, which had not been forecasted by any downgrade. With a view to ensuring the stability of the ratings, the rating agencies used the through-the-cycle approach, putting more emphasis on the long-term components of the credit risk. In addition, they also treated the migration of the rated issuers and securities prudently. All of this resulted in severe underestimation of the short-term credit risk (*Melnick 2008*).

Compared to the ordinary condition of the markets, the crisis focused attention on additional problems inherent in the system. The moral hazard faced by the rating agencies was also previously known, and its role in the fact that the rating did not reflect the true financial situation – e.g. in the case of Enron – was not insignificant. *O'Sullivan et al.* (*2012*) report that the business model of the rating agencies fundamentally changed in the 1970s. Previously, the revenue of rating agencies came solely from investors for performing specific ratings. However, starting from the 1970s issuers could also apply for rating – as a paid service – for the securities they intended to issue. Since a better rating means cheaper financing, for which it is worthwhile to pay a higher fee to the rating agency, moral hazard appeared in the rating situation (*O'Sullivan et al. 2012*). This moral hazard is particularly strong for rating agencies facing fierce competition in their own market, if a substantial portion of their revenues is concentrated at a small number of issuers. This is exactly what happened in the case of the ill-famed mortgage structure products in the crisis (*Langohr – Langohr 2010*).

Thus, it is understandable that the regulation of rating agencies and oversight of their activity became a requirement of market participants after the crisis, the results of which we have already mentioned (*IMF 2010; European Council 2009, 2011*). The transparency of the rating methodology bears special importance in strengthening investor confidence. In this paper, we examine the transparency of the methodology by assessing the degree to which the methodological documentation of the rating agencies make it possible to reproduce the classification and specific rating determined by the agencies. Naturally, transparency helps the users of the ratings in assessing the "correctness" of the models – regardless of whether we talk about the "correctness" of accuracy, stability or timeliness – but the transparency criterion we have selected, i.e. the possibility of accurate reconstruction of specific ratings, does not characterise any of these criteria.

In the literature, the antecedents related most closely to our paper are the results of *Ligeti – Szőrfi* (*2016*). They measure transparency in a more detailed manner than this paper; in addition to the reconstructibility of the specific classification, they also

examine the reconstructibility of the model itself. The criteria of the authors include: "the extent to which the indicators considered are explicitly explained; availability of scales applied for the evaluation of the indicators; availability of the weighting assigned to individual dimensions; the extent to which the values calculated for individual indicators are available; availability of an indication by the agency regarding the current evaluation of individual dimensions." (*Ligeti – Szőrfi 2016:20*). Based on the methodological documentation available in 2016, they performed an analysis for several countries, including Hungary. They obtained the following results: in the case of S&P, they clearly managed to reproduce the indicative rating range, whereas when using the Moody's documentation supplementary assumptions had to be made. In the case of Fitch, the published methodology included no information on the weighting and scales, and thus the authors did not even attempt to make an estimate.

Apart from the work of co-authors *Ligeti – Szőrfi* (*2016*), we find literature relevant for our paper mainly in respect of sovereign credit rating models. Very rich literature is available on the topic of quantitative economic variables explaining the ratings. Typically, the indicators with explanatory power include GDP per capita, real GDP growth, the level of external debt, the level of government debt, the fiscal balance, GDP growth, inflation, foreign exchange reserves, economic development and the number of years elapsed since the last default (*Bruha et al. 2017; Afonso et al. 2011*). In several cases, the authors also test the forecasting power of these models, i.e. they also calculate the future ratings (revised rating) with their models. This trend in the technical literature can be observed both before and after the crisis, e.g. Afonso published several papers on this topic (*Afonso 2003; Afonso et al. 2012; Afonso et al. 2011*) and the earlier work of *Bissoondoyal-Bheenick* (*2005*) is also available. The paper written at the beginning of 2017 by the colleagues of the European Central Bank also mentions that since the rating agencies do not publish their models, a large part of the technical literature focuses on the construction of models, which return a rating identical to that issued by the rating agencies. The authors of the paper cite several research studies – from Bruha et al., through the work of Mora in 2006[2] to Gaillard's[3] results in 2014 – as examples (*Bruha et al. 2017*).

3. The methodology of sovereign credit rating

Since *Ligeti – Szőrfi* (*2016*) have already analysed the methodological issues of the rating agencies in detail, upon describing the methodology of sovereign credit rating, we partially rely on the information content of the cited research. Our objective is that this paper should be the partial continuation of the Ligeti–Szőrfi paper, and thus – similarly to them – by the sovereign credit rating of Hungary we also mean the credit risk rating of the long-term, foreign currency-denominated

[2] Mora, N. (2006): *Sovereign credit ratings: Guilty beyond reasonable doubt?* Journal of Banking & Finance, 30(7): pp. 2041–2062.
[3] Gaillard, N. (2014): *What Is the Value of Sovereign Ratings?* German Economic Review, 15(1): pp. 208–224.

debt of Hungary (as an issuer) (*Ligeti – Szőrfi 2016*), but we limit the analysis to Hungary and do not extend it to the debt of other European countries.

A sovereign credit rating is essentially an opinion formulated on the loan repayment capacity and willingness of the respective state (*IMF 2010*). A sovereign state can be deemed insolvent if it is unable to discharge its principal or interest payment obligations towards the investors on the due date (*IMF 2010*). Credit rating agencies rank the default risk on a scale, where the sovereign states allocated to the same category show similar credit risk (*Ligeti – Szőrfi 2016*). The credit risk classifications of the three largest rating agencies are illustrated by *Figure 1*. As shown, the sovereign issuers with the best rating receive three "As", while those with the worst rating receive a "D" rating on the credit rating scale. In addition, the rating agencies indicate the probability of modifying the current rating by the negative, stable and positive outlook and the watch list categories (*Ligeti – Szőrfi 2016*).

Figure 1
Credit rating classifications used by Fitch Ratings, Standard &Poor's and Moody's

Fitch Ratings	Standard &Poor's	Moody's
AAA	AAA	Aaa
AA+	AA+	Aa1
AA	AA	Aa2
AA–	AA–	Aa3
A+	A+	A1
A	A	A2
A–	A–	A3
BBB+	BBB+	Baa1
BBB	BBB	Baa2
BBB–	BBB–	Baa3
BB+	BB+	Ba1
BB	BB	Ba2
BB–	BB–	Ba3
B+	B+	B1
B	B	B2
B–	B–	B3
CCC+	CCC+	Caa1
CCC	CCC	Caa2
CCC–	CCC–	Caa3
CC	CC	Ca
C	C	C
D	D	D

Source: Moody's (2016a), Fitch (2017a), S&P (2017a)

The rating framework for the riskiness of the sovereign issuers is provided by the model detailed in the methodological documentation of the credit rating agencies. The big three rating agencies typically allocate the indicators considered for the purposes of sovereign rating to four or five groups of variables, i.e. dimensions. Most of the dimensions group distinct variables which are similar in terms of magnitude at all three rating agencies. All three institutions use the macro economy and general government dimensions, while institutional efficiency is used in the model of two actors, i.e. Moody's and S&P. External balance indicators are used by two rating agencies (Fitch and S&P). S&P, contrary to the other two institutions, assesses the effectiveness and flexibility of the sovereigns' monetary policy in a separate dimension. Moody's and Fitch created a separate dimension for event risk and structural features, respectively.

The assessment of the individual dimensions is based on certain key variables, which are not necessarily identical at the three institutions, and then the model may modify the initial score returned by the assessment by considering additional variables. The indicators examined by the rating agencies essentially capture identical economic processes; however, their calculation methodology and weighting within the dimension vary by institution. Furthermore, in respect of the credit ratings it should be noted that although the actual credit ratings usually fall within the indicative rating level obtained by applying the methodological model, the rating committee may decide, from time to time, on a rating other than that proposed by the model (*Ligeti – Szőrfi 2016*).

Another important factor related to the credit rating methodology is that the institutions, with a view to avoiding procyclicality, consider multi-year averages for certain variables, obtained on the basis of historic, current year and forecast values (*IMF 2010*; *Ligeti – Szőrfi 2016*). This calculation method ensures that the ratings reflect the fundamental process of the economy rather than responding to fluctuations in business cycles (*IMF 2010*; *Ligeti – Szőrfi 2016*).

4. Special features in the methodology of the three rating agencies

In the following part of the paper, we discuss the special features of the methodological documentation of Moody's, S&P and Fitch, and present the content of the latest methodological documentation of all three institutions, prevailing at the time of writing this paper.

4.1. Special features of the Moody's methodology

Moody's assesses sovereign credit risk in four dimensions. The variables considered in these four dimensions are presented in *Annex 1* at the end of the paper. The Moody's model, in line with the general credit rating methodology, fine-tunes the initial scores obtained on the basis of the key variables by considering additional

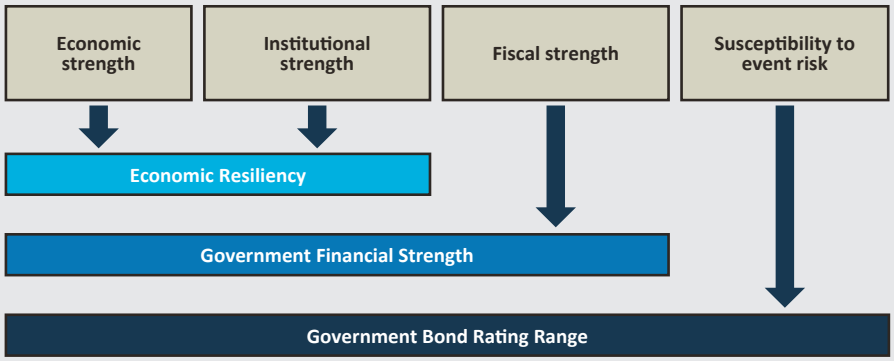
variables. The prevailing methodology of the institution contains almost all information necessary for accurate model calculation: the variables determining the basic score of the individual dimension, their weight within the dimension and the scales underlying the assessment are all known. At the same time, transparency is not full, since there is no evaluation scale for certain indicators modifying the initial score of the individual dimensions, and some individual variables are not expressed by a specific indicator. Examples of these include the indicator measuring the strength of the banking sector (BCA), which is a multi-component indicator of Moody's, partially reflecting its subjective value judgement (*Moody's 2016a*).

The evaluation of three of the four dimensions is performed on the basis of 5 to 6 key variables, depending on the dimension, and then the model modifies the results obtained using additional variables. The score of the fourth dimension – susceptibility to event risk – is generated using twelve key variables and is not influenced by additional variables. Most of the indicators considered by Moody's are quantitative: for some of these the model calculates the ten-year average of historic and forecast values, but there are also less quantifiable variables, particularly in the dimensions institutional strength and susceptibility to event risk (*Moody's 2016a*).

The individual variables are evaluated on specific scales ranging from 1 to 15, based on which the methodology of the institution allocates the variables to fifteen different categories. The category classifications are from "VH+" representing the highest grade, to "VL–" being the lowest one. Following categorisation, the methodology of Moody's allocates a midpoint to each variable suitable for its category. The weighting of the variables within the dimension is performed in accordance with the midpoint obtained on the basis of the categorisation. This ensures that the variables belonging to the same category take the same value upon weighting. Naturally, the weighting of the variables may differ, depending on their importance within the dimension. The model aggregates the values obtained through the weighting within each dimension, as a result of which the scores of the dimensions are obtained. Thereafter, the model ranks the scores of the dimension – similarly to the evaluation of the individual variables – on a scale from 1 to 15, based on which it allocates each dimension to one of the fifteen categories (*Moody's 2016a*).

After the allocation of the individual dimensions to categories, the model combines the four dimensions in the following way and sequence (*Figure 2*): The model first aggregates the economic strength and institutional strength dimensions, applying a symmetric weighting for the two. Combining the two dimensions results in the economic resiliency profile. In the next step, the model combines the economic resiliency profile with the fiscal strength dimension, resulting in the government financial strength profile. As the last step, the government financial strength profile, obtained from the aggregation of the previous three dimensions, and the susceptibility to event risk dimension are combined, which designates the midpoint of the three-notch rating range proposed by the model (*Moody's 2016a*).

Figure 2
Schematic chart of the aggregation of the dimensions included in the Moody's methodology



Source: Based on Moody's (2016a)

Another special methodological feature of Moody's is that the assessment of external balance developments is performed in a special manner. In addition to the indicators capturing external vulnerability, in this dimension (susceptibility to event risk), Moody's also considers indicators capturing political risk, the liquidity position of the general government and the vulnerability of the banking sector. The score of the dimension is also determined in a different way than usual: the final score of the variable group is obtained based on the evaluation of the indicators of the area deemed to represent the highest risk of the four tested areas, i.e. the one with the highest score (*Moody's 2016a*).

4.2. Special features of the Standard & Poor's methodology

S&P assesses sovereign credit risk using five dimensions. The variables considered in the five dimensions are included in *Annex 2* at the end of the paper. The evaluation of three of the five dimensions – economic, fiscal and external assessment – is performed on the basis of well quantifiable data, while the model evaluates the other two dimensions – institutional and monetary policy assessment – typically on the basis of qualitative information (*S&P 2017a*). Reconstruction of the latter dimensions is substantially facilitated by the fact that in its latest credit rating reports the institution also discloses the score of the individual dimensions, and thus the score values of the dimensions can be determined accurately by also considering the textual description in the report.

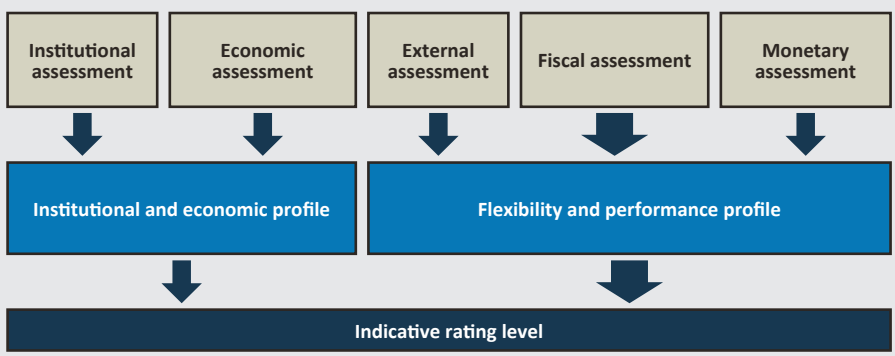
In the case of the economic, fiscal and external dimensions, the institution's methodology contains the variables that determine the initial score of the dimensions, as well as the scales underlying the evaluation, which are of great help for the precise reconstruction of the evaluation of the dimensions. The evaluation of the institutional dimension is performed entirely on a subjective basis:

neither the methodology of the institution nor the credit rating reports specify any indicators that substantiate the score for this dimension. The methodology divides the evaluation of the monetary policy dimension into two parts: it assesses the exchange rate regime pursued by the sovereign issuer on the one hand, and the credibility and effectiveness of its monetary policy on the other (*S&P 2017a*).

S&P evaluates all of the key variables on an individual scale from 1 to 6. The score of the five dimensions is obtained on the basis of the score of the variable belonging to the individual dimensions. Subsequently, considering additional criteria, the S&P model can modify the initial scores obtained on the basis of the key variables by a maximum of two or three scores, depending on the dimension. The methodological documentation contains the modifying factors considered within the individual dimensions, as well as the conditions to be fulfilled to ensure that the amended model returns the originally obtained score. For example, one of the areas underlying the evaluation of the fiscal dimension is evaluated one score lower, if a predetermined level is exceeded by at least two of the foreign currency ratios for government debt, the government securities holding of non-residents, the sovereign exposure of the banking sector or the volatility of the debt service profile parameters (*S&P 2017a*).

In the case of S&P (*Figure 3*), the process of combining the dimensions is simpler than at Moody's. As a first step, the model combines the score of the institutional and economic dimensions, the arithmetic average of which designates the score of the institutional and economic profile. In the next step, the model calculates the average of the scores of the fiscal, external and monetary policy dimensions, thereby obtaining the flexibility and performance profile. As the last step, the model takes the arithmetic average of the two profiles, which designates the midpoint of the three-notch rating range (*S&P 2017a*).

Figure 3
Schematic chart of the aggregation of the dimensions included in the S&P methodology



Source: Based on S&P (2017a)

4.3. Special features of the Fitch Ratings methodology

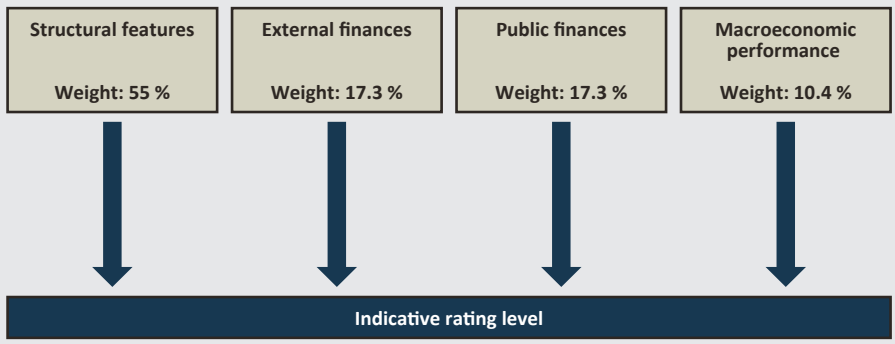
Similarly to Moody's, Fitch also evaluates the sovereign credit risk using four dimensions (*Annex 3*). In contrast to the other two dominant rating agencies, Fitch uses a multivariate regression model for the sovereign rating rather than predefined scales, based on which the methodology allocates weights to the individual variables (*Fitch 2017a*). The weights are defined objectively, solely on the basis of the regression model's coefficients, which also means that the institution regularly reviews the weights allocated to the variables and modifies them as necessary. The weights show what percentage of the variance of the rating is explained by the variance of the respective group of variables.

According to Fitch's latest analytical framework, the model rating is influenced to the highest degree (55 per cent) by the dimension containing the structural features of the economy. The second most important dimension is the group of variables capturing the external balance (external finances) and general government (public finance) developments, each with a weight of 17.3 per cent. This is followed by the dimension including the indicators describing macroeconomic performance, with a weight of 10.4 per cent. For half of the variables grouped within the dimensions, the model considers the average of the data calculated for the current year, the value of the previous year and the value estimated for the next year, but the institution does not publish regular information on the estimated data in its credit rating reports (*Fitch 2017a*). This means that when reconstructing the model calculations, we can rely on assumptions, at the most, in determining these values.

In the interests of making the rating calculated by the model more accurate, from time to time the institution also considers less quantifiable variables (qualitative overlay), which – based on a comparison with sovereign issuers with identical credit ratings (peer analysis) – may upgrade or the downgrade the rating of the sovereign issuer under review by as many as three grades (*Fitch 2017a*). In the report on the respective review, Fitch regularly mentions the modifying factors considered for the purpose of the rating, which may help reconstruct the model calculation more accurately.

The credit rating methodology of Fitch also differs from the analytical framework of the other two institutions in the sense that the model does not create different profiles after determining the scores of the individual groups of variables. The scores of the groups of variables are obtained as the sum of the product of the variables included therein and the regression coefficient belonging to them. Fitch also publishes the constant value of the regression model (intercept term). Accordingly, the rating is obtained as result of the published regression model (*Figure 4*), while the scores of the individual dimensions quantify the degree to which they contribute to the credit rating (*Fitch 2017a*).

Figure 4
Dimensions included in the Fitch methodology and their weights



Source: Based on Fitch (2017a)

5. Reconstruction of the model calculations of the three rating agencies

In the next part, we reconstruct the model calculations of the three credit rating agencies for Hungary. In all three cases, the reconstruction is performed for the date[4] of the latest available credit rating decision, in accordance with the methodological documentation valid at the time of the review. The values of the indicators used for the purpose of the model calculation are included, as mentioned before, in *Annexes 1, 2* and *3*.

Before presenting the results, it should be noted that the potential difference between the ratings obtained on the basis of the reconstruction of the model calculations and the real ratings maintained by the credit rating agencies may be attributable to three factors. On the one hand, the methodological documentations presented in the previous section are not fully transparent at any of the institutions. On the other hand, two of the three rating agencies do not publish information on all of data they consider, and thus the different result may be also attributable to the difference in the input data used. Naturally, for the purpose of the model calculation, we used the data sources specified in the methodological documentation whenever possible. Finally, in the methodological documentation, all three rating agencies point out that the rating committee may also approve a rating that differs somewhat from the result calculated by the model, and we were not able to take this into consideration based on the available information in the case of all institutions.

In an ideal case, reconstruction of the ratings is based on the knowledge of the methodologies, and the sources and accurate calculation of the used indicators.

[4] At the time of writing this paper, the date of the latest available credit rating review was 4 November 2016 in the case of Moody's, 16 February 2018 in the case of S&P and 9 March 2018 in the case of Fitch.

However, this higher level reconstruction – to a different degree at each institution – is not feasible: as shown in *Annexes 1* to *3*, there are some input data at each rating agency which cannot be determined from external sources independent of the institution. Thus, in this paper, we can attempt the reconstruction only at a lower level from the outset: i.e. the question is whether we can obtain the rating maintained by the institution by combining the publicly available inputs with the inputs included in the institution's reports, and by following the methodology. In the following, in several cases, it was found that even this methodological transparency is prejudiced or the preliminary result is overruled by the rating committee.

5.1. Reconstruction of the Moody's model calculation

Upon the assessment of the individual variables, Moody's uses the data and estimates of the International Monetary Fund (IMF), the European Commission (EC), the World Bank (WB), the Bank for International Settlements (BIS) and the national statistical offices (*Moody's 2015),* and thus we tried to use the same sources. At the same time, in the case of defining the values of certain indicators we were only able to rely on the Moody's credit rating report (*Annex 1*).

As presented in the previous section, Moody's assesses sovereign issuers using four groups of variables in the dimensions: economic strength, institutional strength, fiscal strength and susceptibility to event risk. We describe the result of the model calculation using these four dimensions and the evaluation of the profiles created from the dimensions.

In its credit rating report, Moody's allocated a "moderate level" classification to the rating of the economic resiliency profile, resulting from the combination of the economic strength and institutional strength dimensions (*Moody's 2016b*), which on the scale of fifteen under the Moody's analytical framework corresponds to one of the "M–", "M" or "M+" category classifications (*Moody's 2015*). Based on the methodological steps presented in the previous section, for the economic strength dimension, the determinant variables of which take the values indicated in *Annex 1*, our calculations returned a rating of "M", while for the institutional strength dimension we calculated a value of "H", and thus the economic resiliency profile created from the two dimensions was rated "H–", which differs from the "moderate level" rating included in the report.

As mentioned before, one of the reasons for the difference between Moody's results and our calculations could be that Moody's attached a different value to one or several variables determining the dimension as compared to the one presented in *Annex 1.* Thus, reconstruction of the input data presumably was not fully successful in the case of the first two dimensions. There may be an explanation for the reconstruction of the methodology, according to which Moody's believes, for example, that the qualitative indicators underlying the evaluation of institutional

strength[5] do not always provide a true view on the institutional and political situation of the sovereign issuers, and thus the rating committee may disregard those, as necessary (*Moody's 2015*). However, in this case we deem this unlikely, since the institution makes no reference whatsoever to this in the report on the upgrading.

According to our calculations, based on the key indicators, Moody's calculated a value of "H–" for the fiscal strength dimension, which received a negative adjustment of two categories[6] due to the level of the foreign currency ratio of government debt, and thus finally the dimension may have been rated "M". Accordingly, based on our calculations, the government financial strength profile, created by the aggregation of the economic resiliency profile and the fiscal strength dimension, received a rating of "M+".

According to our calculations, within the susceptibility to event risk dimension, the highest aggregated score was achieved by the indicators in the banking sector vulnerability area – i.e. the indicator measuring the strength of the banking sector (BCA), the total assets of banks as a percentage of GDP, and the loan-to-deposit ratio (*see Annex 1)* – and thus, due to the special definition of the dimension's score, the dimension's rating of "M+" was designated on the basis of the score for this area. The result of the aggregation of the government financial strength profile and the susceptibility to event risk dimension shows that upon the upgrading on 4 November 2016 the Moody's methodology designated the ranges of "Ba2" and "Baa3", and the "Ba1" range midpoint (*Figure 5*), which is one notch lower than the actual rating of "Baa3" maintained by the rating agency (*Moody's 2016b*).

Figure 5
Reconstruction of the November 2016 review by Moody's

Institutional strength	Economic strength			Economic Resiliency	Fiscal strength			
	M+	M	M–		M+	M	M–	
VH–	H	H	H–	H+	H	H	H	
H+	H	H–	H–	H	H–	H–	H–	
H	H–	H–	M+	H–	H–	M+	M+	
H–	H–	M+	M+	M+	M+	M+	M	
M+	M+	M+	M	M	M	M	M	

Susceptibility to Event Risk	Government Financial Strength							
	H+	H	H–	M+	M	M–	L+	L
	Aa3–A2	A1–A3	A2–Baa1	A3–Baa2	Baa1–Baa3	Baa2–Ba1	Baa3–Ba2	Ba1–Ba3
M–	A2	A3	Baa1	Baa3	Ba1	Ba2	Ba3	B1
M	A2	A3	Baa1	Baa3	Ba1	Ba2	B1	B2
M+	A3	Baa1	Baa2	Ba1	Ba2	Ba3	B1	B2
H–	A3	Baa1	Baa2	Ba1	Ba2	Ba3	B2	B3
H	Baa1	Baa2	Baa3	Ba2	Ba3	B1	B2	B3

Source: Moody's (2015; 2016b) and own calculations

[5] World Bank Government Effectiveness Index, Rule of Law Index and Control of Corruption Index
[6] In the Moody's methodology, the foreign currency ratio of government debt is one way to amend the initial score obtained from the values of the key indicators; if its value is high, it may downgrade the dimension by as many as six measures.

Thus, the model calculation returned a result that differs from the actual rating maintained by the institution, which illustrates with regard to the testing of the Hungarian data that – based on the model and the available information – the credit ratings by Moody's can only be reconstructed with approximate accuracy for the time being. Nevertheless, we managed to obtain a rating for the Hungarian foreign currency-denominated government debt that falls within the indicative rating range by working with the input data estimated from the sources shown in *Annex 1*, in accordance with the methodological documentation. Since Moody's did not publish its estimation for all indicators used, the explanation of the difference between the actual rating and the reconstructed rating is not unambiguous: it can be explained both by the difference in the input data and the inadequacy of methodological transparency. It should also be noted that in addition to the methodological documentation of Moody's, we also relied on the information included in the credit rating report.[7]

5.2. Reconstruction of the model calculation by S&P

In its credit rating reports, S&P publishes most of the statistical data it takes into consideration for the purpose of the review, and thus, in contrast to the calculations for Moody's, we used the data included in the report for the model calculation (see: *Annex 2*). The reason for this is that for most of the variables taken into consideration, S&P uses its own estimates and forecasts for the next three years, and we lack sufficient information on the models used for the forecast.

S&P rates the sovereign issuers using five aspects: the institutional, economic, fiscal, external and monetary policy dimensions (*S&P 2017a*). We present the results of the model calculation using the assessment of the individual dimensions, as before.

The S&P report on the review reveals that the institution allocated a score of 4 to the institutional assessment (*S&P 2018*). As emphasised in the presentation of the special features of the methodology, S&P does not substantiate the assessment of the institutional dimension using specific indicators: it determines the value of the dimension based on the efficiency and stability of political decision-making and the functioning of checks and balances, relying on its own value judgement (*S&P 2017a*). In the report on the rating under review, S&P justified the relatively low score, among other things, by stating that in its opinion as a result of the institutional changes introduced since 2010, the system of checks and balances has weakened, which restricts the predictability of political decision-making, and the measures aimed at the restriction of mass media and non-governmental organisations resulted in increasing political centralisation (*S&P 2018*).

The initial score of the economic assessment is based on GDP per capita, estimated by S&P for the respective year in the amount of USD 15,500, which yields a score of 4 in the methodological documentation. In our opinion, the score of the dimension

[7] See, for example, the values of the indicators shown in *Annex 1*.

was not influenced by any modifying factor, and thus the score of the institutional and economic profile, generated from the two dimensions, was also 4.

S&P divides the fiscal assessment into two parts, i.e. fiscal performance and flexibility, and debt burden. The first is obtained based on the change in the GDP-proportionate net government debt, while the latter is obtained based on the ratio of the GDP-proportionate nominal government debt and the general government interest expenditures and revenues. The final score of the dimension is obtained as the arithmetic mean of the score of the two parts (*S&P 2017a*). S&P, corresponding to our own calculations, gave a score of 2 for the fiscal performance and flexibility based on the average change in the net government debt of 2.6 per cent. The prevailing score of 4 for the debt burden (*S&P 2018*) comes from average value of 65.1 per cent of the GDP-proportionate nominal government debt, and the average ratio of 6.2 per cent in the general government interest expenditure and revenues. Accordingly, the score for the two areas estimated on the basis of S&P's data corresponds to the prevailing scores, and based on the average of these two, the fiscal assessment may have received a score of 3.

The initial score of the external assessment is obtained as the ratio of gross external financing needs to the sum of the current account receipts plus usable official foreign exchange reserves, and as the ratio of the narrow net external debt to the current account receipts (*S&P 2017a*). Upon the review, based on the S&P data the first value was 96.3 per cent, while the ratio of the narrow net external debt to current account receipts took the average value of 17.9 per cent. Accordingly, based on our own calculations, the dimension received a score of 2, which corresponds to S&P's assessment (*S&P 2018).*

For the monetary policy assessment, S&P maintained the score of 4 (*S&P 2018*). The institution assesses this dimension on the basis of the sovereign issuer's exchange rate policy and the effectiveness of its monetary policy. The exchange rate policy, based on the categorisation of the IMF exchange rate regime, receives a score of 3 in the S&P guide. At the same time, for the assessment of the effectiveness of monetary policy, we relied on the information published by S&P in prior reviews (see e.g. *S&P 2017b*), since no distinct change has taken place in this area since the date of the last rating, and hence presumably S&P's opinion has not changed either. Based on these, the monetary policy effectiveness received a score of 4. All of this is also supported by the report on the February 2018 credit rating, where the rating agency explains that in its view the accumulated non-performing loan portfolio still curbs the effectiveness of Hungarian monetary policy transmission (*S&P 2018*).

The result of our model calculation was obtained as the combination of the input data included in S&P's reports, the textual assessment of a qualitative nature included in the previous reports and the methodological information related to the classification of the dimensions. The score of the flexibility and performance profile created from the score

calculated by us for the three dimensions (external assessment 2, fiscal assessment 3, monetary policy assessment 3.6) was 2.86, which – combining it with the institutional and economic profile score of 4 – designated the "BBB–" midpoint of the range (*Figure 6*). This corresponds to the February 2018 rating maintained by S&P (*S&P 2018*).

Figure 6
Reconstruction of the February 2018 rating by S&P

Flexibility and performance profile	Institutional and economic profile											
	Assessment	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
	1–1.7	aaa	aaa	aaa	aa+	aa	a+	a	a–	bbb+	N/A	N/A
	1.8–2.2	aaa	aaa	aa+	aa	aa–	a	a–	bbb+	bbb	bb+	bb–
	2.3–2.7	aaa	aa+	aa	aa–	a	a–	bbb+	bbb	bb+	bb	b+
	2.8–3.2	aa+	aa	aa–	a+	a–	bbb	bbb–	bb+	bb	bb–	b+
	3.3–3.7	aa	aa–	a+	a	bbb+	bbb–	bb+	bb	bb–	b+	b
	3.8–4.2	aa–	a+	a	bbb+	bbb	bb+	bb	bb–	b+	b	b
	4.3–4.7	a	a–	bbb+	bbb	bb+	bb	bb–	b+	b	b–	b–
	4.8–5.2	N/A	bbb	bbb–	bb+	bb	bb–	b+	b	b	b–	b–
	5.3–6	N/A	bb+	bb	bb–	b+	b	b	b–	b–	b–[3]	b–[3]

Source: S&P (2017; 2018) and own calculations

Based on the result, it can be stated that in the case of S&P, the available methodological documentation and the exact knowledge of part of the data considered by the institution renders the precise reconstruction of Hungary's credit rating possible. Accordingly, the published methodological documentation was transparent in the sense that we were able to reconstruct the Hungarian rating properly. At the same time, it was not possible to generate independent input data, and thus we made no attempt to perform an analysis assuming a higher degree of reconstructibility, making the calculation relying on our own data.

5.3. Reconstruction of the model calculation by Fitch

For the reconstruction of Fitch's model calculation, we made attempts, as in the case of Moody's, to use the data of institutions specified in the methodology, i.e. the International Monetary Fund (IMF), the World Bank (WB) and the national statistical offices. However, despite our efforts, for some of the indicators we were compelled to refer to the reports of Fitch, i.e. full reconstruction of the inputs cannot be achieved in the case of the third rating agency either (see: *Annex 3*).

As noted earlier in the presentation of the special features of the methodology, Fitch's credit rating model differs significantly from that of the other two rating agencies. Although in the past years Fitch has published more and more details on its credit rating methodology, the reproducibility of the model calculation without

the forecast values of certain variables is still questionable, since the institution does not publish the values used for all of the indicators taken into consideration.

At Fitch, the dimension with the highest weight is the group of variables capturing the structural features of the economy. The score of the dimension is obtained on the basis of the World Bank's governance indicators, GDP per capita, the world-GDP ratio, the number of years elapsed since the last default and the broad money supply (*Fitch 2017a*). The score of the dimension can be well estimated, since the institution defines the value of all indicators based on the latest available data, which can be accessed in the aforementioned statistical databases. Based on the weighting of the indicator's value, according to our calculations, the score of the dimension in March 2018 was 7.60, which – according to the credit rating report – was not influenced by any modifying factors.

One of the dimensions with the second highest importance is the group of variables capturing external balance developments (external finances). The score of the dimension is determined by the reserve currency flexibility, net external assets as a percentage of GDP, commodity dependence, external interest service, the sum of the current account balance and FDI inflow and foreign exchange reserves. It is more difficult to accurately estimate the score for this dimension, since in the case of three of the five variables it considers the average of data calculated for the current year, last year's data and the value estimated for the next year, which we cannot determine precisely in the absence of Fitch's forecasts[8] (*Fitch 2017a*). Based on the weighting, the dimension had a value of –0.09, which was reduced by the rating committee by further one notch, and thus, according to our calculations, the score of the dimension at the time of the current review may have been –1.09 (*Fitch 2018*).

The third dimension assessed by Fitch is the group of variables capturing the general government developments (public finances). The score for this dimension comes from the GDP-proportionate government debt, the foreign currency ratio of the government debt, the fiscal balance as a percentage of GDP and the ratio of interest service and general government revenues. Here as well, the estimation of the dimension's score was complicated by the fact that the value of all variables comes from the average of historic, current and forecast data. At the same time, in one of the background materials we managed to find approximate values for two of the four values (*Fitch 2017b*), which somewhat eased the calculations. Based on the weighting, according to our calculations, the public finances dimension acquired the value of –2.01, which, according to the report, was not modified by the committee (*Fitch 2018*).

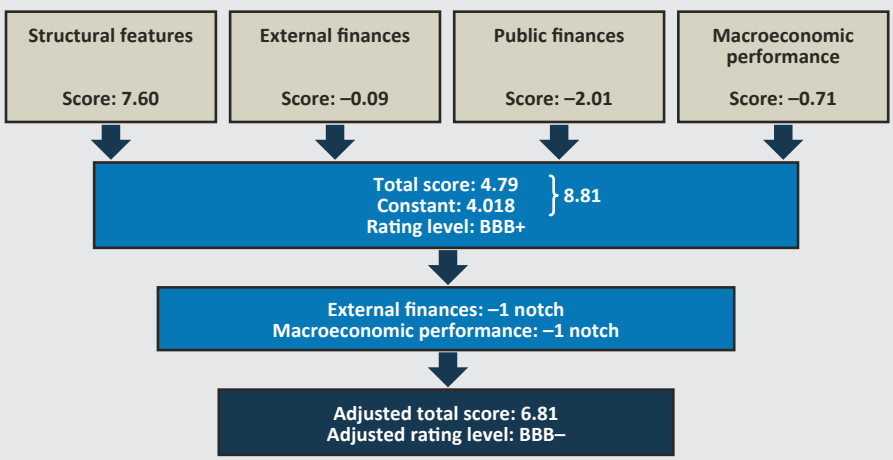
The fourth group of variables, with the lowest significance, is the dimension comprising the indicators describing macroeconomic performance. The variables primarily considered in this dimension include real GDP growth, real GDP volatility

[8] The calculation of the dimension's score was further complicated by the fact that no data were available for Hungary's external interest service values in the statistical databases defined in the analytical framework. Upon the weighting of the value, we calculated using the median of the countries with similar rating.

and inflation. The estimation of the score for the macroeconomic performance dimension was also complicated by the fact that in the case of two of the three indicators, Fitch also considers forecast values; however, the background material mentioned earlier once again helped us to determine the estimated value. According to our calculations, the initial score for the dimension at the time of the review may have been –0.71, reduced by the rating committee by further one notch, and thus the dimension had the final score of –1.71.

As mentioned earlier, Fitch – in contrast to the other two rating agencies – creates no profiles after determining the score of the individual groups of variables; it simply adds up the scores obtained based on the weighting, and supplements it with the constant value of the regression model. Based on the model calculation described above, the sum of the dimensions' score was 4.79, while – according to the analytical framework of 2017 – the constant value was 4.018 (*Fitch 2017a*). Thus the result of our own model calculation, without considering the amendments specified in the reports, is a score of 8.81, which designates a rating of "BBB+". Of course, this does not correspond to the March 2018 rating of "BBB–" maintained by the institution. If we adjust our calculations with the amendments applied by the rating committee (–2 notches), the obtained final score of 6.81 is equivalent to the current "BBB–" rating (*Figure 7*).

Figure 7
Reconstruction of the March 2018 rating by Fitch



Source: Fitch (2017a; 2018) and own calculations

Although the reconstruction of the Fitch model calculations returned a result for Hungary different from the actual credit rating, when we examined the methodology and reconstructed the credit rating, we found that – in contrast to the finding of *Ligeti – Szőrfi* in 2016 – the new methodological documentation is already detailed

and transparent enough to allow for the modelling of the institution's credit rating with good approximation.

In our view, the above result was influenced by the following factors: On the one hand, the values given by Fitch to the indicators also including the estimates of the institution are not known, and, according to the methodological model, the weight of these is not determinant. We also saw that if we substitute the inputs in the model identically with the institution, our results correspond to the primary dimension values reported by Fitch. The additional differences are attributable to the fact that the rating committee adjusted the calculated dimension value on two occasions. We were able to verify this on the basis of the public data, because Fitch, in its latest report on Hungary's credit rating, disclosed whether the rating committee had changed the originally obtained score for any dimension. However, we do not know whether the institution will regularly publish this information in the future as well, in the absence of which the reconstruction attempt would be less assessable.

6. Conclusion

Based on the analyses related to Hungary's foreign currency-denominated debt, this paper illustrated the degree of accuracy to which, given the present transparency of the credit rating processes and methodological documentation, the ratings of sovereign issuers of the big three rating agencies can be reconstructed. With a view to answering our research questions, we provided a brief overview of the relevant domestic and international literature, and presented – along the IMF paper – the basic roles fulfilled by the credit rating agencies in the global financial system: they provide information on issuers, encourage borrowers to take corrective measures and provide the rated entities with certificates. However, their work is not free from methodological errors and moral hazard, as seen by market participants in 2008 during the crisis. As a response to this, the regulation of rating agencies and oversight of their activity appeared as a requirement of market participants after the crisis. Transparency also features among the regulatory requirements, which we discuss in detail in this paper.

We based our paper partially on a series of articles published by two Hungarian co-authors, who earlier analysed to what degree the credit rating steps can be modelled. The referenced papers report substantial results. However, the methodological documentation, more detailed than before, published by the rating agencies in recent years, allowed us to understand the rating agencies' decision-making processes more accurately and subject the latest methodological documentation to a review similar to that performed by *Ligeti – Szőrfi* (*2016*). However, in contrast to them, we performed our analysis for a single country, i.e. for Hungary, as a case study.

In order to answer our research question, we used the credit rating methodology of Moody's, S&P and Fitch, as well as the information included in the published reports. We always calculated the values of the indicators necessary for the credit rating models

from the sources specified by the rating agencies, whenever this was possible. Right at this point, we made a necessary compromise: full reconstructibility of the inputs was not feasible with any of the institutions. The weakest institution in this respect was S&P: in the case of S&P, in the vast majority of the cases, we used the inputs communicated by the institution, while in the case of the other two rating agencies, reconstruction of the inputs was much more successful. In the course of our model calculations, we found that – with the current level of transparency – the reconstruction of the credit rating of Hungary's foreign currency-denominated debt by S&P could be performed the most accurately. The result illustrates that upon using inputs corresponding to those of S&P, the published methodology is transparent enough to reconstruct each step of the model calculation correctly. The result of the model calculation performed for the review by Moody's showed that the ratings of the institution related to Hungary can be reconstructed only with approximate accuracy for the time being. The reason for the difference may be equally attributable to the deviation in the values of used variables or to the absence of methodological transparency. However, we have no information in this respect. Compared to the work of Ligeti-Szőrfi, the largest improvement was shown by the transparency of Fitch. The reconstructibility of the inputs ran into difficulties, and thus we also had to consider information included in the report for several variables, or the correct value of the variable was not clear (see: *Annex 3*). At the same time, the transparency of the model proved to be adequate according to the analyses performed for Hungary. If we adjust the result of our calculations for the amendments by the rating committee, we obtain the rating maintained by the institution.

In summary, it can be stated that the transparency of the three institutions has improved compared to what was presented in an earlier analysis performed by *Ligeti – Szőrfi* (*2016*). At the same time, major progress could only be achieved if the rating agencies calculated the input indicators of the model from known data sources with known calculation at all times. However, the functioning of the models can be sufficiently reconstructed to allow the decision-makers of sovereign issuers, economists and market participants to see when and how a change in the data related to a sovereign issuer may be integrated into the credit rating. However, at the current level of transparency, predicting rating actions – which was our initial future research direction – is not only hampered, for the time being, by the fact that the rating committee may amend the initial rating, but also by the identified uncertainties of the modelling and the input data. The conclusions we have drawn based on the present case study would be more generalisable if – similarly to *Ligeti – Szőrfi* (*2016*) – we performed the model calculations for several countries. Such a research would allow us to implement analyses – far beyond the scope of our present study – based on which we could shed light on whether there are sovereigns, and what characterises them, for which the model calculations can be performed more accurately. If the level of transparency was to improve further, it would also be an interesting research direction to explore whether considering the same data that is used by the institutions would lead to identical dimension scores and ratings at all times, or there are under/overvalued sovereigns.

Annexes

Annex 1: Variables taken into consideration for the purpose of Moody's model calculation and the source thereof

Moody's Investor Service			
Variable group	**Indicator**	**Value**	**Source**
Economic strength	Average real GDP growth (per cent)	2.0	IMF WEO
	Real GDP volatility (per cent)	3.1	IMF WEO
	WEF competitiveness index	4.3	WEF
	Nominal GDP (USD billions)	120.6	IMF WEO
	GDP per capita (PPP, USD)	26,275.3	IMF WEO
Fiscal strength	Government debt as a percentage of GDP (per cent)	74.7	Eurostat
	Government debt/government revenues (per cent)	157	Eurostat
	Interest servicing/government revenues (per cent)	7.3	Eurostat
	Interest servicing/GDP (per cent)	3.5	Eurostat
	Foreign currency ratio within government debt (per cent)	30	Government Debt Management Agency
Institutional strength	Government Effectiveness Index	0.491794795	World Bank
	Rule of Law Index	0.404108435	World Bank
	Control of Corruption Index	0.104408205	World Bank
	Inflation (per cent)	2.2	IMF WEO
	Volatility of inflation (per cent)	2.6	IMF WEO
Susceptibility to event risk	Internal politics risk	–	–
	Geopolitical risk	–	–
	Gross borrowing requirement/GDP (per cent)	23.2	Government Debt Management Agency, IMF
	Non-residents' government securities holdings (per cent)	47.8	Eurostat
	Implied credit rating based on market indices	Baa3	Moody's
	Total assets/GDP (per cent)	102	ECB
	Baseline Credit Assessment	b1	Moody's
	Loan-to-deposit ratio (per cent)	81	MNB
	Current account + FDI/GDP (per cent)	–1.1	World Bank
	External vulnerability index (per cent)	114	Moody's
	Net international investment position/GDP (per cent)	–64.4	Eurostat

Note: With the exception of average real GDP growth, the real GDP volatility and the volatility of inflation, the values of the individual indicators are always the latest data available at the time of the respective rating.

Annex 2: Variables taken into consideration for the purpose of Standard and Poor's model calculation and the source thereof

Standard and Poor's			
Variable group	**Indicator**	**Value**	**Source**
Economic assessment	GDP per capita (USD thousands)	15.5	S&P
External assessment	Gross external financing requirement/current account revenues + reserves (per cent)	96.3	S&P
	Narrow net external debt/current account receipts (per cent)	17.9	
	Status of the currency in international transactions	–	
Fiscal assessment	Net government debt as a percentage of GDP (per cent)	65.1	S&P
	Interest burden/government revenues (per cent)	6.2	
	Change in the government debt/GDP (per cent)	2.6	
Monetary assessment	Exchange rate regime	3	IMF
	Credibility and effectiveness of monetary policy	4	Previous S&P information

Note: With the exception of the exchange rate regime and the efficiency of the monetary policy, all indicators are the average of the value estimated by S&P for the respective year and the forecast for the next three years.

Annex 3: Variables taken into consideration for the purpose of the Fitch model calculation and the source thereof

Fitch Ratings			
Variable group	**Indicator**	**Value**	**Source**
Macroeconomic performance	Real GDP growth (per cent)	3.1	IMF WEO
	Real GDP volatility (per cent)	2.9	IMF WEO
	Inflation (per cent)	1.7	IMF WEO
Public finances	Government debt as a percentage of GDP (per cent)	72.8	IMF WEO
	Interest servicing/government revenues (per cent)	6.8	Eurostat
	Foreign currency ratio within government debt (per cent)	23.5	Government Debt Management Agency
	Fiscal balance as a percentage of GDP (per cent)	–2.1	Fitch, OECD
External finances	Net external assets/GDP (per cent)	2.5	World Bank
	Commodity dependence (per cent)	10	WTO, World Bank
	Current account + FDI/GDP (per cent)	5.1	Fitch
	Reserve currency flexibility	–	IMF
	External interest servicing (per cent)	4.3	Fitch
	Reserves/import (number of months)	2.6	World Bank
Structural features	Average of World Bank governance indicators	66.4	World Bank
	GDP per capita (percentile)	56.5	World Bank
	Share in global GDP (per cent)	0.2	World Bank
	Broad money supply/GDP (per cent)	60.1	World Bank

Note: The values of the indicators are not solely the latest data available at the time of the respective rating; in the Fitch model, in the case of certain indicators, multi-year averages or variances serve as input. In addition to the historic data, from time to time future estimated data are also necessary for the calculation of the indicators, where the model used by Fitch for the forecast is not known, just like the estimated forecasts.

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