Forecasting Companies' Future Economic Development

Jaroslav Dvořáček, Radmila Sousedíková[1], Pavel Barták[2], Jiří Štěrba[3] and Kamil Novák[4]

The subject of this paper is financial forecasting. The objective is to predict whether a company can continue in successful operation or is jeopardised by default. The paper takes into account an application of discriminate analysis concerning data files of 85 non-bankrupt, and 85 bankrupt firms in the Czech Republic, at which point mining companies are in minority, industrial enterprises predominate. 5-8 input variables in the form of ratios and indexes have been used for the analysis. The non-bankrupt vis-à-vis bankrupt classification accuracy is defined.

Key words: Bankruptcy, Discriminate analysis, Prediction accuracy

Introduction

In the past decades, it was the principal objective of the mining industries to provide for minerals, many of which were reported as strategic. State ownership of these industries rather belittled the importance of economic and financial implications of running these industries. The paradigm changed markedly after 1989. Financial and economic issues have become of primary interest since then. For mining companies but in fact for any firm, it is of essential interest to know what will be the economic footing of their business partners in future. Then, the problem can be defined as the ability of predicting the future economic situation of corporate businesses in general.

Current financial and economic problems worldwide stress the importance of accurate forecasting of corporate business developments. Predicting economic developments of a corporate business implies an assessment of the probability of its success or failure. Inability to pay their mature debts is the principal reason of firms' default.

Efforts of predicting risk of bankruptcy, as based on assessments of financial conditions testified by related financial statement documents, were first made in the thirties of the last century. Dvořáček et al. (2008) have referred to some literature on the problem.

Although many different methods have been applied in the area of our interest, all efforts have been commonly oriented by exploiting standard financial information resources, namely bookkeeping documents. Also, the accuracy of prognostications concerning future economic developments has been involved in these studies. Nevertheless, all the studies available have not analysed the reasons of assessing some firms' performances wrongly.

Background

This paper's investigations were initiated by knowledge concerning final stages of mining company operations in the Czech Republic, as related to the trend of restricting mining activities in the latter part of the last century. Justifiable reasons exist to maintain that parallel developments, and similar company behaviour strategies can be identified also in other industries.

From a material standpoint, business is nothing else but a fabrication of products or performing of services, but economically, irrespective of the actual business, it is just a circulation of capital.

Originally, it is the capitalist's own capital (share capital, etc.) or the outside capital (credits, loans, etc.). The capital pays for fixed assets (landed property, buildings, machines, etc.), current assets (raw materials and others inputs), and hiring of workforce. A classical production process starts with the processing of raw materials or semi-products; operation adds the value of fixed assets (depreciations) and workforce to the semi-finished products. Further processing of the semi-finished products is finalised by the production of goods - wares for the market. Marketing and sales of the wares change them into receivables that - being realised - transform again to capital. This capital is a fresh input of the running process of the capital circulation. It refreshes consumed current assets, pays for the workforce, and redresses the balance of fixed assets. A part

[1] *prof. Ing. Jaroslav Dvořáček, CSc., RNDr. Radmila Sousedíková, Ph.D.*, Institut ekonomiky a systémů řízení, Hornicko-geologická fakulta, VŠB-Technická univerzita Ostrava, 17. listopadu 15, 708 33 Ostrava, Česká republika

[2] *Ing. Pavel Barták, Ph.D.,* KÁMEN OSTROMĚŘ s.r.o., Nádražní 414, 507 52 Ostroměř, Česká republika

[3] *Ing. Jiří Štěrba Ph.D.*, Institut kombinovaného studia Most, Hornicko-geologická fakulta, VŠB-Technická univerzita Ostrava, 17. Listopadu 15, 708 00 Ostrava, Česká republika

[4] *Ing. Kamil Novák, Ph.D.,* ArcelorMittal S.A. a. de la Liberte, L-2930, Luxembourg

of the capital is used for loan repayments or for stockholders in the form of dividends. Capital resources also can be expanded by outside interventions so that rejuvenation of assets may accelerate on a higher level.

It is obvious from this enterprise functional paradigm that capital and job renewal are processes that ask for stable rejuvenations. Although these processes can be variably structured, they cannot stop. Cutting the capital flow cycle would result in the necessity to finance the capital and job maintenance only by the intervention of outside entities, which, in fact, can be done only for limited periods.

In a narrow sense, capital circulation can be defined as the formation of capital concerning capital resources and its utilisation. In this process, nevertheless, disturbances may occur. Among these are as follows:

- difficulty or impracticability of equity capital extensions (owner's investment, etc.),
- difficulty or impracticability of getting debt capital (bank loans, liabilities),
- problematic maintenance of operational cash flows as a result of bad sales and operating in the red (which make the problem of disrupted cash flows even worse),
- problematic sales of fixed assets items.

Breaking of the capital circulation is related to dysfunctions of its 3 critical stages:

- reduced sale,
- disrupted debt collection,
- impaired production.

Reduced sale: Sale reductions imply decreased receivables and decreased debt collection (i.e., reduced amount of capital in circulation). Usually, it is paralleled by decreases of inventories, cash, and current assets. Lack of capital hinders fixed asset investment. Because of depreciation and operation decommissioning, the value of fixed assets decreases. Sale reductions are paralleled by the same fixed costs, which leads to red figures. As a consequence, equity goes down. For continued operations, capital intervention from outside is needed. Usually, current liabilities go up, which can also be the case of bank credits.

Disrupted debt collection: The disturbance in debt collection may be caused by the unwillingness of customers to pay their debts because of their difficult financial situation. The double-entry accounting does not necessarily reflect this occurrence as decreased profit; nevertheless, the cash flow is reduced. Again, to sustain the activities, outside capital intervention is necessary, which means that the company's indebtedness goes up.

Impaired production: Disregarding technological causes of disrupted production processes, from the economic point of view, difficulties may occur if there is not enough capital. The lack of capital diminishes production inputs; reduced production implies sale decreases, which, as a consequence, is analogous to the situation previously described.

As such, capital circulation dysfunctions are paralleled by the following:

- sale and debt collection decreases,
- decreased financial assets,
- current assets reduction,
- fixed assets reduction,
- total assets reduction,
- dropped equities,
- increased indebtedness.

The analysis of the basic accounting documents of bankrupt firms provides evidence of these facts if the bankruptcy had been affected by disruptions of the capital circulation.

Impaired functioning of capital circulation can sustain for several months or even years before firms go bankrupt. Economic activities of firms are mirrored by their basic accounting documents, such as Balance Sheet, Cash Flow Statement, or Profit and Loss Account (Income Statement).

There have been many attempts to predict future economic footings of corporate businesses that have been based on basic documents of their financial reporting.

Discriminate analysis has been a classical method of predicting corporate failure or success (Altman, 1968).

Discriminate analysis method

This method starts with a file of firms that have been structured into 2 classes, namely those of non-bankrupt and bankrupt businesses. Each firm is characterised by values that are called discriminators. The objective of working with the file is to determine a discriminate function that would provide for identification of any other firm that has been characterised by the same set of discriminators as successfully operating or threatened by default. A classical discriminate analysis investigates relations between a group of independent attributes (discriminators, m) and a single qualitative dependent variable (output, G).

The simplest case is represented by a binary variable output of 0 (zero) value or 1. An object belongs to Class I if the binary variable output is 0 and to Class II if the binary variable output is 1 (Meloun & Militký 2004).

The linear discriminate analysis was applied to a number (n) of enterprises that were structured into 2 classes of non-bankrupt (n_1) and bankrupt (n_2) businesses. To each business, a set of discriminators ($x_1, x_2, \ldots, x_m$) was attributed. The objective is to find a discriminate function

$$Z = a_1 x_1 + a_2 x_2 + \ldots + a_m x_m \tag{1}$$

that would provide for classifying non-bankrupt and bankrupt firms, as characterised by the defined discriminators.

If Class I of non-bankrupt (n_1) firms is characterised by a mean value vector,

$$\overline{\mathbf{x}}_1 = \left(\overline{x}_{11}, \overline{x}_{12}, \ldots, \overline{x}_{1m} \right), \tag{2}$$

of which, the individual elements are represented by discriminator averages of non-bankrupt firms and a covariance matrix $\mathbf{S}_1$, the Class II of bankrupt (n_2) provides for mean values

$$\overline{\mathbf{x}}_2 = \left(\overline{x}_{21}, \overline{x}_{22}, \ldots, \overline{x}_{2m} \right), \tag{3}$$

of which, the individual elements are represented by discriminator averages of bankrupt firms and a covariance matrix $\mathbf{S}_2$, then the discriminate function coefficients $a_1, \ldots, a_m$ are calculated:

$$\mathbf{a} = \mathbf{S}^{-1} \left(\overline{\mathbf{x}}_1 - \overline{\mathbf{x}}_2 \right). \tag{4}$$

If mean value vectors, Classes I and II, are substituted in the discriminate function (1), we can calculate average values, $\overline{Z}_1$ and $\overline{Z}_2$.

The optimal threshold value C, which determines objects as belonging to Class I or Class II, can be calculated:

$$C = \frac{\left(\overline{Z}_1 + \overline{Z}_2 \right)}{2}. \tag{5}$$

Non-classified firms whose linear discriminate function values are in excess of C can be classified as non-bankrupt. If the linear discriminate function values are less than C, firms are classified as bankrupt.

The reason for choosing the discriminate function method for our investigation was that traditional methods of corporate economic development evaluate ratio indices in one dimension. The interpretation of the values of such indices may be ambiguous. The discriminate analysis enables incorporation of a greater number of ratio indices into a single model and, as such, provides for a more complex, multi-dimensional evaluation of the investigated firm.

Discriminate analysis data

The discriminate analysis has been based on 2 data sets - non-bankrupt and bankrupt businesses. Both files comprised 85 firms.

The bankrupt firms were identified following press communications, where company identification numbers provided for acquisition of basic account book documents and financial statements. Balance Sheets and Income Statements were downloaded from open to public information resources on the Internet, or they were provided by respective judicial authorities. Bankruptcy proceedings were taken in periods, 1997-2008. The numbers of bankruptcies in each period are rather related to the accessibility of corresponding financial documentation than by the general economic situation of the period.

The non-bankrupt firm research was based on the Internet information freely accessible to the public. The firms were considered non-bankrupt if the current period net income (i) and accumulated earnings (ii) were not in the red, concerning business operations of the year in which the financial documents were made and a preceding year. Such firms were chosen for investigation whose total assets were more or less on a par with bankrupt firms. Comparison of firms, as based on total asset figures of the last Balance Sheet, is shown in Tab. 1.

Tab. 1. Number of Firms as Regards Total Assets, CZK Million[1]).

	Up to 100	101-200	201-300	301-400	401-500	Above 500	Σ
Non-bankrupt	58	13	6	3	2	3	85
Bankrupt	66	9	5	3	1	1	85

Concerning industrial branches, bankrupt firms have been chosen from an overall range of the Czech business enterprises. The choice represents industrial companies, building businesses, agriculture, sales, and services. Reference studies concern individual industry branches, for example, footwear production (Pindado & Rodriques 2001) and banking (Tam & Kiang 1992). However, in general, variety of branches is involved: 24 industrial branches (Norton & Smith 1979); industrial production companies (Altman 1968); production and non-production firms (Beaver 1966); production and commerce companies (Altman 2000); and machine engineering, steel, textile, and sugar industries (Winakor & Smith 1935).

Concerning bankrupt firms, the period between making of the Balance Sheet and the Income Statement and related bankruptcy order is important, as it is the period between the making of financial documents and their assessments concerning non-bankrupt firms. If we designate,

t   Date of the bankruptcy order or the date of the non-bankrupt firm assessment,

t-1   Date of the final financial documentation making before the bankruptcy order or the non-bankrupt firm assessment (usually to a year's closing date, 31.12.), but in a few individual cases, the basic accounting documents were issued one day before bankruptcy was declared),

t-2   Date of financial documentation provision as 1 year before the last financial documentation was made, that is, before the designated period, (t-1),

then, the difference between time (t) and (t-1) was 6 months in case of bankrupt firms and 17 months in case of non-bankrupt firms. This was because of their availability on the Internet - where occasionally, related accounting documents were published with considerable delay.

Data of the period (t-2) were used for the calculations of development indexes of the related parameters in the form (t-1) / (t-2).

In terms of input data, choosing the variables for discriminate analysis (i.e., choosing the discriminators) is the key factor. This study selected input data as provided by economic development period of one or 2 years before the bankruptcy order or non-bankrupt firm assessments for that matter. Average values of the principal indices of the Balance Sheet and Income Statement are given in Tab. 2. The table enables drawing of the following conclusions comparing time development and comparing the enterprises themselves.

Non-bankrupt firms: Total assets grow, and they are more than half above those of bankrupt businesses. The total assets increase is the result of moderate growth fixed assets, as well as accelerated growth of current assets.

Tab. 2. Balance Sheet and Income Statement Figures, BASIC AVERAGES [CZK thousands].

	NON-BANKRUPT FIRMS			BANKRUPT FIRMS			INDEX NON-BANKRUPT /BANKRUPT
	Period	Period	Index	Period	Period	Index	In the period
	(t-2)	(t-1)	(t-1)/(t-2)	(t-2)	(t-1)	(t-1)/(t-2)	(t-1)
Receivables for Subscribed Capital	8	8	1,00	259	2	0,01	4,00
TOTAL ASSETS	108 135	115 005	1,06	100 316	74 459	0,74	1,54
In the number: Fixed Assets	63 525	65 775	1,04	50 368	42 425	0,84	1,55
Current Assets	42 115	46 846	1,11	48 166	30 569	0,63	1,53
In the number: Financial Assets	9 858	13 228	1,34	2 881	1 509	0,52	8,77
Other assets	2 487	2 376	0,95	1 523	1 463	0,96	1,62
LIABILITIES AND EQUITY	108 135	115 005	1,06	100 316	74 459	0,74	1,54
In the number: Equity	60 306	68 543	1,14	-153	-20 057	131,09	-3,42
Total Liabilities	47 103	45 942	0,98	96 959	90 404	0,93	0,51
In the number: Current Liabilities	18 201	17 962	0,99	47 805	43 464	0,91	0,41
Other Liabilities	726	520	0,72	3 510	4 112	1,17	0,13
Total Production	105 968	115 552	1,09	94 825	69 998	0,74	1,65
Sales of Goods and Services[2)]	98 759	121 070	1,23	95 483	70 070	0,73	1,73

There is a marked trend of cash flow growth (especially as regards banking deposits), which is 8 times higher in comparison to the situation of bankrupt firms. The growth of both current assets and banking deposits follows the trend of the increased production and sales revenues that exceed markedly the levels of production and revenue of the bankrupt firms. Consequently, positive developments of the production provide for equity growth in parallel to total liability decreases. Also, current liabilities go down, which reflects good cash positions (liquidity) of non-bankrupt firms.

Bankrupt firms: Total assets decrease for more than a quarter, as a result of fixed asset decreases (limited investments, depreciations, out of operation settings) and a marked decrease of current assets. The latter is influenced by plunging liquidity, almost by half. Also, steep fall of service provision and sales revenue figures is reflected here. The enterprises are deeply in debt, and the total liability ratio (total liabilities/ total assets) keeps increasing. In the period before the bankruptcy order, total liabilities are in excess of total assets. Current liability decreases are caused by lower production figures and overall operation restraint of default businesses.

Comparing development indexes of non-bankrupt and bankrupt firms, it follows that the most significant differences between them concern financial assets, that is, liquidity.

At the beginning of our study, it was necessary to establish the number of variables to be used for the discriminate analysis. The quantification of variables (financial ratios) differs considerably concerning particular studies in the field. Pindado & Rodrigues (2001) used only 2 ratio coefficients. Also, Altman firstly (1968) used 5 and later (2000) 7 ratio coefficients. Beaver (1966) made selections from a variety of 30 financial ratios. Norton & Smith (1979) applied 32 mostly ratio coefficients. Tam & Kiang (1992) used 19 ratio coefficients, where Fitzpatrick (1932) used 13 ratios.

In such situation, asking a question about the appropriate number of input variables is only obvious. It is possible to assume that the quantity criterion should be in the accuracy of feedback classification of the companies as non-bankrupt or vice versa.

From the data shown in Table 2, we started with 5 variables as follows:

1. Ratio, $\dfrac{\text{total liabilities, t - 1}}{\text{total assets, t - 1}}$, characterizes indebtedness rate,

2. Index, $\dfrac{\frac{\text{total liabilities, t} - 1}{\text{total assets, t} - 1}}{\frac{\text{total liabilities, t} - 2}{\text{total assets, t} - 2}}$, characterizes indebtedness development,

3. Index, $\dfrac{\text{current assets, t - 1}}{\text{current assets, t - 2}}$, characterizes current assets development and circulation of capital that is vital for a firm's survival,

4. Index, $\dfrac{\text{production, t} - 1}{\text{production, t} - 2}$, characterizes a firm's production activities (sales of goods and services, changes in stock level, own work capitalised),

5. Ratio, $\dfrac{\text{financial assets, t - 1}}{\text{current assets, t - 1}}$, financial assets are the most liquid assets of the company that can pay debts and, as such, avoid bankruptcy order.

Further calculations used 6 variables, that is, to the variables given above, another was added, namely

6. Ratio, $\dfrac{\text{current assets, t - 1}}{\text{total assets, t - 1}}$, characterizes a firm's wealth structure. Non-bankrupt firms have sufficient levels of current assets providing for production, of which, the sales ensure sustainable circulation of capital.

Nevertheless, the last variable can be distorted by changes in stock and accounts receivable. That was why further calculations were completed by the seventh variable, namely,

7. Ratio, $\dfrac{\text{sales revenue, t - 1}}{\text{total assets, t - 1}}$, which characterises assets productivity. Sales are the most important factors sustaining circulation of capital.

The final calculation involved also the variable,

8. Ratio, $\dfrac{\text{current liabilities, t - 1}}{\text{total assets, t - 1}}$, which reflects a firm's liquidity.

9. The final calculation involved also the variable,

10. Ratio, $\dfrac{\text{current liabilities, t - 1}}{\text{total assets, t - 1}}$, which reflects a firm's liquidity.

Vis-à-vis our former investigations (Dvořáček et al., 2008), the discriminators choice varied as caused by the following:

•   Analysing larger files of companies,

•   Aiming at elimination of distortions given by parameter developing trends; for example, if bankrupt firms are taken into account, their equity values are frequently negative. As such, from the point of view of mathematics, deepening of the equity negative trend equals increases of positive equity. The problem

of the development of economic results of the past years (retained earnings index) is in close analogy to this.

In contrast to other studies in the field, not only ratios but also indexes were used, the latter characterizing development trends. Table 2 illustrates the fact that successful firms differ from those in default not only in financial ratios but also in financial indexes that indicate direction and intensity of financial situation development trends.

Using 5-8 input variables (discriminators), discriminate analysis was applied to a set (file) of 85 non-bankrupt and 85 bankrupt firms. Coefficients of linear discriminate function $a_1, a_2, \ldots, a_m$ and values of optimum threshold point C were calculated as criteria for classifying individual firms. Accuracy of forecasting was established individually for each group of bankrupt or non-bankrupt firms. For each firm, the linear discriminate function value was calculated and compared with the value of the optimum threshold point. If the linear discriminate function value exceeded the value of the optimum threshold point, the firm analysed was qualified as non-bankrupt.

Alternatively, if the linear discriminate function value was below the value of the optimum threshold point, the firm was qualified as bankrupt. Shares of accurately classified firms are given by percentages, concerning total numbers (85) of companies in each category.

Results and Discussion

Percentages of successful and failed predictions in the category of non-bankrupt and bankrupt firms, inclusive of related discriminate function and optimum point coefficients as given by varying numbers of input variables used, are provided in Tab. 3.

Tab. 3. Results of Discriminate Analysis Concerning Number of Input Variables.

Input Variables	Linear Discriminate Function Coefficients				Non-bankrupt firms		Bankrupt firms	
	5 variables	6 variables	7 variables	8 variables	Prediction percentage [%]			
					Success	Failure	Success	Failure
Total liabilities/Total assets	-0,80	-0,78	-0,83	-0,71				
Total liabilities/Total assets Index	0,58	0,57	0,61	0,75				
Current assets index	1,44	1,44	1,46	1,48				
Production Index	0,02	0,02	0,02	0,01				
Financial assets/Current assets	4,81	4,81	4,80	4,82	78,8	21,2	90,6	9,4
Current assets/Total assets		-0,26	-0,44	-0,34	81,2	18,8	91,8	8,2
Sales of goods and services/Total Assets			0,09	0,09	84,7	15,3	91,8	8,2
Current liabilities/Total assets				-0,24	84,7	15,3	91,8	8,2
Threshold point optimum	2,13	1,99	2,04	2,25				

Comparing prediction accuracy of economic developments in the categories of non-bankrupt and bankrupt businesses, we can conclude that:
- Prediction is more accurate for any number of input variables (discriminators) if bankrupt firms are taken into account, which is not the case of non-bankrupt companies,
- Prediction accuracy for non-bankrupt firms rises with discriminator numbers from 5 to 7. Going above this number makes no difference, as regards prediction accuracy,

- Prediction accuracy for bankrupt firms rises if 6 discriminators are used for the analysis. If 7 and 8 discriminators are used, the prediction accuracy remains the same.

Our case study could attain maximum accuracies in both categories using just 7 input variables. Accuracy increases in the category of bankrupt firms can be elucidated by their desperate situation influencing the majority of items of the Balance Sheet and Income Statement documents.

Nevertheless, it might be of some interest to know the causes of classification failures in both categories. Just from the point of view of mathematics, the classification criterion is provided by linear discriminate function values vis-à-vis optimum values of threshold points. If linear discriminate function coefficients are constant, the linear discriminate function values are given by input variables (discriminators) specific for each firm under study. Comparing individual discriminators of wrongly classified businesses with average values of the whole set of the given category, we can identify causes of wrongly forecasted developments.

Such comparisons and the following analysis of basic accounting documents, as regards both categories of businesses, provided for these conclusions:

Non-bankrupt firms wrongly categorised as bankrupt: Irrespective of the number of discriminators, the value of the ratio $\dfrac{\text{financial assets}}{\text{current assets}}$ was 2/3 to 10 times lower than the average, concerning the total number of 85 firms in the set (file) analysed. Table 2 shows the highest values of the cash and cash equivalent (financial assets) indexes, comparing bankrupt and non-bankrupt firms. The discriminate function coefficient as regards the ratio $\dfrac{\text{financial assets}}{\text{current assets}}$ is by far the highest, concerning all linear discriminate function coefficients. Markedly lower values of this discriminator may cause lowering of the discriminate function value beyond the optimum threshold value. Further analysis of lower values of this financial ratio showed that this was caused by the following:

- High shares of current assets in a firm's wealth structure given by its specific character, concerning especially services with low share of fixed assets,
- Low levels of cash and cash equivalents caused by:
  - o Investments in fixed assets using both credits and available financial resources,
  - o Low levels of production and service provisions,
  - o Increased current account receivables, as a consequence of customers not paying their debts,
  - o Way of financial management, when a foreign parent company depletes all available cash resources.

Bankrupt firms wrongly classified as non-bankrupt: The prevailing cause of this error was the high share of financial assets in current assets. In 4 of 7 erroneous classifications, this share was higher than it would be average concerning non-bankrupt firms. It is possible to assume that these difficult companies did not invest in tangible assets and had low or zero inventories and that production decreases resulted in lower account receivables. Consequently, the volume of current assets was small, and the share of financial assets in the current assets was relatively high. Other causes were as follows:

- Accounting deficiencies, where auditors pointed out fixed asset overvaluations,
- Company dissolution caused by long-term inability to pay debts. A profitably operating firm, having been moderately in debt, accounted for threefold increase of receivables, cutting down production slightly, and dramatically depleting financial assets.

It may be said that scrutiny of basic accounting documents used for discriminate analysis can exclude majority of distorting factors that might be the cause of erroneous predictions.

Conclusions

The results of the discriminate analysis conducted for the set of 85 non-bankrupt and 85 bankrupt firms by using 5-8 input variables (discriminators) provide evidence for the conclusion that the highest accuracy (84,7 % non-bankrupt and 91,8 % bankrupt firms) is attained if 7 discriminators are used for the analysis. If another discriminator is used, no accuracy difference is experienced. In average, the values for calculation of ratios were 6-17 months before a firm's assessment or bankruptcy order for that matter.

Concerning practicalities, it is recommended that usage of the threshold point criterion is paralleled by at least one analysis of the related Balance Sheet and Income Statement. This can provide verification of prognosticating a firm's economic development regarding 1- to 2-year periods, in which relatively reliable results can be expected.

Notes:

1. *An approximate conversion rate, 1 USD = 18 CZK, can be taken into account.*
2. *If the sales revenue exceeds total production, the sales involved also finished goods stocks, and stock levels decrease. Conversely, a part of produced goods is not sold, and finished goods stocks increase.*

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