Comparison of bankruptcy models for prediction of the financial health of the Slovak civil engineering companies

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Abstract

Purpose of the article Main purpose of the paper is to give a new pattern how to compare selected creditworthiness and bankruptcy models and to determine which model is appropriate for private construction companies in Slovakia.

Methodology/methods The analysis was based on real selection of companies from the static point of view (one year data) and selection of companies being actually in recession from the dynamic point of view (4 years data). The static analysis was carried out for 1360 private Slovak civil engineering companies. From the dynamic point of view, we have analyzed the predictive value of the IN05 model for companies in bankruptcy over four full consecutive calendar years immediately prior to their bankruptcy (the dynamic point of view). The number of companies in bankruptcy was 35. The informative value of the chosen indicators is in case of the dynamic analysis evaluated according to the number of correct or incorrect predictions.

Scientific aim The scientific aim is to analyze selected creditworthy and bankruptcy models and to detect their informative value for private construction companies in Slovakia. The paper contributes to the literature regarding the analysis of financial health of the Slovak companies. Our study enhances and complements the existing study which analyzes the creditworthy and bankruptcy models.

Findings We found out, that the best model is the index IN05. The results of our analyses have brought comparable results. Based on them, the index IN05 and the Altman model showed up as the most reliable for building industry.

Conclusions Informative value of the chosen indicators is in case of the dynamic analysis evaluated according to the number of correct or incorrect predictions. This method was not suitable to use for the static analysis based on a real sample. The results of the static analysis were based on the comparison of the examined models in the individual categories (structure of success) and at the same time within the whole sample. Better was considered the model that had a more advantageous structure of success in terms of business (company). Indicators of creditworthiness and bankruptcy should be a part of a deeper analysis of the financial situation of companies. If a company decided to ascertain the status only through these indicators, it should choose at least two indicators. In the case of private domestic construction companies, we would recommend the combination of the IN05 and the Altman model as they complement each other appropriately.

Keywords: Altman model, Taffler model, Index IN05 Quick test, Binkert model, Credit worthiness index, building industry, bankruptcy, restructuring, Credit worthiness and bankruptcy models

JEL Classification: C35, M10, G32

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Introduction

To examine the six selected bankruptcy and Credit worthiness models based on a real sample of private Slovak companies operating in the construction sector, we have come to the following facts: At present, thanks mainly to the contracts with the state, the situation has slightly improved, in recent years there has been a decline in construction output in Slovakia. Although the construction sector continues to play a significant role in GDP creation of the Slovak Republic, it may be included in the crisis industries (The Statistical Office of the Slovak Republic, 2016). According to the data from the available financial statements of the Finstat, Ltd. company, large, medium, small as well as micro businesses are at risk. In construction sector, there is a higher number of companies in decline or companies possibly heading to the decline compared to other sectors or (Finstat data-base, 2017).

The problem in Slovakia is also the relatively small number of businesses and the missing data needed to carry out rigorously the analysis. It is not just the problem of Slovakia, but also of other smaller countries where there are no extensive databases available (Pervan, et al., 2011; Smaranda, 2014; Režňáková, Karas, 2014). To make the sample larger, we decided to perform the analysis on real samples, which includes each relevant company with complete data, while the sample did not take into account the number of prosperous and unsustainable enterprises (for example, what Altman or Gulka model (Gulka, 2016) was based on). At the same time, the results from the real sample analysis should be reliable and as accurate as possible.

We have analyzed the following six models: Altman Z-Score, Index IN05, Credit worthiness Index, Quick Test, the Taffler Model and the Binkert Model, so we have verified their significance for the Slovak construction companies by the static and dynamic analysis.

The static analysis was based on one-year data on a sample of 1360 companies, of which 157 businesses were actually bankrupt. The dynamic analysis of models was based on data over the last four years taken immediately before bankruptcy from a sample of 15 companies.

Considering the similar economic situation in the Czech and Slovak Republics, we assume that the most suitable models for the Slovak companies should be those created for the Czech Republic. The advantage of the Czech models is that most of the data needed to calculate the index is also available for Slovak companies. The items of the financial statements the Czech models are based on, are almost identical in both countries (Diheneščíková, Hičák, 2011; Růčková, 2015). In the following section of the paper, there is the used methodology and the description of the data listed. In section 2, we present the results of our analyses and, in the Conclusion, we summarize the facts.

1 Methodology and Data

In our comparative study, we have used the static and dynamic approach for the analysis of the available data. We have mainly used the cross tables. Using the Chi quadrate test (Anderson et al., 2010), we have verified the suitability of the used model.

The databases were taken from the Finstat, Ltd. company, subsequently being modified - refilled, linked and filtered according to needs and checked e.g. for the Data duplication. The analyses were carried out in the IBM SPSS Statistics (Verma, 2013; Řehák, Brom, 2015) and the Microsoft Excel software. If necessary, there was, in accordance with the Finstat scaling, the scaling of enterprises to prosperous, indefinite (grey zone) and unsustainable (bankruptcy) used corresponding to the used models: Altman Z-Score, Index IN05, Credit Score, Quick Test, the Taffler Model and the Binkert Model (Klempaiová, 2017).

The indicator values had to be adjusted according to their border limits to three categories - prosperous, average and unsustainable. Also, the situation had to be treated in the case of the lowest or highest value for a prosperous company so that the prosperity of the company is consistently identified for all the examined models.

The static analysis was carried out on the real sample of 1360 companies with the unequal number of companies in bankruptcy (157) and the number of prosperous or average enterprises, respectively indefinite (1203). From the sample there were not companies in the grey zone excluded. The fact, how many years before (or after) the bankruptcy or restructuring in the case of bankrupt companies the model identified the company as a non-profitable, was not taken into consideration. The year of gaining the financial data that was taken into the analysis, was in case of companies in bankruptcy, mostly one to two years before the start of the proceedings, when the veracity of all the indicators is the highest. Also included in the analysis were companies in bankruptcy where the date of commencement of bankruptcy or restructuring proceedings was not stated. A real sample was based on the following starting points:

- If the difference between the year of gaining the financial data and the year of initiation of bankruptcy or restructuring proceedings in companies was not identical, the veracity of all the examined indicators would be decreased respectively increased fairly in the year before the bankruptcy. Therefore it would not have a significant impact on the outcome of the indicators´ veracity analysis.

- If only non-profitable and profitable companies (without the grey zone) would be analyzed, it could be so on the basis that they were tagged by all the indicators as non- profitable or profitable simultaneously (not just by one solo indicator because it could have the advantage or disadvantage in comparison to other indicators), what could significantly affect the outcome of the indicators´ veracity analysis. (e.g. in a group of companies that are actually in decline, which would be created in this way, a high percentage of successful predictions could also be predicted by the indicators which under other circumstances would not be predicted respectively by all the indicators). Or, it could be done on the basis of simple information yes- no, i.e. whether the firm is actually bankrupt or being restructured or not. In that case, the companies rated by the indicators being on average (in the grey zone, indefinite), would also be analyzed. We have considered the second way for analyzing the success of indicators to be the more suitable.
- If the same number of unsuccessful enterprises (real bankruptcy or restructuring), and profitable (prosperous businesses, including indefinite enterprises) were taken into the sample, this ratio would not represent the ratio in reality. More to the reality would be the ratio of unsustainable and prosperous companies in the entire sample of 1360 companies. Being aware of the fact that the results may be different in the case of equally numerous and unequally numerous groups of companies and may not meet the expectations, we analyzed the sample of 1360 companies on the indicator's ability to report, together with the explanation of the results.

The dynamic analysis was performed on the sample of fifteen companies after having filtered the companies for which the bankruptcy or restructuring proceedings commenced (or the date of commencement of the proceedings was stated) and which included the values of all indicators for the entire four consecutive calendar years taken immediately before the announced bankruptcy i.e. the date of commencement of bankruptcy or restructuring proceedings. The sample of companies consisted only of companies that were actually bankrupt examining which model has identified most of the samples as unsustainable. This model was the most successful from this point of view.

1.1 The Simple Sum Method

When comparing the indicators with the simple sum method, it is based on addition of correct or incorrect model predictions. By mutual comparing the model with the highest number of correct predictions or vice versa with the lowest number of incorrect predictions is determined. For the most successful model is the model with the highest number of correct predictions evaluated. In the case of incorrect predictions, the error type 1 (error α) is distinguished which represents the incorrect classification of insolvent companies as solvent (prosperous) and the error type 2 (error β) that evaluates the solvent companies as insolvent (unsustainable) (Zalai et al, 2016; Tsai, 2009).

2 Results

2.1 The Static analysis

For each model, one cross table was set up in the way which is shown on the example of the Altman Z-score. Subsequently, the cross tables of each model were compared to each other.

Table 1 Altman Z-Score – Case processing summary

	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Bankruptcies and Restructurings * Credit scoring – Altman Z-score	1360	99,9%	1	,1%	1361	100,0%

Source: own processed on Finstat, 2017

It was confirmed by the Chi-square test, that there is a dependence between the Altman index and the company´s prosperity assessment (Table 2).

Table 2 Altman Z-Score, Chi-square test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	290.809a	2	.000
Likelihood Ratio	268.117	2	.000
Linear-by-Linear Association	221.064	1	.000
N of Valid Cases	1360		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 45.71.

Source: own processed on Finstat, 2017

From the Altman Z-score cross table (Table 3), to which the data as variables telling whether a company is actually bankrupt or not and the data on prosperity, average achievement and the unsustainability of a company were set, are these results: Of 1 360 companies under analysis, there were actually in bankruptcy or restructuring 157 (11.5%), there were identified 396 non-performing or unsustainable companies (29.1%) by the model. As unsustainable, there were 259 (65.4%) of companies identified by the indicator, but they were not actually bankrupt or restructured. The remaining 137 (34.6%) of companies, which have been labeled as unsustainable, in bankruptcy or restructuring actually were. From the really unsustainable companies, there were correctly labeled 87.3% and incorrectly 12.8% by the model. Similarly like non-prosperous companies, there can be described companies in the grey zone and prosperous businesses. There were 413 companies labeled by the model as companies in the grey zone of which 10 were actually in bankruptcy or undergoing restructuring and 403 were not. There may be considered 10 companies as incorrectly labeled. There were 551 companies labeled as prosperous, of which 10 were actually in bankruptcy or restructuring, 541 were not. The number of misclassified companies was 10. Overall, the Altman model has ranked 279 companies incorrectly and 1081 correctly.

Table 3 Altman Z-Score Crosstabulation

			Credit scoring – Altman Z-score			Total
			bankruptcy	Gray zone	prosperity	
Bankruptcies and Restructurings	no	Count	259	403	541	1203
		% within Bankruptcies and Restructurings	21.5%	33.5%	45.0%	100.0%
		% within Credit scoring – Altman Z-score	65.4%	97.6%	98.2%	88.5%
		% of Total	19.0%	29.6%	39.8%	88.5%
	yes	Count	137	10	10	157
		% within Bankruptcies and Restructurings	87.3%	6.4%	6.4%	100.0%
		% within Credit scoring – Altman Z-score	34.6%	2.4%	1.8%	11.5%
		% of Total	10.1%	.7%	.7%	11.5%
Total		Count	396	413	551	1360
		% within Bankruptcies and Restructurings	29.1%	30.4%	40.5%	100.0%
		% within Credit scoring – Altman Z-score	100.0%	100.0%	100.0%	100.0%
		% of Total	29.1%	30.4%	40.5%	100.0%

Source: own processed on Finstat, 2017

By comparing the cross tables of the selected models using the simple summation method we have come to the results in Table 4.

Table 4 The correct and incorrect assignments of individual models based on the simple sum method

Rankings	The highest number of correct ratings	The lowest number of incorrect ratings
Binkert model	1193 (87.7%)	167 (12.3%)
Taffler model	1124 (82.6%)	236 (17.4%)
Credit worthiness index	1111 (81.7%)	249 (18.3%)
Quick test	1084 (79.7%)	276 (20.3%)
Altman model	1081 (79.5%)	279 (20.5%)
Index IN05	933 (68.6%)	427 (31.4%)

Source: own processed on Finstat, 2017

Subsequently, the success of the indicators was examined in the categories listed in Table 5. The order of models within the given category is marked with numbers 1-6. Let us note that 1 means the highest number of correct ratings in percentage %.

Table 5 The ranking of models based on success in the categories

	Category: If the company was in bankruptcy or restructuring	Category: If the company was not in bankruptcy or restructuring	Category: If the model labeled the company as a non-prosperous one	Category: If the model labeled the company as an average one	Category: If the model labeled the company as a prosperous one
Binkert model	5.	1.	1.	3.	5.
Taffler model	6.	2.	6.	4.	6.
Credit worthiness index	3.	3.	3.	6.	4.
Quick test	4.	4.	5.	5.	1.
Altman model	2.	5.	2.	2.	2.
Index IN05	1.	6.	4.	1.	3.

Source: own processed on Finstat, 2017

For sorting the models in Table 5 there were the auxiliary tables for each category used (See Table 6 for the category - If the model has labeled the company as a prosperous one).

Table 6 The success of models in the category "If the model labeled the company as a prosperous one"

		IN05	Altman Z-score	Credit worthiness index	Quick test	Binkert test	Taffler test
Bankruptcies and Restructurings	no	97.8%	98.2%	97.1%	98.9%	91.3%	89.4%
	yes	2.2%	1.8%	2.9%	1.1%	8.7%	10.6%
	% of Total	39.3%	40.5%	53.7%	26.0%	24.4%	85.3%

Source: own processed on Finstat, 2017

Table 6 shows: The highest number of companies of the total number of 1360 companies were labeled as prosperous 85.3% (1160) by the Taffler model of which 89.4% (1037) were actually not in decline and 10.6% (123) were in decline. The lowest number of companies of the total number of 1360 companies were labeled as prosperous 24.4% (332) by the Binkert model. Of the number of predicted prosperous companies 26% (354) was the lowest number of companies in decline 1.1 (4) detected by the Quick Test. IN05 of the predicted 39.3% (535) included 97.8% (523) companies not in decline.

Table 7 captures the rankings of models for the non-prosperous, average and prosperous companies by individual indicators within the entire sample of 1360 companies. Let us note that 1 means the most % also in an absolute expression, 6 means the least % also in an absolute expression.

Table 7 The ranking of models for classification of companies from their total number

Model	The model labeled the company as a non-prosperous one of the Total	The model labeled the company as an average one of the Total	The model labeled the company as a prosperous one of the Total
Altman model	2.	3.	3.
Index IN05	1.	5.	4.
Credit worthiness index	3.	4.	2.
Quick test	4.	2.	5.
Binkert model	6.	1.	6.
Taffler model	5.	6.	1.

Source: own processed on Finstat, 2017

For instance, the Taffler model- with regard to other models, classified the most companies as prosperous and so on a sample consisting of 1360 companies from which only 157 in bankruptcy, correctly estimated in an absolute expression the most companies as prosperous in the percentage comparison, however, finished in the last place- i.e. from the number of companies which it has identified as being prosperous, only 89.4% have been classified correctly, while other models showed this percentage on a higher level. In the category "If the model labeled the company as a prosperous one" its ability to report was the worst, similarly in the other two categories. It was more successful only in the category": If the company was not in bankruptcy or restructuring", what, regarding the highest number of companies identified as prosperous ones, could be expected. In this category, which represented the sum of prosperous and average companies, it was surpassed only by the Binkert model, which classified the highest number of companies as average ones. The Binkert model classified the lowest percentage of companies as non- prosperous ones, being immediately followed by the Taffler model. Unlike Taffler, however, from the lowest number classified the highest percentage of companies in the category "If the model labeled the company as a non-prosperous one" correctly, i.e. the companies were really non-prosperous. Taffler had the lowest percentage of correctly ranked companies in this category. Based on these considerations, the Binkert model can be, altogether, described as the more successful when mutually comparing the Taffler-Binkert models.

Of the total number of companies, the Index IN05 (Neumaierová, Neumaier, 2005) classified the highest number of companies as the non-prosperous ones, being followed by the Altman model. This could have been the reason why in the category "If the model labeled the company as a non-prosperous one" was the Index IN05 ranked on the fourth place and in the category "If the company was not in bankruptcy or restructuring" even on the last sixth place. So, in these categories it was not successful (what is good from the companies´ point of view). On the contrary, in the category "If the company was in bankruptcy or restructuring" it estimated most of the companies in real decline as the non- prosperous ones. The Index IN05 got the primacy also in the category "If the model labeled the company as an average one"- i.e. from the companies that were rated by the Index IN05 as the average ones were in the actual decline, expressed in percentage, the least number of companies.

From the point of view of companies, they must always be prepared for the worse option. The Taffler and Binkert models have labeled the least companies as the non- prosperous ones, the Index the IN05 most. Although the Binkert model may have been more successful in single individual categories than the Index IN05, the success structure of the IN05 was more favourable from the point of view of the companies. Therefore, it is possible to mark the IN05 on the basis of the found facts to be altogether more successful than the Binkert model.

An interesting and reliable model seems to be also the Altman model, which ranked on the second place the highest number of companies as the non- prosperous ones. Considering the number of companies labeled as prosperous and average ones, in both of these cases was the Altman model placed in the third (middle) position. In the single individual categories, it was ranked in the second place, i.e. it showed the second highest number of correct assignments in the category. In the fifth place was the Altman model placed only in the category "If the company was not in bankruptcy or restructuring" i.e. from the companies not being in bankruptcy or restructuring it rated almost the highest number of companies in percentage as the non- prosperous ones (however, what is good from the company´s point of view resp. this error cannot endanger the company to such an extent as if it was on the contrary).

2.2 The Dynamic analysis

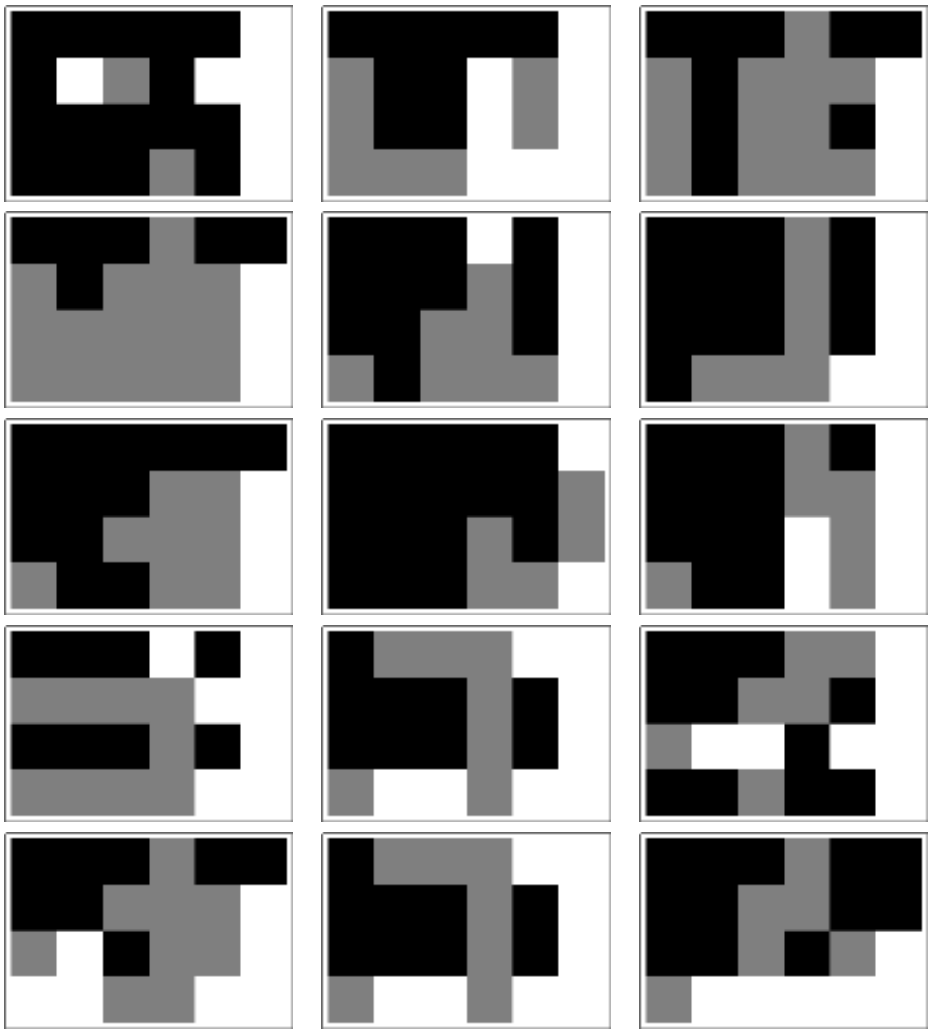
The Table 8 was created by the manual counting of companies, which were labelled by the models as prosperous, average (grey zone) and non- prosperous (unsustainable, bankruptcy) ones for all four years.

Table 8 Analysis of the ability to report of the compared indicators over four years

		1 year	2 years	3 years	4 years
Altman Z-score	non- prosperous (2)	14	10	9	4
		93%	67%	60%	27%
	average (1)	1	5	6	9
		7%	33%	40%	60%
	prosperous (0)	0	0	0	2
		0%	0%	0%	13%
Index 05	non- prosperous (2)	14	13	12	7
		93%	87%	80%	47%
	average (1)	1	1	1	4
		7%	7%	7%	27%
	prosperous (0)	0	1	2	4
		0%	7%	13%	27%
Quick test	non- prosperous (2)	13	7	8	4
		87%	47%	53%	27%
	average (1)	2	8	6	9
		13%	53%	40%	60%
	prosperous (0)	0	0	1	2
		0%	0%	7%	13%
Binkert model	non- prosperous (2)	4	2	3	1
		27%	13%	20%	7%
	average (1)	9	12	10	10
		60%	80%	67%	67%
	prosperous (0)	2	1	2	4
		13%	7%	13%	27%
Credit worthiness Index	non- prosperous (2)	13	6	7	2
		87%	40%	47%	13%
	average (1)	1	7	7	6
		7%	47%	47%	40%
	prosperous (0)	1	2	1	7
		7%	13%	7%	47%
Taffler model	non- prosperous (2)	6	1	0	0
		40%	7%	0%	0%
	average (1)	0	1	1	0
		0%	7%	7%	0%
	prosperous (0)	9	13	14	15
		60%	87%	93%	100%

Source: own processed on Finstat, 2017

The highest reporting value showed all the indicators one year before bankruptcy. The same findings for Slovakia was reported in (Brozyna, Mentel, Pisula, 2016). The Index IN05 became a clear winner, which predicted the highest number of bankruptcies to companies in each single year and simultaneously already four years before a bankruptcy – i.e. at the earliest – labelled the highest number of companies as the non- prosperous ones. Unlike the Altman model, however, the IN05 marked also more companies as prosperous in the period under review. One year before a bankruptcy, the Altman's model and the IN05 indexed one company as the average one, but it was not the identical company. As can be seen from the Table 8, the worst reporting ability over the four years had the Tafflerov model (with the only exception when one year prior to bankruptcy, the Binkert model was placed on a lower position), which ranked the highest number of companies even as prosperous ones.



Source: own processed on Finstat, 2017

Figure 1 Financial situation of 15 companies according to individual single models in the 1st, 2nd, 3rd and 4th year before bankruptcy

The financial situation of all fifteen companies, as it was assessed by the individual indices over the course of four years, presents the Figure 1 (15 rectangles schemed 3x5). Each of the charts (Charts 1 to 15) contains six columns - for each model one column and four lines – for each year one line. In the highest lines of the chart there is the business situation one year prior to bankruptcy for each model displayed, so the lowest line represents the business situation according to models four years prior to bankruptcy. The black square in the chart indicates that the company is classified to be in the border zone of decline (bankruptcy), the grey square - grey zone, the white square - prosperity.

3 Discussion

The simple summation method is reliable for 50:50 samples, that is, when 50% of the prosperous and 50% of the non- prosperous (unsustainable) companies are in the sample. In order to get a realistic picture of the indicators´ ability to report, based on a real sample (not 50:50), it is necessary to notice their success in individual categories (the structure of success) while taking into account also their assessment throughout the entire sample. While better is the model that contains the structure of success being more advantageous from the point of view of the company. The credit worthiness and bankruptcy indicators should be a part of an overall deeper analysis of the company's financial situation, but if a company attempted to orientatively determine the state only through these indicators, it should choose at least two.

Conclusion

Based on the above mentioned facts, we would recommend for the Slovak private construction companies to use the combination of the Index IN05 and the Altman model, which would correct the possible bad indications of the Index IN05. The least appropriate seems to be the Taffler model.

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