SOLVENCY PREDICTION MODELS FOR THE HUNGARIAN AGRICULTURAL[1] ENTERPRISES

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Abstract: The prediction of solvency of the enterprises has for a long time concerned creditors. It is especially true in case of agricultural enterprises, as the given branch has always been considered to be a risky and a slowly returning investment area. Still relatively little research has been carried out in this field. After the appearance of computers the prediction of insolvency of debtors became a subject of serious statistical research. The majority of positive results have been achieved with the application of the discriminant analysis. In the present study the author presents a brief description of two well-known insolvency prediction models, two models of his own, as well as a critical evaluation of their application for Hungarian agricultural enterprises.

IMPORTANCE OF THE SPECIFIC PREDICTION MODEL

The relationship between the enterprise and bank may be considered from two viewpoints:

1. the bank and the enterprise as the bank's future client,
2. the bank and the enterprise as the bank's present client.

We may talk about the first case, when the enterprise needs external capital. This might have different reasons: increasing production capacity, temporary crisis, liquidity shortage due to seasonality, etc. The bank examines the possible investment opportunity and depending on the result of the examination the relationship begins or not. We may talk about the second case, when the bank manages the credits in progress or grants new credits meeting the demands of the enterprise and its situation. A very important common step in both cases is the customer or debtor rating. Therefore, the relationship between the bank and the enterprise may be traced back to the prediction of the enterprise's solvency.

In the event of selling or buying on credit or settlement of accounts in final products a short term debtor-creditor relationship (the current liabilities and the trade receivables) is formed, which is not always characterized by contractual payment. To form the deadlines, methods and limits of payment the customer as well as the seller needs the customer rating system. The solvency predictability of their own company and partners is extremely important for the company's management.

The prediction of solvency with statistical methods is not a novelty. It has been applied in crediting in other countries for decades. The bankruptcy models are more and more frequently used in debtor rating systems in Hungary as well. In spite of this these methods are rarely used in enterprise management and not used at all in the agricultural sector. In the author's opinion in the judgment of the solvency of agricultural enterprises the following factors, typifying agriculture, must be considered:

[1] By agricultural enterprise the author means forestry, fishery and hunting parks as well.

- the Hungarian agriculture suffers from chronic capital shortage, its capital structure differs from other branches,
- the relation of ROE (Return on Equity) and ROD (Return on Debts) in the Hungarian agriculture is reversed compared to other branches,
- the values of liquidity and other rates fluctuate to a grate extent within a year due to seasonality, and their interpretation may change depending on the date of calculation.

Therefore it may be justified to control the applicability of widespread insolvency prediction methods for using in case of the Hungarian agricultural enterprises, or to develop new models exclusively for the Hungarian agricultural enterprises.

THE ANALYSIS OF FINANCIAL RATIOS

The first research aimed at the prediction of bankruptcy appeared at the end of 30ies in the United States. Many of the basic methods of the analysis of economic and financial difficulties are used to the present day. As the result of the research programs in which the majority of consulting firms took part independently from one another the fact has been recognized, that some financial factors of the failed enterprises considerably differ from the factors of the stably working ones.

The first to start applying the analysis of financial ratios, as a method of bankruptcy prediction, was W. H. Beaver (1966). In his research he compared ratios of insolvent firms one by one to the same ratios of normally working firms, and he has found, that long before the bankruptcy the difference between them is striking. Both groups consisted of 79 enterprises and five years prior to crisis signs could be detected allowing the conclusion that the bankruptcy is approaching.

In all of the similar research suggestions were given as for which ratios should be taken into account and what conclusions can be made, observing their changes in time. However, they did not succeed in defining the probability of bankruptcy because the attempts to solve the problem with only one or two ratios frequently resulted in false or inconsistent results.

MATHEMATICAL-STATISTICAL MULTIPLE VARIABLE METHODS

After Beaver's comparative methods more and more schemes were born to solve the problem. The author has summarized the best-known works on the prediction of insolvency with the help of multiple variable statistical methods, the applied methods and their accuracy of the prediction one year before bankruptcy.

It is easy to notice, that the most popular one is the discriminant analysis. Since the middle of eighties a method of logistic regression — Logit — has also been applied. The appearance of the given methods in a prediction of bankruptcy is caused by that during their application they were able to give answers to the questions to which the traditional techniques were not, namely:

- What financial ratios are most important during estimating the chances of bankruptcy of the economic unit?
- In what proportions is it necessary to consider the given ratios?
- With which method is it possible to define these ratios and their relations to one another? (VIRÁG – HAJDU, 1995)

Table 1

The best-known models of the bankruptcy prediction

Models	Methods	Accuracy (%) one year before
Altman (1968)	DAN	95
Deakin (1972)	DAN	97
Altman – Lorris (1976)	DAN	90
Korobow – Sturh – Martin (1976)	REG	90
Altman – Halderman – Narayanan (1977)	DAN	93
Springate (1978)	DAN	93
Springate – Botheras (1979)	DAN	88
Dambolena – Khoury (1980)	DAN	96
Zmijewski (1984)	Probit	76
Zmijewski (1984)	Probit	97
Altman – Izan (1984)	DAN	92
Fulmer (1984)	DAN	98
Barth – Brumbaugh – Sauerhaft – Wang (1985)	Logit	87
Frydman – Altman –Kao (1985)	REK	94
Pantelona – Platt (1987)	DAN	95
Pantelona – Platt (1987)	Logit	96
Legault (CA-Score) (1987)	DAN	83
Platt – Platt (1990)	Logit	90
Altman – Hartzell – Peck (1995)	DAN	92
Moody's Riskscore™ (HERRITY, 1999)		79

DAN = discriminant analysis
REG = regression model
REK = recursive partitioning

based on VIRÁG — HAJDU (1995), with additions

Authors of the models listed in table 1, gave various answers. This is not surprising, as research was carried out in different times, in various market conditions, on various samples of enterprises, using various methods.

In the present study two of them are introduced. In the environment where these models were developed, they showed a rather high degree of reliability. The other reason for choosing them is that both models were developed on the basis of small and medium-sized enterprises.[2] The third reason for the choice: models use exclusively the data of the income statement and the balance sheet. Differently from e.g. the better-known Altman model, market capitalization is not considered in them. Thus, the circle of application is not constricted for corporations, whose shares are subject to free trading on the stock exchanges, that is not at all typical of Hungarian agricultural enterprises. Naturally, there are some such enterprises, but so few that it is difficult to process their data with statistical methods.

THE BRIEF DESCRIPTION OF FULMER'S MODEL

The model was created on the basis of processing data of sixty enterprises: 30 failed and 30 normally working with an average asset size of $455,000. The first version of the model contained 40 financial ratios; the final version uses only nine.

[2] Inclusion in the given categories is true for American and Canadian enterprises and was done on the basis of the average asset size of these firms (the author)

A general view of model:[3,4]

$$H = 5.528x_1 + 0.212x_2 + 0.073x_3 + 1.270x_4 - 0.120x_5 + 2.335x_6 + 0.575x_7 + 1.083x_8 + 0.894x_9 - 3.075$$

where

$$x_1 = \frac{Retained\ Earning}{Total\ Assets} \qquad x_2 = \frac{Sales}{Total\ Assets}$$

$$x_3 = \frac{Earnings\ Before\ Taxes}{Equity} \qquad x_4 = \frac{Cash\ Flow}{Total\ Debt}$$

$$x_5 = \frac{Debt}{Total\ Assets} \qquad x_6 = \frac{Current\ Liabilities}{Total\ Assets}$$

$$x_7 = \log\left(Tangible\ Total\ Assets\right) \qquad x_8 = \frac{Working\ Capital}{Total\ Debt}$$

$$x_9 = \log\left(\frac{Earnings\ Before\ Taxes}{Interest} + 1\right)$$

If $\boldsymbol{H} < 0$, bankruptcy is inevitable. Accuracy of the forecasts made with the help of the given model for a year forward was 98 %, for two years 81 % (FULMER, 1984).

THE BRIEF DESCRIPTION OF SPRINGATE'S MODEL

This model was developed by Gordon L. V. Springate (1978) at Simon Fraser University in 1978 with the help of the stepwise discriminant analysis method, which had been developed by Altman in 1968. In the process of creating the model only four remained in the final model out of the 19 financial ratios considered the best.

A general view of model:

$$Z = 1.03x_1 + 3.07x_2 + 0.66x_3 + 0.4x_4$$

In which

$$x_1 = \frac{Working\ Capital}{Total\ Assets} \qquad x_2 = \frac{Earnings\ Before\ Taxes + Interest}{Total\ Assets}$$

$$x_3 = \frac{Earning\ before\ Taxes}{Current\ Liabilities} \qquad x_4 = \frac{Sales}{Total\ Assets}$$

If $\mathbf{Z} < \mathbf{0.862}$, the firm is classified as "failed". During the creation of the model Springate used the data of 40 enterprises and achieved a 92,5 percent accuracy in the prediction of insolvency for one year forward. Later Botheras (1979) achieved an 88 percent accuracy of prediction using Springate's model on the data of 50 enterprises with an average asset size of $2.5 million.

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[3] The meaning of constants in the original formula was not –3,075, but –6,075. This change is caused by distortion of value of a variable $\boldsymbol{x_7}$, which is due to the rules of filling forms of balance in Hungary, according to which the data are indicated in thousand HUF. *(the author)*

[4] In the original formula $x_9 = \log\left(\frac{EBIT}{Interest}\right)$ and *EBIT = Earnings Before Taxes + Interest (the author)*

SAMPLE OF HUNGARIAN AGRICULTURAL PRODUCTIONS

For his work the author used a database of the Information Service of the Ministry of Justice of the Hungarian Republic (IM Mérlegtár, 1999/2). The sample contains the data of the income statement and the balance sheet of 146 agricultural enterprises (activity codes: EAOR 3, TEAOR A, TEAOR98 A) for the year 1999. 73 of them (henceforth "non-failed") work normally to date, and against the other 73 (henceforth "failed") liquidating processes were started in 2000.[5] No more than ten percent (in case of agricultural enterprises about 1 % — *the author*) of all insolvent small enterprises start bankruptcy proceedings, as it is impossible to avoid paying debts. Therefore they usually wait, till one of the creditors start the legal process. The processes with the purpose of delay of payments are started even more rarely, first of all because of the debtors' insufficient knowledge of laws, and also because it is very long — possibly several years — legal proceedings during which neither debtors, nor creditors see their money. Therefore the most widespread is the liquidating process initiated by creditors (CSERNYÁNSZKY, 2001).

THE AUTHOR'S OWN MODEL FOR SMALL ENTERPISES (*Logit 1M*)

Logit 1M is the author's model for enterprises with registered capital less or equal 1 million HUF. It was developed with the help of binary logistic regression. The author used a likelihood ratio based forward stepwise algorithm. A view of the model:

$$\pi = \frac{odds}{1 + odds}$$

where π is a possibility of the firm's solvency,

$$\ln(odds) = 1{,}950x_1 + 3{,}322x_2 - 0{,}874x_3 - 0{,}698$$

$$x_1 = \frac{Cash\ and\ cash\ equivalents}{Current\ liabilities}$$

$$x_2 = \frac{Inventories}{Working\ capital}$$

$$x_3 = \frac{Inventories}{Net\ sales}$$

If $\pi \leq 0.5$ (the *cut value* is 0.5) or $\ln(odds) \leq 0$, the enterprise is classified as "failed" and it will become insolvent within a year.

THE AUTHOR'S OWN MODEL FOR MEDIUM AND BIG ENTERPISES (*Logit 1M+*)

Logit 1M+ is the author's model for enterprises with registered capital greater than 1 million HUF. It was developed with the help of binary logistic regression, and here the author used a likelihood ratio based backward stepwise algorithm. A view of the model:

[5] In accordance with Hungarian law it is possible to start liquidation, voluntary dissolution and bankruptcy proceedings against insolvent enterprise. The first one is started by the creditors, the last two are started by the enterprise itself.

$$\pi = \frac{odds}{1 + odds}$$

where π is a possibility of the firm's solvency,

$$\ln(odds) = 4{,}649x_1 + 8{,}917x_2 - 0{,}335x_3 - 14{,}71x_4 + 17{,}371x_5 - 0{,}826x_6$$

$$x_1 = \frac{Intangible\ assets}{Non\text{ - }current\ assets} \qquad x_2 = \frac{Equity}{Total\ assets}$$

$$x_3 = \frac{Equity}{Authorised\ capital} \qquad x_4 = \frac{Cash - flow}{Total\ liabilities}$$

$$x_5 = \frac{Cash - flow}{Current\ liabilities} \qquad x_6 = \frac{Inventories}{Net\ sales}$$

If $\pi \leq 0.5$ (the *cut value* is 0.5) or $\ln(odds) \leq 0$, the enterprise is classified as "failed" and it will become insolvent within a year.

RESULTS OF MODELS' APPLICATION

Microsoft Excel and SPSS 10.0 were used for the calculations. It was necessary to use the IF logical function for typing the formulae in order to avoid division by zero and calculating the logarithm of zero and negative numbers. Results meet the expectations (see tab. 2).

Table 2

Prediction accuracy of models one year prior to insolvency

0 = "failed" 1 = "non-failed"		**Fulmer**			**Springate**			**Logit 1M**			**Logit 1M+**			**Logit 1M+ control**[6]		
		Predicted		Correct	Predicted		Correct	Predicted		Correct	Predicted		Correct	Predicted		Correct
		0	1	%	0	1	%	0	1	%	0	1	%	0	1	%
Observed	0	48	25	65,7	58	15	79,5	24	2	92,3	42	5	89,4	17	2	89,5
	1	25	48	65,7	44	29	39,7	9	14	60,9	3	47	94	3	45	93,8
Overall				**65,7**			**59,6**			**77,6**			**91,8**			**92,5**

Fulmer's model takes more factors into account; therefore it works more stably among circumstances differing from the original. Besides, this model also takes into account the size of firms, which is probably appropriate both in America and in any other market economy. The model recognizes the failed and non-failed enterprises with the same accuracy. The results of Springate's model are very asymmetrical. The model is obviously "moved" towards bankruptcy, and it recognized nearly two thirds of the non-failed firms badly.

Accuracy of American and Canadian models appeared much lower, than in the environment where they were developed. Here are some reasons:

1. The values of variables in original models were given in American and Canadian dollars. During application in other countries it is necessary to take into account the distortion of values of logarithms. Recalculation for dollars solves the problem, but changes of the exchange rate may cause insignificant mistakes.
2. In Hungarian accountancy the values in forms of reports are indicated in thousand HUF. Correction is necessary, however it breaks the continuity.

[6] The sample contains the data of the income statement and the balance sheet of 19 "failed" and 48 "non-failed" agricultural enterprises for the year 2000.

3. Conditions of the Hungarian agriculture's economy strongly differ from economic conditions of the United States or Canada.
4. The distinctive feature of Hungarian politics and agriculture is that — especially among small agricultural enterprises — economic difficulties begin to assume a social character. Thus, principles of market economy are broken.

It is possible to increase the accuracy level of models by changing the coefficients using the method of iteration. By the introduction of a constant into Springate's model it is possible to compensate its asymmetry. By simple manual selection after several steps applying a principle of constant improvement it is possible to increase the model's accuracy up to 70 % (in Fulmer's model — higher). It is possible to use expansion function Solver in program MS Excel. In this case it is important to choose the starting values of the variable coefficients.

The models developed by the author show a better goodness of fit for both small and bigger enterprises. It was only possible to control the results in the case of the companies with the authorized capital of at least one million HUF, but the fitting on the control sample was approximately the same. So, the fitting of the model does not depend on the sample.

ADVICE ON POSSIBLE APPLICATION

First of all, it is not advisable to apply models developed in a different environment without checking them on experience data. In the description of the model the terminology was used according to the Hungarian accounting practice, however during the adaptation of the model for a different environment it is necessary to clear — to check in practice — some concepts. While testing the models for Hungarian enterprises, the following interpretation was used:

Cash flow = Earnings After Taxes + Depreciation
Working capital = Current assets – Current liabilities
Equity = + Registered Capital + Additional paid-in capital +
+ Reserve capital + Retained earnings + Net Income

With the help of statistic software (SPSS or other) it is possible to carry out the discriminant analysis of the data of concrete enterprises, using ratios from the presented models. This way the author managed to increase the accuracy of Fulmer's model to 75 % with discriminant analysis, and to 77 % with logistic regression. Even more important is that the algebraic sign of the coefficient of value x_6 was changed from plus to minus, which means that the effect of this ratio on the judgment of Hungarian agricultural enterprises' solvency is counter to its effect in the of American economy. The possibility that the ratios' interpretation in other economic environment is also different should not be excluded. All things considered the best but rather difficult solution is to develop a new model adapted for the local economic conditions. The accuracy levels of the author's own models are much better, than the accuracy of the foreign models.

These models, as well as any others, must be used only as auxiliary means of the analysis of enterprises. It is unreasonable and dangerousle to completely rely on their results. They may be applied only after checking and correction in the environment of the future application. Examples of possible uses are listed below:

1. Data processing of potential borrowers with the aim of defining the risk of insolvency.
2. Definition of conditions of the credit.
3. Purchasing or selling the enterprise.
4. Early Warning System for the management of the enterprise.

5. Checking the accepted decisions in simulations of economic situations.
6. Creation of a dynamic picture of the solvency of the enterprise (trend analysis), using the data of previous accounting periods.

The last three uses may be built in management information systems (MIS) and carried out automatically.

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