Optimisation of Studies Designed to Diagnose Companies using Econometric Models based on Subtle Sets

Ion IONITA *, Alice SOARE **, Adelina GRAPA***, COSTEL SERBAN****

ABSTRACT
In this article, the authors intend to demonstrate the possibility of perfecting company diagnosis studies by means of applying econometric models based on subtle and fuzzy sets. To be more precise, we shall refer to those elements of general diagnosis employed in order to determine and analyse a company’s economic and managerial viability potential, as well as the company personnel’s creation and innovation capacity. According to the literature in the field of company diagnosis, these elements are identified by resorting to simplistic models, which bring about a series of inaccurate factors that may be disposed of by applying subtle sets. We believe that the econometric models structured on subtle sets and fuzzy sets may provide thoroughly substantiated information concerning the state a company finds itself in at the time of the diagnostic. In our study we shall present both the methodology for elaborating these models, as well as the significance of applying them in the analysis of a company’s development horizon.

1. Introduction
In order to diagnose a company’s economic and managerial viability potential, a series of models are employed, the more common of which are the Altman Z-Score, the model of matrixes for assessing internal and external factors, the model of assessment criteria. In the case of the Altman Z-Score, the most commonly used, the essence of diagnosis is provided by the five business performance criteria, based on which a company’s viability is assessed [8]. The criteria are marked with the letter \( x_n \), where \( n \) has values from 1 to 5, as follows:

a) The company’s flexibility degree (\( x_1 \)), which is determined as the ratio between the floating assets and the total assets;
b) The possibility of financing assets from profits (\( x_2 \)), expressed as the ratio between the net reinvested profit and the total assets;
c) The organisation’s capacity to obtain profit (\( x_3 \)), determined as the ratio between the gross profit and the total assets;
d) The rate of debt (\( x_4 \)), which is determined as the ratio between the value of the shares and the total debts;
e) The return on assets (\( x_5 \)), established as the ratio between the turnover (CA) and the total assets.

Each parameter receives an assessment score, based on its importance judged by the assessor, a score used as a weight factor upon the level of the corresponding ratio and, by way of addition, we obtain the company’s economic viability (\( Z \)). The \( Z \) parameter obtained is compared with certain levels whose value is subjectively set forth based on the assessor’s judgement. Based upon these levels one can outline the state of the diagnosed company, as follows: it is on the brink of bankruptcy; it faces difficulties that may, however, be overcome if the future owner takes restructuring and revamping measures; it is viable and on track to score profit.

We believe that these states a company may find itself in at the time of the diagnosis may be determined with high accuracy by resorting to econometric models based on the theories of subtle sets and fuzzy sets.

2. The analysis of information accuracy regarding the company’s development horizon
During the diagnosis study preparation phase, the team of analysts collects from the company executives information regarding the projected evolution of the main economic and financial indicators for
the following five years. The essential objective pursued by the analyst during this phase is the accuracy of
the acquired information as the projected information may be erroneously assessed, either due to the
professional competence level of the people who compiled it, or as a result of subjective factors stemmed
from the company executives’ interests pursued in relation to the study results. Therefore, the diagnosis team
is bound to verify such information to the best possible extent.

If the analyst lacks the means to accurately determine the reliability of this information, they may
still formulate estimates of an acceptable accuracy level, based on a coherent analysis, starting from actual
information related to the period prior to the diagnosis and information synthesized within the general
diagnostic, as well as from the projections of development scenarios at the economy and the business
segment levels. For instance, the company executives may provide, for the future fiscal years, forecasts whose
progression does not coincide with the previous evolution. In this case, the analyst will be able to reduce the
risk of not accomplishing such evolutions by adopting particular parameters within the projection methods,
especially for the discount rate. Similarly, a weighted average of the profits over the past three years may help
in the projection of future profits. Moreover, the information synthesized within the general diagnostic allow
the performance of estimates on the company’s future evolution, in accordance with the previously defined
strong and weak points, with a major emphasis on its ability to generate positive results in the long run. The
analyst has to demonstrate, with pertinent arguments, the viability of these perspectives. The proposals to
restructure, to abandon segments and products, to introduce new technologies and assimilate products shall
be quantified at a value level, and the projected results shall be subsequently used in the company’s actual
diagnostic process.

In the case of companies with currently weak results, the short-term progress study shall be
supplemented with an analysis on the treasury evolution and, in the long run, with the feasibility analysis of
the recovery programmes and of the projected results following their implementation. Useful arguments in
assessing the projection accuracy may also be those related to the development scenarios at a
macroeconomic level and of the company-specific business segment, by borrowing the values projected for
the next five years.

3. The assessment of the factors that influence risk and the chances of profit

The influence factors may be determined in a static and dynamic (tendentially) manner. Among the
static influence factors we shall mention the following:

- the ratio between the organisation’s annual losses \( p_h \) and annual profit \( P_h \), namely \( \frac{P_h}{p_h} \);

- the ratio between the receivables \( CR \) and the turnover \( CA \), namely \( \frac{CR}{CA} \);

- the ratio between the annual debts \( d_h \) and the annual profit, namely \( \frac{d_h}{P_h} \);

- the ratio between the management non-quality score \( PN \) and the management quality score \( PC \) granted by
  the internal audit, namely \( \frac{PN}{PC} \);

- the ratio between the average index of annual growth for the prices of raw materials, materials and semi-
  finished items \( I_{ms} \) and the average growth index for the price of finished items \( I_{pf} \), namely \( \frac{I_{ms}}{I_{pf}} \), etc.

Each of these factors, calculates over one year, may turn into a tendentially indicator, over a T time
frame (as a rule, T=5 years). The data are obtained from the projections elaborated for the analysed
companies and we shall write them down as follows:

\[ \Delta p_h, \Delta P_h, \Delta CR, \Delta CA, \Delta d_h, \Delta PN, \Delta PC, \Delta I_{ms}, \Delta I_{pf} \]  

For each influence factor one may consider a fuzzy set which, in the theory of subtle sets, is called a
thread. For example, for the \( \frac{P_h}{p_h} \) ratio we obtain a fuzzy set whose affiliation degrees are provided by the
relation:

\[ \mu_{\Delta P_h/\Delta p_h}(\frac{P_h}{p_h}) = e^{-k_1 \frac{P_h}{p_h}}, \text{ for } P_h \geq P_{h_{min}} \]  

where: \( k_1 \) – a coefficient determined by the experts based on the importance of the criterion taken into
account;

\( P_{h_{min}} \) – minimum profit, as determined by the experts

This degree of affiliation reflects the company's property of having the chance to make profits. For
the tendentially indicator the relation below is used:

100
\[
\Delta p_h \Rightarrow \mu_c \left( \frac{\Delta p_h}{\Delta p_h} \right) = e^{-\frac{\Delta h}{\Delta h_{\text{ms}}}},
\]

where, \(\Delta p_h>\Delta p_{h\text{min}}\), where \(k^{-1}\) - the significance coefficient assigned by the experts to the tendentially indicator;
\(\Delta p_{h\text{min}}\) - the minimum profit bonus, determined by the experts. If \(p_h<p_{h\text{min}}\) then relation (2) becomes:
\[
\mu_c \left( \frac{p_h}{p_h} \right) = e^{-\frac{p_h}{p_h_{\text{ms}}}}, \text{ where } p_h<p_{h\text{min}}
\]

Likewise, if \(\Delta p_h<\Delta p_{h\text{min}}\) then relation (3) becomes:
\[
\mu_c \left( \frac{\Delta p_h}{\Delta p_h} \right) = e^{-k^{-1} \frac{\Delta h}{\Delta h_{\text{min}}}}, \Delta p_h<\Delta p_{h\text{min}}
\]

One can apply the same method to all the considered criteria, and ultimately aggregate them using a multiplying procedure. The result is a total degree of affiliation featured by the profit-obtaining property, \(\mu_c\), in the form below:
\[
\mu_c = e^{-k^{-1} \frac{p_h}{p_h_{\text{ms}}} e^{-k^{-1} \frac{\Delta p_h}{\Delta p_h_{\text{ms}}} e^{-k^{-1} \frac{\Gamma_{\text{CA}}}{\Gamma_{\text{CA}_{\text{ms}}}} e^{-k^{-1} \frac{\Gamma_{\text{PF}}}{\Gamma_{\text{PF}_{\text{ms}}}} e^{-k^{-1} \frac{\Gamma_{\text{PN}}}{\Gamma_{\text{PN}_{\text{ms}}}}}} e^{-e}}}
\]

By way of analogy, one may determine the risk of incurring losses by using the company's unfavourable influence factors. These may be obtained by reversing the ratios used to determine the chances of profit. As such, by analogy with relation (4), one will obtain the total degree of affiliation to the risk of incurring losses, that is:
\[
\mu_r = e^{-\frac{\Delta h}{\Delta h_{\text{ms}}}}
\]

The comparison between the affiliation degree of the company's profit-making property \(\mu_c\) and the affiliation degree of the company's property of facing the loss-incurring risk \(\mu_r\) may stem the following relations:

A) \(\mu_c >> \mu_r\), the company is highly profitable.
B) \(\mu_c > \mu_r\), the company is profitable, usually not threatened by bankruptcy, but facing the possible danger of situations leading towards bankruptcy;
C) \(\mu_c \equiv \mu_r \equiv 0.5\), the company is in dire danger of bankruptcy. The degree of doubt concerning the chances of saving the company is high. One may calculate a degree of confidence \(g_{\text{rf}}\) in assessing the state of the company by using the relation:
\[
g_{\text{rf}} = \begin{cases} 1 - e^{-\lambda (\mu_c - \mu_r)}, & \mu_c \geq \mu_r \vspace{1mm} \\
1 - e^{-\lambda (\mu_c - \mu_r)}, & \mu_c > \mu_r \end{cases}
\]

where: \(\lambda\) - a coefficient assessed by the experts.

We may see that \(g_{\text{rf}} \rightarrow 0\), if \(\mu_c \equiv \mu_r\), which means that when the chances of making profit are just as high as the chances of incurring losses, the degree of confidence in assessing the state of the company tends towards zero.

D) \(\mu_c < \mu_r\), the company is on the brink of bankruptcy. According to relation (6), the higher the difference between \(\mu_c\) and \(\mu_r\), the higher the degree of confidence in this statement.

Consequently, we can rank companies based on the bankruptcy risk criterion, depending on the differences, in a descending order, between the degree of affiliation to the company's property of facing the risk of losses \(\mu_r\) and the degree of affiliation to the company's property of making profit \(\mu_c\).

### 4. The assessment of the company personnel's creation and innovation capacity

For this item we wish to demonstrate that the models we present may be applied to diagnose all of the company's functions.

In the company diagnostic studies, the assessment of the personnel's creation and innovation capacities, as the essential element of the research and development function, represents a significant requirement, particularly when they serve a process of establishing the company's market value. The possession of such a capacity by the company staff implicitly leads to the increase of profit and obtaining extra profit or goodwill, respectively. An accurate assessment of a company's goodwill/badwill influence factors may be conducted by using the GERT (Graphical Evaluation and Research Techniques) method, assisted by subtle sets, where the scoring method also applies. For each invention/innovation one may
determine both the profit bonus $\Delta P$ effectively obtained after its implementation, as well as the total PT score estimated for it by the experts. The result is an economic efficiency statistical indicator of the $-i$ ranked company, with the following form:

$$\Pi_{ei} = \frac{\Delta P}{PT}$$

Similarly, one may assess the efficiency of the $-i$ ranked company based on other global criteria, such as the environmental, ergonomic, psychological ones, etc.

In the case of an interdisciplinary team of economists, engineers, environmentalists, biologists, sociologists, psychologists, etc., one may determine the usefulness bonus of the innovation/invention applied within the $-i$ ranked company, marked $\Delta U_i$. This method of expressing efficiency shall be marked as $\hat{\Pi}_{ei}$, $\hat{\Delta}c_{ei}$, $\hat{\Delta}erg_{it}$, $\hat{\Delta}psi$, etc. for the global environmental, ergonomic, psychological, etc. criteria in the assessment of the $-i$ ranked company's activity.

If the interdisciplinary team monitors the dynamics of these criteria, they will obtain the efficiency indicators: $\hat{\Pi}_{eti}$, $\hat{\Delta}c_{eti}$, $\hat{\Delta}ergit$, $\hat{\Delta}psi_t$ etc. where $t \in \{1, 2, ..., T\}$ and $T$ is the forecast perspective considered by the experts. In this case one will actually obtain a partial evolution of the global and analytical performance of all the disciplines that are part of the interdisciplinary collective. Monitoring all the partial evolutions of all the interdisciplinary teams in the world, one may obtain a qualitative projection "in the vicinity of" the total one, in which case the interdisciplinary team tends towards what the philosophers call transdisciplinarity (the cooperation of the technical, economic, biological, etc. disciplines leads to the favourable evolution of each of those taking part) and capitalizes on the ideas of numerous academics, including Romanian ones, who brought significant contributions to the development of world science.

5. Conclusions

Determining the economic and managerial viability potential is a mandatory requirement of the studies focused on company diagnostic or estimating a company’s market value. In order to determine this potential, we currently use subjective, non-scientific methods that may lead to false results in relation to a company’s actual state and, consequently, to flawed management decisions.

We believe that the main weakness of these methods is that of not providing information regarding the factors that generate added value, business value and within the latter, the value of the so-called Goodwill, in the absence of which one cannot accurately determine a company’s economic and managerial viability potential. The goodwill, which represents the profit surplus obtained by the analysed company as a result of additional returns in comparison with the other business operators in the field, is the essential factor which dictates both the scope of a company’s economic and managerial viability potential, as well as its market value.

By applying the econometric models based upon the theories of subtle and fuzzy sets, one may obtain accurate information related to both the factors determining the goodwill value, as well as the share each of these factors add up to its formation. Furthermore, the model we presented may be used to diagnose any function of a company, a vital necessity within the specific processes taking place in the market economy, such as privatisation, sale, division, fusion, etc. The partners engaged in these processes are also interested in knowing the factors that generate goodwill, including their share in the process. And this objective may be accurately achieved, as described in the article, precisely by using the econometric models based on the theories of subtle sets and fuzzy sets.

References