Measuring corporate management in business maturity forecasting models

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ABSTRACT

Modern corporate theory interprets enterprise-wide risk management (ERM) as an agent between stakeholders and corporate governance. In accordance with the latest ERM framework, corporate risk management in business includes the methods and processes used by organizations to manage uncertainty and use the opportunities associated with achieving their goals. The aim of the study is to measure corporate management in business maturity forecasting models. The author predicted a company cluster based on signal to noise ratio. As the basic model, the author used the calculation method proposed by G. Taguchi to assess product quality as well as for the design and optimization of processes. The research method used for the study was empirical. The author obtained financial performance data relating to all 218 companies from the SPARK database. It was applied two-step cluster analysis to compare companies within the sample. Also, it was calculated the geometric mean for each quantitative variable to avoid the influence of temporary shocks and distortions. The results of a nonparametric test showed that the relationship between the signal-to-noise ratio (SNR) and ERM is significant. Thus, based on the results of the theoretical and empirical studies, we can argue that the measurement of ERM through the SNR is justified.

Keywords: Risk management, Signal-to-noise ratio, Firm value, Logistic regression.

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1. Introduction

The implementation of corporate risk management optimizes the management processes of the company so that more disciplined companies over the long run outperform those that don’t manage risk. Corporate risk management is a multifaceted and multidirectional system; therefore, it is impossible to apply agent theory in its pure form. Enterprise risk management is establishing itself as the dominant paradigm of corporate risk management [1-5]. A significant amount of research in the field of corporate risk management indicates its high relevance.

In general, the development of corporate risk management (hereinafter, corporate risk management and enterprise-wide risk management are used interchangeably) can be divided into two eras: practical and theoretical. The “practical era” is represented by a large number of risk management recommendations initiated by various departments, authorities, stock exchanges, financial companies, auditors, and consultants. Most of these recommendations resulted in modern risk management framework ERM, an integrated approach. The main goal of this framework is to formalize and systematize existing approaches to risk management that one way or another disclose a strategic approach to risk management [6-14].

C. Ingley and X. van der Walt [15-19] state that corporate risk management is a special function of corporate governance, which needs to be formalized in order to determine and increase its (corporate governance) effectiveness can be considered the beginning of a “theoretical era”. From this point on, the approach to corporate
risk management has changed significantly. Thus, in earlier studies, ERM was defined as the minimum set of solutions for a given level of expected performance. And in later ones, corporate risk management is described as a tool to improve added value. In terms of methods, risk management has also undergone significant changes. The cost approach has significantly expanded the boundaries of management through a risk-return paradigm. Instrumental research methods resulted in dynamic models [20-25]. Currently, ERM is most often interpreted as a corporate governance tool that directs and coordinates the behaviour of managers, raising awareness of all sources of risk and combining the adoption of strategic and operational decisions in an organization, taking into account the company’s risk appetite [26-28]. Thus, the positive role of RM is not in doubt. However, most hypotheses regarding ERM have not been confirmed [29-32]. In general, research in this field is carried out within the following areas:

• A cost-based approach explores how risk management reduces corporate costs (including management costs) [33-37];
• The value-based approach examines how value is created as a result of risk management;
• The market approach explores how the market responds to risk management signals [38-44].

Stakeholders are a key factor in risk management. In this case, ERM acts as an agent between different groups of stakeholders, both external and internal. Besides, the stakeholder approach, in the context of a theory of a firm there is an evidence of mature business; on the other hand, in using this approach, the analysis of each managerial process separately is pointless. A stakeholder approach seems to be most appropriate, as most researchers note that an empirical study of risk management systems is difficult due to the lack of information about what corporations do inside the company, the lack of transparency and low quality of publicly available information for assessing corporate governance [45-47], and the difficulties in perceiving the system from the point of view of management as an indicator of the quality of company management [48]. Based on the foregoing, we can assume that the deeper ERM is integrated into corporate governance, the higher its efficiency and lower costs, the better chance the firm has of building a mature business [49-53].

2. Materials and methods

Given the multitasking of ERM and its variability, as well as deep integration into all corporate processes, it would be wrong to manage each factor in these processes separately. In this case, we need an indicator that will allow us to compare the inputs and outputs of the company and, based on this, assess how effective the risk management system is. Based on the task, we can assume that the signal-to-noise ratio may be the most acceptable measure of the difference between inputs and outputs. As the basic model, we will use the calculation method proposed by G. Taguchi [54] to assess product quality as well as for the design and optimization of processes.

The signal-to-noise ratio (SNR) is the reciprocal of the coefficient of variation. It measures the strength of a studied signal to the background noise. The issues of the commensurability of the signal-to-noise ratio and the correlation coefficient were studied by the authors [55-60]. This methodology is considered the most promising in terms of continuous improvement of the business strategy.

The research method used for the study was empirical. The 287 companies comprising the sample represent the Russian metal industry. We dropped companies for which at least one variable was missing, for a valid sample of 218 companies. This sample, which comprehensively represents the Russian metal industry, will shed light on the relationship between SNR and output, created by ERM. Software in which all calculations were carried out – IBM spss statistics -ver26 [61-64].

We obtained financial performance data relating to all 218 companies from the SPARK database. We calculated the geometric mean for each quantitative variable to avoid the influence of temporary shocks and distortions. Because the original data were positively skewed, signalling higher skewness, we worked with logarithms. We follow the literature on corporate risk management, corporate governance, and corporate finance to evaluate the relationship of SNR with relevant proxy.

Companies operate under the same conditions but achieve completely different results. This is largely determined by the type of organization of ownership, macroeconomic characteristics, the stage of the economic cycle, market competition, etc [65-72]. Their further development is determined by the level of risk that owners are ready to take on, as well as the entrepreneurial abilities of managers (agents). The role of management in this case is to increase the likelihood of achieving goals of a company, taking into account the specifics of the business. The probability of achieving certain goals depends, among other things, on corporate
risk management. Integrated management systems and continuous risk monitoring are most preferred. All of the above leads to our next hypothesis.

H1. The higher the signal-noise ratio, the more likely the maturity of the business is to be predicted.

3. Results and discussion

3.1 Validation of a variable and its application in business forecasting

Two-step cluster analysis is used to study the data structure, on the basis of which it will be possible to unite the sample into homogeneous groups. Initially, the number of groups was unknown. The main principles of clustering are as follows: inside the cluster, all objects are as similar as possible; this is determined based on the measure of proximity (the distance between the objects is minimal); and there is a clear distinction between clusters, which is determined based on a measure of distance (the distance between the clusters is the maximum). The principles of clustering must be respected at the same time [73-78].

The Schwartz’s Bayesian criterion was used as a clustering criterion. To assess the quality of clustering, the silhouette criterion of cohesion and separation was used. The validation of the clustering results was carried out by applying different measures of proximity and distance [79-84]. Next, we estimated a logistic regression (using the cluster membership as a reference) that predicted the likelihood that a firm will improve its maturity in comparison with other companies, Equation (1):

$$\text{Logistic (Mature companies, vs. Other)} = \alpha + \beta_1 \text{SNR} + \beta_2 \text{Costs} + \beta_3 \text{EVA} + \varepsilon_i.t + 1$$

We follow the literature in accounting and corporate finance and use R&D investment, leverage, liquidity, profitability, size, and cash flow to proxy the heterogeneity of companies. Thus, for example, in empirical studies, R&D investment is used as a criterion for long-term growth [85] and effective risk management [86-89], as well as a criterion for the stability of the company in crisis situations. As the authors note, this feature rather steadily characterizes the maturity of corporate governance. J. Tirole [90] noted that companies differ significantly in their ability to generate cash flow. This criterion is stable and may be a characteristic of the company [91].

Cash flow was used as a sign of maturity and well-being of the company. Cash flow into assets is very important in assessing the ability to buy new assets in case old assets become obsolete. According to H. Jankensgård, the expected average value of future cash flows is maximized when agents make risk management decisions that are not affected by conflicts of interest and behavioural biases [1]. In a broad sense, a positive cash flow characterizes a company’s profitability much better than profit itself. Financial leverage, on the one hand, demonstrates the preferences of companies when choosing a source of investment, on the other hand, it defines financial constraints. The size and the type of business entity were also used in cluster analysis.

In Table 1, we report the number of observations (N), the means, medians, and standard deviations (STDev) of the variables, and quartile (75% and 25%) distributions of the variables. We split the sample into public and not-public companies. In Table 2 we report the correlation between selected variables. The analysis revealed that there is a semi-strong correlation between binary variables for public companies.

| Table 1. Descriptive Statistics |
|--------------------------------|
| **SNR** | 218 | 92.76 | 225.66 | 159.5291 | 23.79244 |
| **Size** | 211 | 18.46 | 26.73 | 22.1016 | 23.79244 |
| **Intangibility** | 136 | -16.87 | -1.26 | -8.3812 | 3.00499 |
| **CEO_tenure** | 139 | 0.00 | 2.77 | 1.6783 | 0.88909 |
| **Leverage** | 207 | -7.69 | 1.36 | -0.5590 | 0.91563 |
| **Profitability** | 158 | -4.61 | 0.04 | -2.7260 | 1.06155 |
| **Liquidity** | 211 | -26.11 | -17.50 | -21.5770 | 1.93949 |
Table 2. Correlations

|               | Leverage | Profitability | Intangibility | Liquidity | NegCF |
|---------------|----------|---------------|---------------|-----------|-------|
| **Size**      | Correlation Coefficient | 1,000 | 0.591** | 0.570** | 0.667** | 0.523** | 0.470** |
| Sig. (2-tailed) | .        | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | |
| No            | 538      | 538 | 538 | 538 | 538 | 538 | |
| **Leverage**  | Correlation Coefficient | 0.591** | 1.000 | 0.519** | 0.665** | 0.638** | 0.483** |
| Sig. (2-tailed) | 0.000   | . | 0.000 | 0.000 | 0.000 | 0.000 | |
| No            | 538      | 538 | 538 | 538 | 538 | 538 | |
| **Profitability** | Correlation Coefficient | 0.570** | 0.519** | 1.000 | 0.541** | 0.630** | 0.553** |
| Sig. (2-tailed) | 0.000   | 0.000 | . | 0.000 | 0.000 | 0.000 | |
| No            | 538      | 538 | 538 | 538 | 538 | 538 | |
| **Intangibility** | Correlation Coefficient | 0.667** | 0.663** | 0.541** | 1.000 | 0.668** | 0.381** |
| Sig. (2-tailed) | 0.000   | 0.000 | 0.000 | . | 0.000 | 0.000 | |
| No            | 538      | 538 | 538 | 538 | 538 | 538 | |
| **Liquidity** | Correlation Coefficient | 0.523** | 0.638** | 0.630** | 0.668** | 1.000 | 0.469** |
| Sig. (2-tailed) | 0.000   | 0.000 | 0.000 | 0.000 | . | 0.000 | |
| No            | 538      | 538 | 538 | 538 | 538 | 538 | |
| **NegCF**    | Correlation Coefficient | 0.470** | 0.483** | 0.553** | 0.381** | 0.469** | 1.000 |
| Sig. (2-tailed) | 0.000   | 0.000 | 0.000 | 0.000 | 0.000 | . | |
| No            | 538      | 538 | 538 | 538 | 538 | 538 | |

** Correlation is significant at the 0.01 level (2-tailed).

The result is a model with six significant variables (Figure 1), and two clusters were obtained. The Bayesian Information Criterion (BIC) is of 1594.182 for the first one and 77,412 for the second one. The silhouette measure of cohesion and separation is sufficiently high (Figures 2-3). The second cluster (21% of sample) is presented with companies of large size, with positive profitability and sufficient liquidity. The financial leverage of these companies is more than one-third of total assets and presented with long-term debt. These companies usually invest in R&D but have negative CF in this current year. The predictor importance of these inputs is more than 0.6 [92-95].

![Figure 1. Predictor importance of variables](image-url)
Thus, 79% of companies look rather weak. These companies are of medium size, usually issue expensive short-term debt, and do not invest in sustainable growth. Thereby these companies do not meet the expectations set for public companies and are not under the interest of strategically oriented stakeholders. The companies included in the second cluster initially have inputs equal to the first cluster. The companies in this cluster are the result of the entrepreneurial management skill, which has found its own mechanism for the efficient use of factors affecting the transaction costs and sustainable growth. Long-term investments, diversification of investment projects, and as a result the sustainable profit and liquidity are the core of survival of any company.

In our study, we assume that corporate risk management will crowd out fewer promising companies towards more resilient ones, more interesting for stakeholders. The result is a model with three significant variables, and two clusters were obtained. The silhouette measure of cohesion and separation is sufficiently high. The first cluster (27% of sample) is presented with companies of medium size, with negative or zero profitability and zero R&D investment. Other variables are not significant in the model [96-98]. The results were verified by the Chi-square test, which confirmed the statistical significance of differences within groups. So, we have four different clusters both for public and not-public companies based on financial performance. Companies significantly differ from each other in size, size of debt, positive return on business, and long-term investments. Currently, 21% of companies have no problems with liquidity, but the cash flow is negative, which may be due to large investments made the day before [99-101].

3.2 The real effect of SNR on companies

Corporate risk management is provided by economic channels through which corporate governance affects the company’s maturity. Excessive passion for managing value added does not necessarily imply optimality, since it can also mean over-investment, which reduces efficiency and increases the costs of the company. To solve
this problem, we tested the effect of costs, economic value added, and SNR on the firm to study the real impact of ERM [102-108]. In Table 3 we report the number of observations (N), the means, medians, and standard deviations (STDev) of the variables, and quartile (75% and 25%) distributions of the variables. In Table 4 we report the correlation (Spearman Rho) between selected variables. The analysis revealed that there is a semi-strong correlation between cluster membership and SNR and SGA [109-111]. There is no linearly significant relationship between EVA and cluster membership. The results of model 1 are reported in Table 5.

Table 3. Descriptive Statistics

|                  | SNR Mean | SGA Mean | EVA Mean |
|------------------|----------|----------|----------|
| No Valid         | 135,97756| -2,03937 | -1,49814 |
| No Missing       | 31,810561| 1,628979 | 1,920455 |
| Minimum          | 68,480   | -10,835  | -9,249   |
| Maximum          | 196,460  | 1,851    | 4,169    |
| 25               | 109,85500| -2,60967 | -2,58527 |
| Percentiles      | 135,78000| -2,25542 | -1,51244 |

Table 4. Correlations

|                  | Cluster membership | SNR | SGA | EVA |
|------------------|--------------------|-----|-----|-----|
| Spearman’s rho   | 1,000              | 0,325**| -0,407**| -0,130|
|                  | Sig. (2-tailed)    | .   | 0,002| 0,000| 0,222|
|                  | No                 | 90  | 90  | 90  | 90  |
| SNR              | 0,325**            | 1,000| -0,330**| 0,014|
|                  | Sig. (2-tailed)    | 0,002| .   | 0,001| 0,896|
|                  | No                 | 90  | 90  | 90  | 90  |
| SGA              | -0,407**           | -0,330**| 1,000| 0,228*|
|                  | Sig. (2-tailed)    | 0,000| 0,001| .   | 0,031|
|                  | No                 | 90  | 90  | 90  | 90  |
| EVA              | -0,130             | 0,014| 0,228*| 1,000|
|                  | Sig. (2-tailed)    | 0,222| 0,896| 0,031| .   |
|                  | No                 | 90  | 90  | 90  | 90  |

**Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 5. Variables in the Equation

| Step 1* | B     | S.E.   | Wald  | df | Sig.  | Exp(B) |
|---------|-------|--------|-------|----|-------|--------|
| SNR     | 0,018 | 0,009  | 3,750 | 1  | 0,050 | 1,018  |
| SGA     | -0,586| 0,225  | 6,774 | 1  | 0,009 | 0,557  |
| EVA     | -0,099| 0,135  | 0,544 | 1  | 0,461 | 0,906  |
| Constant| -2,586| 1,218  | 4,512 | 1  | 0,034 | 0,075  |

*Variable(s) entered on step 1: SNR, SGA, EVA.

The coefficient estimate of the relationship between SNR and dependant variables is significant at the 5% level and positive in Model 1, indicating that SNR has a positive impact on cluster membership. At the same time, SGA is significant at the 1% level and negative to cluster membership. EVA is not significant in the model; however, Omnibus Tests of Model Coefficients (Table 6) suggest that adding a variable to the model...
is justified and significant at 0.001. The determination coefficient is very low (Table 7) [112-114] and shows that only 28% of the response variation is explained by the variation of model variables. According to the Hosmer and Lemeshow test (Table 8), the model is adequate; the statistical significance is above 0.5 and equal to 0.647.

Table 6. Omnibus Tests of Model Coefficients

| Step    | Chi-square | df | Sig. |
|---------|------------|----|------|
| Step 1  | 19,362     | 3  | 0.000|
| Block   | 19,362     | 3  | 0.000|
| Model   | 19,362     | 3  | 0.000|

Table 7. Model Summary

| Step | -2 Log likelihood | Cox & Snell R Square | Nagelkerke R Square |
|------|-------------------|----------------------|---------------------|
| 1    | 86,989*           | 0.194                | 0.279               |

Estimation terminated at iteration number 5 because parameter estimates changed by less than 0.001.

Table 8. Hosmer and Lemeshow Test

| Step | Chi-square | df | Sig. |
|------|------------|----|------|
| 1    | 6,000      | 8  | 0.647|

The average classification percentage is 74%, which means that cluster membership predicted by the logit model is 74%, the same as predicted (Table 9). The asymptotic significance of the ROC-curve (Table 10) is less than 0.05 and equal to 0.000. The constructed model predicts the probability quite well [115-117]. Thus, we can assume that the contribution of ERM to the company is significant, which was confirmed in our hypotheses.

Table 9. Classification Table

| Observed | Cluster Membership | Predicted | Percentage Correct |
|----------|-------------------|-----------|--------------------|
|          | Cluster Membership | 1         | 2                  |                     |
|          | Overall Percentage | 2         | 19                 | 46                 | 84.0               | 70.8               | 74.4               |

The cut value is 0.750.

Table 10. Area Under the Curve

| Test Result Variable(s): Predicted probability | Area | Std. Error* | Asymptotic Sig. ** | Asymptotic 95% Confidence Interval |
|-----------------------------------------------|------|-------------|-------------------|-----------------------------------|
|                                               | 0.781| 0.055       | 0.000             | Lower Bound 0.673 Upper Bound 0.888 |

* Under the nonparametric assumption.
** Null hypothesis: true area = 0.5.

4. Conclusions

In this paper, we predicted a company cluster based on signal to noise ratio. Two-step cluster analysis revealed that only 21% of companies have satisfactory results and may be of interest to interested parties as an object of long-term relationships. The coefficient of determination of the model, explaining the impact of SNR on the welfare of the company, is small enough, but sufficient to study the real contribution of ERM. On the path to maturity, ERM is a more necessary step than a means of creating a mature company. Our findings are supported by the most recent work in the theory and practice of corporate risk management, that state that
corporate risk management and corporate governance are inseparable, the higher the integration, the higher the effect.

In this study, the relationship between risk management and transaction costs, as well as their combined effect on the maturity of the company, is not sufficiently studied. The study can be qualitatively improved by comparing the results of random walks and the logistic model. Of considerable interest is the ability of ERM to mitigate the effects of information asymmetry, which in the long term brings more losses than the risks of internal business processes.

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