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Chair of Business Valuation

# Corporate failure prediction in the Italian energy sector: application of the Altman Z-score and Ohlson O-score model

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**Introduction**

The purpose of this thesis is to verify the predictive ability of Altman's Z-score model applied to Italian unlisted companies belonging to the energy sector. Specifically, through an ex-post analysis on a sample of companies that failed in previous years, the study aims to understand whether Z-Score is more reliable in this sector of application compared to other industries in different countries. In addition, Ohlson's model is also applied to the same sample to check if the result obtained from the implementation of the first method is confirmed.

In order to get to the research question, it is appropriate to start from the final considerations of the paper *Can Z-Score Model Predict Listed Companies' Failures in Italy? An Empirical Test* written by Massimiliano Celli in 2015. He studied a sample of Italian listed companies belonging to different sectors and came to the conclusion that *"the predictive ability of the Z-score in the Italian context tends to be lower than that measured by Altman. In our opinion, this difference is "physiological," as the model was built and tuned with reference to companies and markets qualitatively different from the Italian ones"*[1].

So, this thesis aims to extend the study conducted by Celli. In particular, the present work intends to demonstrate if, using as a sample unlisted companies belonging to a single industry (that of the energy sector), the predictive ability of the Z-Score turns out to be better than in the case analyzed by other authors in different countries and whether this ability turns out to be confirmed by the O-Score model as well.

Therefore, the research question is the following:

*"Is the degree of accuracy and reliability of the Z-score applied to unlisted Italian companies operating in the energy sector comparable to that obtained by other researchers in tests conducted in other countries in different sectors? Does Ohlson's model, for the same conditions, turn out to confirm this thesis?"*

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[1] Celli Massimiliano, (2015) *Can Z-Score Model Predict Listed Companies' Failures in Italy? An Empirical Test*

In more detail, this thesis is composed of four sections.

The first chapter - *The distressed firms* - aims to analyze the definition and characteristics of financial distress from a theoretical point of view. In particular, there is an overview that points out the factors that lead companies to reach this state of distress and for which four different stages of corporate crisis can be identified. In addition, considering that the typical valuation methods for this type of enterprises are not always accurate, it is useful to make a generalization of the characteristics that they may present in this condition. Finally, there is a focus on the two key models of the thesis, the Altman Z-Score and the Ohlson O-Score. They are described in detail from their initial construction to the most relevant properties.

The second chapter - *Literature Review* - aims to analyze existing literature related to the study and application of the two predictive models mentioned above. In the first part of the chapter, there is an analysis of papers related to bankruptcy prediction of companies in the energy sector in Europe. Then, several papers were taken into examination regarding the application of the two predictive models, Altman and Ohlson, on different industries in various countries. At the end, a summary table is provided showing the predictive accuracy rates of the Z-Score related to several countries and different industries obtained from the research analyzed.

The third chapter - *The analysis* - represents the actual analysis in support of the present work. In the first part it is present a description of the sample of firms and the approach that is intended to be used. Subsequently, there is the practical application of the two models to the above sample in which each enterprise is examined individually and accompanied by a comprehensive explanation of the results obtained from an economic perspective.

The last section of this paper - *Conclusions* - shows the results obtained from the analysis carried out in the previous chapter.

**Chapter 1 – The financial distressed firms**

*1.1 Definition and characteristics of financial distress*

The phenomenon of business distress has always been the subject of extensive debate by Italian and international management literature. During the past fifty years, there have been numerous studies conducted to evaluate the financial health of a firm.

Concerning a general definition of bankruptcy, it is possible to define it as a condition in which a company can no longer continue to operate properly due to the experiencing of financial difficulties.

In particular, financial distress or bankruptcy usually occurs when current liabilities exceed current assets or when the amount of liabilities is greater than the fair value of assets. Moreover, these two distress conditions can have a very serious impact on the world economy if they affect leading enterprises.

*Ramadhani and Lukviarman* (2009) and *Ghosh* (2013) focused on asserting that a bankrupt firm is characterized by a decrease in the company's financial condition that persists for a continuous and extended period of time.

In recent years, however, interest on the topic has been intensified as a result of the increasing frequency of cases of insolvency and weakening of the survivability of numerous enterprises, which, in multiple circumstances, have resulted in the loss of their viability and, in the most serious situations, bankruptcy.

*"An industry is distressed if the median sales growth of pure play firms in an industry is negative and the median stock return is -30%"* (*Opler T.C. & Titman S.,1994*).

In Italy, a very important definition of crisis has been proposed by *Luigi Guatri*[2]. It is expressed in terms of the theory of value and is based on the one hand on the awareness that the enterprise, in the course of its life cycle, will inevitably have to face moments of crisis (hence the need to develop a doctrine of "permanent reorganization") and, on the other hand, on the understanding that crisis can be related to business events (decrease in flows) but also to the changing of the external environment (changing risk conditions).

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[2] Guatri L., (1995) *Turnaround. Declino crisi e ritorno al valore, Egea, Milano*

The causes of financial distress can derive from internal or external sources. The former can be summarized as inexperience of managers and incompetence regarding the effective management of assets and liabilities. The latter can be summarized as factors like depreciation of foreign currencies, inflation, legal system, and taxes.

Although it is not possible to identify all possible factors that lead companies to reach this state of crisis, it is important to list the most common ones[3].

- *Poor operating performance and high financial leverage*: due to poorly executed acquisitions, international competition, overcapacity, new channels of competition within an industry, commodity price shocks, and cyclical industries
- *Lack of technological innovation*: whenever technological innovation occurs, it creates negative shocks for firms that do not adapt to the innovation. The same happens for firms that possess related but less competitive technologies
- *Liquidity and funding shock*
- *Relatively high new business formation rates in certain periods*: new businesses have a higher failure rate than businesses that are in a mature state
- *Deregulation of key industries*: deregulation removes the protective cover of a regulated industry by going to favor the entry and exit of more firm. In addition, in a deregulated environment there is a greater presence of competition
- *Unexpected liabilities*: firms can fail due to off-balance sheet contingent liabilities that suddenly become significant liabilities on the balance sheet.

The state of corporate crisis cannot be determined according to a "static" mode but must be identified and analyzed by taking into consideration a particular time frame of the company's life.

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[3] Altman, (2019) *Corporate financial distress restructuring and Bankruptcy*

Following this logic, four different stages of corporate crisis can be identified[4]:

- *Incubation*: this is the first phase. At this stage, the first effects of the crisis can be identified, such as a decline in the value of production or surplus inventory. During this phase, however, it is possible to implement the so-called "quick win" actions with the aim of converting the crisis phase into a reversible status that present achievable effects already in the short term.

- *Maturation*: this is the second phase. At this stage, the effects of the crisis present negative impacts that can be seen from the operating accounting results. This means that they have a duration of more than 12 months. At this point, it is possible to convert the crisis to a reversibility status with the implementation of more significant actions that also have effects in the medium-term.

- *Insolvency*: this is the third phase. At this stage, the company is no longer able to meet its obligations to creditors normally. This situation creates difficulties in the management of working capital, the procurement process of raw materials and the supply of products to end customers. At this point, the actions that can be implemented are those related to the company's strategic "turnaround", such as initiating extraordinary finance actions and debt restructuring.

- *Bankruptcy*: is the fourth and final phase. At this stage, the company has disclosed its state of insolvency in the market and has been unable to initiate "turnaround" actions to bring the crisis back to a state of reversibility. At this point, the only way forward is to initiate bankruptcy proceedings of a judicial or extrajudicial nature.
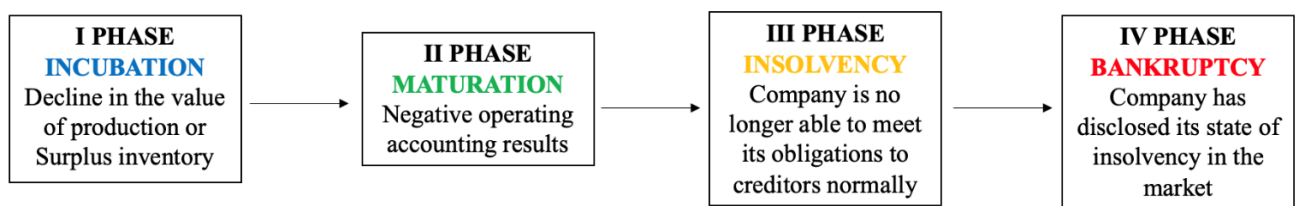


*Figure 1 - Own elaboration*

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[4] Gualtri L., (1995) *Turnaround. Declino, crisi e ritorno al valore*

Another study conducted by *Fitzpatrick* in 1932, on the other hand, showed that there are five different stages which are: *(1) incubation, (2) financial embarrassment, (3) financial insolvency, (4) total insolvency, and (5) confirmed insolvency*. Specifically, the difference with the previous study is that in the latter, insolvency is confirmed first at the financial level, when the firm is unable to collect the sufficient money to meet its obligations, and then at the total level, when liabilities exceed physical assets.

Companies that are facing a crisis can be distinguished by a financial or an economic disequilibrium. The financial disequilibrium is characterized by the complexity in repaying their own financial debts, while the economic disequilibrium is characterized by the presence of negative margins in their own Profit & Losses statements.

In this context, it turns out that the evaluation process is more complicated and for this reason further analysis, divided into two different steps, must be carried out. The first step is the assessment of the distress, in which fundamental analysis is implemented with the aim of identifying and understanding the causes of the crisis.

At this stage, through the study of the intensity and structure of losses, it is possible to understand the actual probability of the company's recovery.

The second step is represented by the choice of the valuation method best suited to the crisis situation in which the firm is placed.

The internationally accepted valuation methods are the following divided into different criteria[5]:

- *Cost criterion*: includes asset methods
- *Cash flows criterion*: includes financial and income methods
- *Market criterion*: includes stock exchange multiple and comparable transaction methods
- *Mixed criterion*: includes mixed methods

However, the evaluation of enterprises in crisis cannot be equated with the evaluation of companies that are not in such a state. In fact, the use of an unsuitable method may lead to results that are far from reality.

So, because the firm is in a distressed phase, normal valuation methods must be filtered and adapted to the real context of crisis in which the company is located.

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[5] Vulpiani, (2014) *Special cases of business valuation, McGraw-Hill*

For this reason, not all the above valuation methods can be used in this circumstance.

The best ones are represented by the financial methods (above all the APV – Adjusted Present Value) "*thanks to their flexibility in modelling companies results evolution*"[6] .

| | Valuation Methodology | | | | | | |
|---|---|---|---|---|---|---|---|
| Crisis degree | DCF | Changing Capital Structure | APV | Mixed | Asset-based | Option value | Multiples |
| **Very Strong** not recoverable | ○ | ○ | ○ | ○ | ● | ● | ○ |
| **Strong** recoverable | ○ | ● | ● | ● | ○ | ◑ | ○ |
| **Medium** | ● | ● | ● | ● | ○ | ○ | ○ |
| **Weak** | ● | ◔ | ● | ● | ○ | ○ | ◔ |

*Figure 2 - Special cases of business valuation, Vulpiani, McGraw-Hill, 2014*

To explain why companies in decline create greater difficulties for analysts in evaluating them, it is appropriate to refer to the characteristics they may present in this condition. Obviously, not all of them present the same set of situations, but it is possible to make a generalization[7]:

- *Declining or stagnant revenues*: it is the most significant signal and may constitute an operational weakness when revenues grow less than the rate of inflation.
- *Negative or declining margins*: this is a condition that usually is associated with revenue stagnation. There are many reasons for this, including a decrease in prices to prevent further diminish in revenues and loss of pricing power. This combination can be interpreted in a deteriorating or a negative operating income in these companies, with an occasional profit jump created by spot profits or asset sales.
- *Asset divestitures*: they are more frequent in distressed firms than in early-stage companies because it is common that existing assets are more valuable to others who intend to put them to a different and better purpose. For this reason, if the declining firm is in a situation of high debt, there will be a greater probability of divestment to reduce debt and specially to avoid default.

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[6] Vulpiani, (2014) *Special cases of business valuation*, *McGraw-Hill,* p. 249

[7] Damodaran, (2009) *Valuing distressed and declining companies*

- *Large payments-dividends and share repurchases*: distressed firms are characterized by little value-generating growth investments, existing assets that can produce positive cash flows, and asset divestitures that create cash inflows. For this reason, if the firm does not have so much debt that becomes a problem, it is fair to assume that distressed firms pay large dividends that can sometimes turn out to be higher than earnings and buy back their own shares.
- *Financial leverage – the downside*: debt has always been considered a double-edged sword. However, distressed firms turn out to be, very often, exposed to the wrong side. In fact, these companies in many cases face a large amount of debt caused mainly by stagnant or declining revenues due to existing assets and poor potential earnings growth. It is useful to point out that most of the debt was probably acquired at an earlier time when the company was in a healthier stage of its life cycle. So, firms will find themselves in a difficult situation not only to meet the obligations they had committed to, but also to refinance the debt as lenders will demand stricter terms.

So, the financial structure of a firm is identified as the set of financing sources and represents, from a dynamic financial sustainability perspective, the maximum amount of debt "tolerable" by the company. This view of investigation is particularly useful for the purpose of examining the financial structure of the firm in crisis, since it is clear that the natural effect of the "non-sustainability" of the debt-to-equity ratio can only be the manifestation of financial stress and, ultimately, insolvency.

Financial disequilibrium is generative of economic losses because the recognition of losses in excess of one-third of the legal minimum not only requires the shareholders to resolve the recapitalization or, alternatively, the dissolution of the company (i.e., transformation into an "inferior"), but also determines a limitation on operations.

In summary, the financial/equity imbalance crisis, is characterized by:
- The severe shortage of equity (by way of capital) and corresponding clear prevalence of means by way of debt.
- The clear prevalence of short-term debt over other categories of debt and imbalances between durable investments and stably available financial means.
- The insufficiency or non-existence of cash reserves.

Financial and capital balance ratios are widely used by financial operators and in particular by lending institutions in order to assess the creditworthiness and the financial risk of the company. The reclassification of financial statements constitutes and provides, in itself, a "real" view of the firm's condition. For the identification of crisis situations, it is appropriate to construct certain parameters and indexes functional to an immediate detection of the economic and financial risks that the business could run in the immediate future.

In addition, the system of indices is more relevant as its application is constant over time.

In fact, the systematic and periodic comparison can highlight key economic and financial trends at the management level.

In order to make a final judgment on the business condition, it is useful to take into analysis not only balance sheet ratios derived from internal information, but also indicators built on extra-accounting quantities.

Finally, analysts used to apply predictive models of failure in order to assess the health of a particular company. They can be divided into two different categories depending on whether they are based on accounting ratios or market values.

*1.2 Altman Z-score*

The Altman Z-score belongs to the category of predictive models based on accounting ratios. Unlike *Beaver (1966, 2005)* who used ratio analysis models and *Ohlson (1980)* who utilized regression models, *Altman (1968, 2006)* implemented discriminant analysis models[8]. Since a number of variables are combined simultaneously to examine a company for its failure potential, the analysis can be considered multivariate.

The formulation of the so-called Zeta Score model led to the definition of an index designed to define the probability of failure of a given company through statistical techniques. Nowadays, given its accuracy, Z-Score is still the most widely used predictive model by researchers, practitioners and academics in the field of accounting.

It was developed in 1968, with reference to industrial companies listed on the U.S. stock market[9], and modified by the same author subsequently.

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[8] Salimi, (2015) *Validity of Altmans Z-Score model in predicting bankruptcy in recent years*

[9] Celli, (2015) *Can Z-Score Model Predict Listed Companies' Failures in Italy? An Empirical Test*

With the help of this model, Altman could predict financial efficiency or bankruptcy up to 2-3 years in advance.

It had been constructed using as a sample 66 manufacturing companies from two different health situations: 33 bankrupt and 33 non-bankrupt firms. It is important to note, however, that, at the time the model was developed, electronic databases were not available, so the analyst had to construct his or her own database using primary sources, such as companies' annual reports, or secondary sources (such as Moody's and S&P Industrial manuals and reports)[10].

In fact, the reason why he used as sample only manufacturing enterprises was the fact that data was available from Moody's Industrial Manual which only contains data on manufacturing firms[11].

The bankrupt companies (Group one) were manufacturers with a mean asset size of 6.4 million US dollars, with a range of between 0.7 – 25.9 million US dollars.

The non-bankrupt firms (Group two) were manufacturers with the asset size range restricted to 1 – 25 million US dollars.

The information taken in consideration for the firms of the two groups were from the same years. For Group one, the data was derived from financial statements one reporting period before the bankruptcy.

At this point, Altman made a selection from these firms, and he eliminated both small (less than US$ 1 million in total assets) and very large ones because of the lack of data for the former and the rarity of bankruptcies at that time of the latter[12].

The next step was the selection of the ratios that could be considered important for studying the financial situation of the companies. Altman drew up a list of 22 potential ratios that were selected because of their potential relevance in studies and their popularity in the literature.

They were classified into five different categories that were the following:

- Liquidity
- Profitability
- Leverage

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[10] Altman, (2019) *Corporate financial distress restructuring and Bankruptcy*

[11] Imelda, Alodia, (2016) *The Analysis of Altman Model and Ohlson Model in Predicting Financial Distress of Manufacturing Companies in the Indonesia Stock Exchange*

[12] Altman, Iwanicz-Drozdowska, Laitinen, Suvas, *Distressed Firm and Bankruptcy Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model*

- Solvency
- Activity

Subsequently, it was necessary to perform a selection process to arrive at the final profile of the variables that was based on the following procedures:

1. Observation of the statistical significance of various alternative functions including determination of the relative contributions of each independent variable.[13]
2. Valuation of the intercorrelations that had been created among the relevant variables.
3. Observation of the predictive accuracy of the various profiles.[14]
4. Analyst's judgment.

The Altman Z-score model for *public manufacturing* firms is:

$$z = 1.2x_1 + 1.4x_2 + 3.3x_3 + 0.6x_4 + 0.999x_5$$

where the variables are defined as:

- *z = overall index*
- *$x_1$ = working capital / total assets*

   It represents a measure of the net liquid assets of the company relative to the total capitalization.

   Going into more detail, it is possible to define the working capital as the difference between current assets and current liabilities. This index explicitly considers liquidity and size dimensions, and it has proved to be the more valuable in analyses than other liquidity ratios such as the current ratio and the quick ratio. In fact, thanks to the working capital it is possible to understand the capacity of the firm in repaying its own obligations.[15]

   A positive working capital indicates a firm's ability to pay its bills. A business entity with a negative working capital will have trouble in meeting its obligations.[16]

[13] Altman, Iwanicz-Drozdowska, Laitinen, Suvas, *Distressed Firm and Bankruptcy Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model*

[14] Altman, Iwanicz-Drozdowska, Laitinen, Suvas, *Distressed Firm and Bankruptcy Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model*

[15] Altman, Iwanicz-Drozdowska, Laitinen, Suvas, *Distressed Firm and Bankruptcy Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model*

[16] Anjum, (2012) *Business bankruptcy prediction models: A significant study of the Altman's Z-score model*

- $x_2$ = *retained earnings / total assets*

  It represents a measure of cumulative profitability over time and reflects the firm's age and its earning power.

- $x_3$ = *earnings before interest and income taxes / total assets*

  It represents the actual profitability or productivity of the company's assets since this version of return on assets is independent of any tax leverage.[17]

  According to Altman, this ratio is a better representation of the profitability of a company than cash flow. In fact, it measures the amount of cash supply available for allocation to creditors, government, and shareholders.[18]

- $x_4$ = *market value of common equity / book value of total liabilities*

  This is a measure of how much a company's assets can decrease in value before liabilities exceed assets and the company becomes insolvent.[19]

  With this index, the model also includes a market value dimension and for this choice, Altman is considered a predecessor to the structural approach, championed by *Merton* (1974).[20]

- $x_5$ = *sales / total assets*

  It represents a capital-turnover that indicates the ability of the company's assets in generating sales and it is a measure of the competitive ability of the management relating to sales. It also measures management's competitive ability, relating to sales.

Finally, Altman divided the Z-values into three different categories that determine the zones of discrimination as follows:

- $z > 2.99$ = safe zone
- $1.80 < z < 2.99$ = grey zone
- $z < 1.80$ = distress zone

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[17] Batchelor, (2018) *Corporate Bankruptcy: Testing the Efficacy of the Altman Z-Score*

[18] Anjum, (2012) *Business bankruptcy prediction models: A significant study of the Altman's Z-score model*

[19] Altman, Iwanicz-Drozdowska, Laitinen, Suvas, *Distressed Firm and Bankruptcy Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model*

[20] Altman, Iwanicz-Drozdowska, Laitinen, Suvas, *Distressed Firm and Bankruptcy Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model*

The most probable range of false prediction was between 1.81 and 2.99, considered as the zone of ignorance or grey area. A Z-value less than 1.80 indicates a strong likelihood of bankruptcy, and greater than 2.99 indicate a low likelihood of bankruptcy *(Altman, 1968)*.

| Type of Company | Public manufacturing |
|---|---|
| Altman Z-Score Model | $z = 1.2x_1 + 1.4x_2 + 3.3x_3 + 0.6x_4 + 0.999x_5$ |

| Zone of discrimination | |
|---|---|
| Safe zone | $z > 2.99$ |
| Grey zone | $1.80 < z < 2.99$ |
| Distress zone | $z < 1.80$ |

*Figure 3 - Own elaboration*

However, according to Altman "*credit analysis, private placement dealers, accounting auditors, and firms themselves are concerned that the original model is only applicable to publicly traded entities (since $x_4$ requires stock price data)*".
So, in 1983 he developed a new model specifically for privately firms.

The Altman Z-score model for *private manufacturing* firms is:

$$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$$

where the variables are defined as:
- *$z'$ = overall index*
- *$x_1$ = working capital / total assets*
- *$x_2$ = retained earnings / total assets*
- *$x_3$ = earnings before interest and income taxes / total assets*
- *$x_4$ = book value of common equity / book value of total liabilities*
- *$x_5$ = sales / total assets*

The new estimation of the model substitutes market value of equity with the book value of equity in $x_4$. As the coefficients changed for the revised model, so did the Z-score results and the zones of discrimination (Altman, 1983). They are:
- $z' > 2.90$ = safe zone
- $1.23 < z' < 2.90$ = grey zone
- $z' < 1.23$ = distress zone

| Type of Company | Private manufacturing |
|---|---|
| Altman Z-Score Model | $z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$ |

| Zone of discrimination | |
|---|---|
| Safe zone | $z' > 2.90$ |
| Grey zone | $1.23 < z' < 2.90$ |
| Distress zone | $z' < 1.23$ |

*Figure 4 - Own elaboration*

In 1993 Altman decided to adapt the model also to non-manufacturing firms. So, it was important to delete the industry effect that was represented by $x_5$ index.

Eliminating sales / total assets minimizes *"the potential industry effect which is more likely to take place when such an industry sensitive variable as asset turnover is included"* (Altman, 1993).

The Altman Z-score model for *non - manufacturing* firms is:

$$z'' = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05x_4$$

where the variables are defined as:

- *$z''$ = overall index*

- *$x_1$ = working capital / total assets*

- *$x_2$ = retained earnings / total assets*

- *$x_3$ = earnings before interest and income taxes / total assets*

- *$x_4$ = book value of common equity / book value of total liabilities*

The new zones of discrimination are the following:

- $z'' > 2.60$ = safe zone

- $1.1 < z'' < 2.60$ = grey zone

- $z'' < 1.1$ = distress zone

| Type of Company | **Non - manufacturing** |
| --- | --- |
| **Altman Z-Score Model** | $z'' = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05x_4$ |

| **Zone of discrimination** | |
| --- | --- |
| Safe zone | $z'' > 2.60$ |
| Grey zone | $1.1 < z'' < 2.60$ |
| Distress zone | $z'' < 1.1$ |

*Figure 5 - Own elaboration*

*1.3 Ohlson O-Score*

In 1980, another important predictive model of corporate bankruptcy was constructed by Ohlson.

It differs from the previous one analyzed by Altman because this new model used logit statistical method in order to overcome the weakness of the Multi Discriminant Analysis used by his predecessor.

In particular, the main problems when using the MDA methodology were[21]:

- The variance-covariance predictors and other statistical requirements imposed on the nature of the distribution of the forecasters must be the same for bankrupt and non-bankrupt firms considered in the analysis.
- Since it is an ordinal ranking, the result of the application of the MDA is a score with a little percentage of intuitive interpretation.
- Problems regarding the "matching" procedure between the bankrupt and non-bankrupt companies. One example of this kind of criteria is the industry size.

The period on which Ohlson's analysis is based goes from 1970 to 1976. His study was conducted on 105 manufacturing companies that went bankrupt and 2058 companies that were not bankrupt during the period.

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[21] Elviani, Simbolon, Riana, Khairani, Dewi, Fauzi, (2020) *The Accuracy of the Altman, Ohlson, Springate and Zmejewski Models in Bankruptcy Predicting Trade Sector Companies in Indonesia*

The difference with Altman's model lay not only in the number of firms considered, but also in the source of data. In fact, the latter, as written above, took data from Moody's manual, while Ohlson used as source the financial statement issued for taxes (10K-Financial Statement).[22] This procedure has one important advantage: the report shows at which moment they are released to the public, and therefore it is possible to check whether the company goes bankrupt before or after the release date.[23]

The model is composed of nine variables consisting of several financial ratios and it is as follows:

$$O\text{-}score = -1.32 - 0.407o_1 + 6.03o_2 - 1.43o_3 + 0.08o_4 - 2.37o_5 - 1.83o_6 + 0.285o_7 - 1.72o_8 - 0.52o_9$$

where the variables are defined as:

- $o_1$ = total assets, inflation adjusted (ln (total assets/GNP price index level))
- $o_2$ = total liabilities / total assets
- $o_3$ = net working capital / total assets
- $o_4$ = current liabilities / current assets
- $o_5$ = net income / total assets
- $o_6$ = earnings before interest, income taxes, depreciation, amortization / total liabilities
- $o_7$ = 1 if net income was negative for the last two years, zero otherwise
- $o_8$ = 1 if book value of shareholders' equity is negative, zero otherwise
- $o_9$ = change in net income (net income – net income$_{-1}$) / absolute value of net income (net income + net income$_{-1}$)

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[22] Imelda, Alodia, (2016) *The Analysis of Altman Model and Ohlson Model in Predicting Financial Distress of Manufacturing Companies in the Indonesia Stock Exchange*

[23] Elviani, Simbolon, Riana, Khairani, Dewi, Fauzi, (2020) *The Accuracy of the Altman, Ohlson, Springate and Zmejewski Models in Bankruptcy Predicting Trade Sector Companies in Indonesia*

The probability of default is given by the formula:

*Probability of default = Exp [O-score] / (1+ Exp [O-score])*

There are also the following zones of discrimination[24]:

- O-score < 0.38 = safe zone

- O-score > 0.38 = distress zone

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[24] Imelda, Alodia, (2016) *The Analysis of Altman Model and Ohlson Model in Predicting Financial Distress of Manufacturing Companies in the Indonesia Stock Exchange*

**Chapter 2 – Literature review**

*2.1 The energy industry*

The energy industry has always been considered a traditional business. However, it is an area of continuous development. In fact, due to the arise of new sciences and technologies, it is possible to divide the energy industry into traditional and new energy one.

The first refers to the use and development of natural energy resources and their mutation into secondary energy. Its production is based on the smelting and extraction of coal, natural gas and oil, also including supply chains of the energy and power.

For what concerning the second one, it involves the use of some new sources and their development.

It can be divided into two different categories:

- New energy that includes hydropower, wind energy, nuclear energy, solar energy, and biomass energy
- New driving force formed by technological innovations

These two types of energy industries, mentioned above, have differences in raw material sources and production methods. However, they are both marked by high fixed costs and large investments in fixed facilities.[25]

As a sector of special importance, the energy industry has always faced several challenges caused by geopolitical uncertainties and the introduction of policy choices with the aim of, not only reinforcing energy security, efficiency, and sustainability, but more significantly, facing issues regarding climate change.

*"At the meantime, huge investments are needed to meet the increasing demand for energy. The International Energy Agency estimates that under its basic scenario of a 30 percent increase in global energy demand by 2040, a total investment of $44 trillion will be needed for energy supply (about 60 percent is for oil, gas and coal extraction and supply, while renewable energy*

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[25] Fu, Shen, (2020) *COVID-19 and Corporate Performance in the Energy Industry*

*production and supply accounts for 20 percent) and another $23 trillion for energy efficiency"* (International Energy Agency, 2016).[26]

Of primary importance appears to be the role of the private sector in this particular context, especially with regard to the promotion of clean energy technologies, the exploration of new energy reserves, and the provision of affordable, secure, and reliable energy to end consumers. The profitability of energy sector enterprises, considered from the perspective of an international context, appears to be a current issue based mainly on the constant developments being generated in the economic and business environment.

According to *Doumpos, Andriosopoulos, Galariotis, Makridou and Zopounidis* as they explained in the paper *Corporate failure prediction in the European energy sector: A multicriteria approach and the effect of country characteristics,* there have been several studies in the past related to the financial performance of companies belonging to the energy sector based on financial indicators (*Capece, Cricelli, Pillo, & Levialdi, 2010; Halkos & Tzeremes, 2012*), corporate social responsibility and competitiveness (*Pätäri, Arminen, Tuppura, & Jantunen, 2014*), productivity and efficiency (*Jamasb, Pollitt, & Triebs, 2008*), and environmental aspects (*Arslan-Ayaydin & Thewissen, 2017*).

However, the paper just mentioned results to be one of the few focused on the prediction of failure of firms belonging to this specific sector in Europe. It is not without surprises considering previous studies that demonstrate how energy markets play a key role in achieving financial stability (*Safarzyn'ska & van den Bergh, 2017*).

The purpose of this paper is to investigate the potential of the construction of cross-country predictive models of business failures for European firms operating in the energy sector.

This analysis presents additional research, respect to the others on the same subject, based on the study of financial distress of these firms, and especially because it takes an approach that covers all energy industry subsectors, instead of focusing only on a single sector such as utilities or oil and gas. As mentioned earlier, the approach used is the cross-country one, which allows the analysis of the role of specific country characteristics of particular interest to the energy sector, such as the state of their global energy trade and the countries' energy performance.

This approach turns out to be very important because it provides an understanding of how policy choices made at the national or international level and actions implemented can have impacts

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[26] Doumpos, Andriosopoulos, Galariotis, Makridou and Zopounidis, (2017) *Corporate failure prediction in the European energy sector: A multicriteria approach and the effect of country characteristics*

on the profitability of energy firms. From a methodological standpoint, the analysis is implemented with the use of an MCDA method for the construction of failure risk assessment models in the form of an additive value function.

The findings support the necessity of using energy-related data in analyses of the distress risk for enterprises belonging to this sector.

In fact, comparing firm-specific characteristics and the economic/business environment, it was discovered that data on the quality and reliability of energy networks, energy sustainability factors (such as $CO_2$ intensity), together with the size and openness of a country's internal energy market, can provide useful additional information. Such matters should undoubtedly be considered as part of the policy-making process, which should also analyze the sustainability in terms of profitability of the energy companies in addition to the impact of the country's policy actions.

There are other examples that highlight the importance of focusing on the prediction of failure of that kind of industry. One of them is presented in the paper named *Assessment of a failure prediction model in the European energy sector: A multicriteria discrimination approach with a PROMETHEE based classification.*

It is based on several energy companies' bankruptcy that occurred in California in the early 2000s and between 2015 and 2016. They generated severe and diverse consequences on the economy, offset only by a ready intervention of the government. It can be seen, therefore, that the use of models for predicting the failure of companies belonging to the energy sector is essential to prevent such catastrophes.

For this reason, according to the research just mentioned, in recent years there has been a growing interest from academics regarding the financial performance of energy companies. These studies are mainly based on the analysis of their financial indicators (*Capece et al., 2010*), environmental aspects (*Arslan-Ayaydin & Thewissen, 2016*), productivity and efficiency (*Jamasb et al., 2008*).

This paper aims to propose a bankruptcy prediction model for companies belonging to the energy sector in Europe. As the applied methodology used, the presented model is based on an MCDA discrimination model with a benchmark given by an outranking method of a classification of energy companies. Specifically, this study introduces the Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE II) (first presented in *Mareschal* et al., 1984), on which a classification of the sample firms is based. It is another well-known MCDA model.

At this point, it is useful to focus on a good number of studies that have tested the reliability of the Z-Score and O-Score predictive models in different countries around the world and with respect to different business sectors in order to better understand the predictive ability of the two models under analysis in relation to different application contexts.

Numerous research has been conducted to understand the causes of financial insolvency of large firms, a common and dramatic phenomenon that has an impact on a nation's social and economic structure.

*Pongsatat, Ramage and Lawrence*, in 2004, in the *paper Bankruptcy Prediction for Large and Small Firms in Asia: a comparison of Ohlson and Altman* have carried out a comparative analysis between the two models in predicting the failure of large and small enterprises in Asia. In particular, the purpose of this research is to understand and analyze the different predictive ability of the two methods applied to Thai firms of different asset sizes.

As for the results of the analysis, it is necessary to divide the findings according to the size of the firms. For enterprises considered large: Ohlson's model showed an overall predictive accuracy of 69.64%; Altman's model achieved a predictive accuracy of 58.93% for the first year before the bankruptcy and 62.50% for the second and third years.

For small businesses, Ohlson's model showed an overall predictive accuracy of 75% for the first year before the bankruptcy and 68.75% for the other two years; Altman's model achieved a predictive accuracy of 64.06% for the first year before the bankruptcy and 68.75% for the second and third years.

So, from the results obtained through the analysis conducted by Pongsatat, Ramage and Lawrence, it can be concluded that, for both large and small enterprises in Asia, the O-Score appears to be more accurate than the Z-Score.

*Imelda and Alodia*, in 2016, in the paper *The Analysis of Altman Model and Ohlson Model in Predicting Financial Distress of Manufacturing Companies in the Indonesia Stock Exchange*, have the purpose of analyzing the accuracy of Altman's and Ohlson's models in predicting bankruptcy of listed manufacturing firms in Indonesia. In particular, the study aims to understand which of the two turns out to be the most reliable.

All of the manufacturing businesses registered on the Indonesia Stock Exchange, between 2010 and 2014, compose the study's population. Concerning the results of the analysis, they show that Altman's model had a predictive accuracy of 61% while Ohlson's model has a predictive accuracy of 73%.

These findings are therefore consistent with the research done by *Moghadam, Zadeh and Fard (2010),* according to which Ohlson's method is more accurate in predicting financial distress than Altman's method, but not with *Karamzadeh (2013)* which stated that the Z-Score model is more reliable than the O-Score one.

Using post hoc and error types, *Nurcahyanti (2015)* examined 46 businesses that were quoted on the Indonesian Stock Exchange throughout the observation period of 2010 to 2013. The findings indicated that the outcomes of the bankruptcy analyses of the Altman Z-score model, Springate model, and Zmijewski model differed significantly. The Zmijewski model was the greatest effective model in terms of the type of error, whereas the Altman Z-score model was the most appropriate prediction based on the post hoc analysis.

*Putri Renalita Sutra Tanjung (2020)* in the paper *Comparative Analysis Of Altman Z-Score, Springate, Zmijewski And Ohlson Models In Predicting Financial Distress* wants to determine which is the most reliable financial distress forecasting model for the pharmaceutical firms listed on the Indonesia Stock Exchange.

The models by Altman, Springate, Zmijewski, and Ohlson differ significantly from one another. No samples are predicted by the Altman Z-Score model to experience financial difficulty, but 8 samples are projected to be vulnerable to it (belonging to the Grey zone).

In contrast, the Springate model shows that 2 samples are predisposed to financial trouble and 7 samples are currently suffering it. There are no subjects that the Zmijewski model predicts will go through or are likely to go through financial difficulties. Finally, when predicting financial distress circumstances for companies in the pharmaceutical industry listed on the Stock Exchange between 2013 and 2017, the Altman Z-Score model is the most reliable with a rate of accuracy equal to 90%.

*Mani Shehni Karamzadeh (2012)* in the paper *Application and Comparison of Altman and Ohlson Models to Predict Bankruptcy of Companies,* aims to compare Altman Z-Score and Ohlson O-Score as the best accurate financial distress predicting models for 90 enterprises from the Tehran Stock Exchange.

Taking into account the findings, the Altman (1968) bankruptcy prediction model can accurately predict the bankruptcy issue of Iranian listed companies with a 74.4, 64.4, and 50% accuracy for 1, 2, and 3 years in advance, and the original Ohlson (1980) bankruptcy prediction model can do the same with a 53.3, 46.6, and 33.3% accuracy for 1, 2, and 3 years in advance.

A comparison of the Z-Score and O-Score models reveals that the Altman method performs better in each of the three scenarios.

As it is possible to see from the analysis of these research, we can't state with certainty an absolute rule regarding the true reliability of the models considered because their effectiveness changes depending on the country and the business to which they are applied.

However, according to *Grice & Ingram, (2001); Grice & Dungam, (2001); Ooghe & Balcaen, (2006); Kapadia, (2011),* given that the model was specifically created and improved by Altman with reference to companies listed on the U.S. market, some authors have criticized the Z-Score (and its variants) predictive ability with regard to businesses established in nations other than the U.S. (and, more generally, Anglo-Saxon).

In particular, in order to have a background on which to base this study, it is appropriate to focus on the Italian panorama, analyzing the research that has been done on this topic. Business academics and researchers have not yet examined thoroughly whether the Z-score model can accurately forecast the distress of industrial businesses and quantify the relevant failure risk with particular attention to the Italian current scenario.
In this context, the two most relevant studies are the following.

*Altman, Danovi, and Falini*, in 2013, in the paper *Z-Score Models' Application to Italian Companies Subject to Extraordinary Administration*, apply Altman's model to Italian firms reported to be under extraordinary administration between 2000 and 2010. This research turns out to be fundamental in verifying the applicability of the model to the manufacturing industry in Italy. The grouping of the different companies interviewed for the research are characterized by different economic, social, operational, temporal and legislative contexts; this appears to be one of the main problems with the application of the model in Italy given the significant differences with the context in which the model was initially developed.
The companies considered by Danovi and Falini were manufacturing firms subjected to extraordinary administration procedures pursuant to Legislative Decree 270/1999 and d.l. 347/2003 during the period 2000-2010. The sample used is composed of a total of 52 companies subject to the Extraordinary Administration procedures.
The two scholars decided to apply the *Z' Score and Z'' Score* models due to the small number of listed companies in the Italian system and, in particular, in the sample considered: in fact, listed companies correspond to only 5% of the selected firms.

For what concerns the result, the 95.5% of the companies were placed in the distress zone in year x-1, the year before the bankruptcy was declared, while the prior years show lower percentages that are nevertheless significant and demonstrate the accuracy of the categorization that was done. It is important to note that the percentage of enterprises with unknown futures, those which belong to the grey zone, has decreased from 50% in x-5 to 20% in x-3 and x-2, until has reached 0% in x-1.

In general, during the course of the five-year pre-bankruptcy period, the classifications of the indicator are accurate in 72.3% of the cases (which climbs to 77.8% if we ignore the data from year x-5).

The results of the analysis suggested that the parameters may be reformulated in light of the features of Italian businesses, particularly their low capitalization, extensive use of bank borrowing, and budget practices that are sometimes non-transparent.


Another relevant research always related to the Italian scenario was conducted by *Massimiliano Celli*, in 2015, titled *Can Z-Score Model Predict Listed Companies' Failures in Italy? An Empirical Test*.

Using an ex-post approach, it verifies whether the model would have been able to forecast the development of the financial difficulties of the companies taken as a sample. Through a subsequent comparison of the results obtained by the statistical model and what actually happened, it is possible to measure the reliability rate of Altman's model for listed companies in Italy.

The test was run on a group of 51 businesses whose shares were permanently delisted or suspended in the years 1995 to 2013 as a result of irreversible crises. An ex-post method was used to assess the reliability of the Z-score. To determine whether it would have accurately forecast the future of those businesses, the model has been implemented to the balance sheet values in the three years preceding the delisting (or prior to suspension from listing).

For what concerns the results, the Z-score effectiveness of estimates provided in the first (T-1), second (T-2), and third (T-3) years previous to the year of delisting or permanent suspension (T) was, respectively, 87.3%, 77.5%, and 66.6%. Consequently, the Z-score demonstrates a fair capability to predict corporate failures, at least one year before the company is delisted. However, as the prediction time horizon rises, its reliability declines.

It should be highlighted that the model's prediction accuracy is marginally inferior to that derived from industrial companies listed on Anglo-Saxon markets. This discrepancy results from the fact that the Z-Score has been created using enterprises and markets that are

fundamentally different from those in Italy. Nevertheless, the model used to classify Italian listed companies has acceptable error rates and accurate classification.

Finally, it is important to note that according to *Alkhatib & Al Bzour (2011)* the Z-score use in categorizing US corporations has been evaluated numerous times at 95% one year before default (year 1), 83% two years before default (year 2), and 62% three years before default (year 3).
However, for companies listed on the Greek market, for instance, the model's accuracy rate is very different *(Gerantonis, Vergos, & Christopoulos, 2009)*: the degree of correct classification is 66% in the year prior to default (year 1), and it gradually declines to 52% and 39% in the following years (year 2 and year 3), respectively.

Instead, for firms listed on the Jordanian market, the model's accuracy rate is still different *(Alareeni & Branson, 2013)*: the Z-score efficacy has been assessed at 87% one year before default (year 1), 94% two years before default (year 2), and 89% three years before default (year 3).

In the table below it is possible to observe, in a summarized manner, the results obtained from past research analyzed above. The Z-score predictive accuracy rate shown is the average of the percentages of the three years preceding the bankruptcy of the companies considered.

| Research | Country | Business Sector | Predictive accuracy rate Z-Score |
|---|---|---|---|
| Putri Renalita Sutra Tanjung (2020) | Indonesia | Pharmaceutical | 90,00% |
| Alareeni & Branson (2013) | Jordania | Pharmaceutical | 90,00% |
| Alkhatib & Al Bzour (2011) | US | Pharmaceutical | 80,00% |
| Altman, Danovi, and Falini (2013) | Italy | Manufacturing | 77,80% |
| Massimiliano Celli (2015) | Italy | Not specified | 77,13% |
| Pongsatat, Ramage and Lawrence (2004) | Asia | Not specified | 64,24% |
| Mani Shehni Karamzadeh (2012) | Iran | Not specified | 62,93% |
| Imelda and Alodia (2016) | Indonesia | Manufacturing | 61,00% |
| Gerantonis, Vergos & Christopoulos (2009) | Greece | Manufacturing | 52,33% |

*Figure 6 - Own elaboration*

# Chapter 3 – The analysis

## 3.1 The sample

To conduct the analysis in support of this thesis, there has been employed, as a sample, 20 unlisted Italian companies belonging to the energy sector that failed between the years *2007* and *2021*. So, the approach used to measure the reliability of the models is ex-post since it verifies whether the model is able to forecast the future bankruptcy of the companies taken as a sample. Through a subsequent comparison of the results obtained by the statistical model and what actually happened, it is possible to measure the reliability rate of Altman's model for the companies considered.

Data on the financial statements of these firms are extracted from the AIDA database, which is produced and distributed by Bureau van Dijk S.p.A. and contains the financial statements, master and product data of all the active and failed companies (excluding Banks, Insurance Companies and Public Entities).

The application of the two models is performed in the last three years preceding the last available financial statements. Thus, not only it is possible to understand the predictive ability of the two methods even several years before the dissolution of the enterprise, but it is also a way to be sure that there have been used data that is as reliable as possible. In fact, data from the last available balance sheet before bankruptcy may not be entirely correct for such an analysis because it is too compromised by the crisis situation in which the enterprise is located.

However, for the analysis of some firms it was necessary to use the last available balance sheet as the starting year (Year T). This was necessary because, for an appropriate application of the Ohlson's model in a given year, data from the financial statements of the previous two years are needed, but such statements were not always available in the AIDA database.

The sample of the 20 enterprises analyzed is as follows:

| Name | ATECO Code | Activity | Type | Date of failure | Last accounting closing date |
|---|---|---|---|---|---|
| 3 L WIND SRL | 351100 | Production of electricity | Manufacturing | 06/08/14 | 31/12/13 |
| 8WM1LUC S.R.L. | 351100 | Production of electricity | Manufacturing | 28/09/16 | 31/12/15 |
| ABENGOA SOLAR ITALIA S.R.L. | 351100 | Production of electricity | Manufacturing | 29/01/18 | 31/12/16 |
| ACQUALEO S.R.L. | 351100 | Production of electricity | Manufacturing | 01/08/18 | 31/12/19 |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | 351400 | Transmission and distribution of electricity | Non-manufacturing | 31/12/18 | 31/12/18 |
| ALGAE FACTOR S.R.L. | 351100 | Production of electricity | Manufacturing | 21/12/18 | 31/12/17 |
| A.P.I.C.E. S.R.L. | 351100 | Production of electricity | Manufacturing | 20/12/13 | 31/12/12 |
| A.S.A.D. S.R.L. | 351100 | Production of electricity | Manufacturing | 23/11/15 | 31/12/14 |
| ENERGIE RINNOVABILI ITALIA S.R.L. | 271100 | Manufacture of electric motors | Manufacturing | 21/12/15 | 31/12/14 |
| SIAMO ENERGIA & PARTNERS S.R.L. | 351100 | Production of electricity | Manufacturing | 09/09/20 | 31/12/16 |
| EIFFEL S.R.L. | 351400 | Trade of electricity | Non-manufacturing | 20/10/17 | 31/12/16 |
| MOBILSERVICE S.R.L. | 351100 | Production of electricity | Manufacturing | 08/13/07 | 31/12/06 |
| FRI-EL POWER TRADING S.R.L. | 351400 | Trade of electricity | Non-manufacturing | 07/12/16 | 31/12/15 |
| VELGA S.R.L. | 351300 | Distribution of electricity | Non-manufacturing | 26/05/21 | 31/12/19 |
| BELLATRIX S.R.L. | 351100 | Production of electricity | Manufacturing | 17/06/20 | 31/12/18 |
| GREEN POWER ENERGY S.R.L. | 351400 | Trade of electricity | Non-manufacturing | 29/01/21 | 31/12/19 |
| SACH S.R.L. | 351100 | Production of electricity | Manufacturing | 17/12/19 | 31/12/17 |
| ITALIAN JOB S.R.L. | 351400 | Trade of electricity | Non-manufacturing | 22/01/20 | 31/12/18 |
| NUOVA IRIDE S.R.L. | 351100 | Production of electricity | Manufacturing | 03/10/19 | 31/12/17 |
| COGENER S.R.L. | 351100 | Production of electricity | Manufacturing | 10/05/17 | 31/12/15 |

*Figure 7 - Own elaboration*

*3.2 The analysis*

It is appropriate to first consider the sample individually, analyzing each firm, and then in a more macroscopic view in the conclusions.

Before applying the Altman Z-Score and Ohlson O-Score models, each enterprise is described in detail. In particular, through the Ateco code, extracted from AIDA, it is possible to distinguish firms into manufacturing and non-manufacturing. This distinction turns out to be fundamental for the application of the appropriate Altman model.

In addition, the date of actual bankruptcy and the date of the last available financial statements are reported for each firm. Subsequent to the application of the models, there is a detailed explanation of the results especially from an economic point of view.

● **3L WIND SRL**

It is a limited liability company based in Potenza.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was liquidated in 2014. The cancellation from the commercial register took place on 06/08/2014, while the last available accounting closing date is 31/12/2013.

For this reason, the models will be applied using data from the financial statements of the years 2012, 2011 and 2010.

**Altman Z-Score model (Manufacturing firm) - 3 L WIND SRL**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2012 | 2011 | 2010 |
| WC | Working capital | -307.675,00 € | -415.574,00 € | -233.313,00 € |
| TA | Total assets | 614.360,00 € | 734.819,00 € | 622.349,00 € |
| RE | Retained earnings | -4.459,00 € | -10.532,00 € | -7.212,00 € |
| EBIT | Earnings before interest, income taxes | 55.281,00 € | -11.844,00 € | -26.512,00 € |
| BVCE | Book value of common equity | 79.881,00 € | 540,00 € | 9.469,00 € |
| TL | Total liabilities | 534.479,00 € | 734.279,00 € | 612.880,00 € |
| S | Sales | 6.040,00 € | 6.312,00 € | 0,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -0,50 | -0,57 | -0,37 |
| $x_2$ | 0,847 | -0,01 | -0,01 | -0,01 |
| $x_3$ | 3,107 | 0,09 | -0,02 | -0,04 |
| $x_4$ | 0,42 | 0,15 | 0,00 | 0,02 |
| $x_5$ | 0,998 | 0,01 | 0,01 | 0,00 |
| **T** | | **-0,01** | **-0,46** | **-0,40** |

*Figure 8 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.
As can be seen from the analysis performed, in all the three years considered, the enterprise has a negative Z-Score. So, the method turns out to have a very good predictive ability.

However, from an economic point of view, it is useful to analyze the increase of Z-Score value from 2011 (*z'=-0.46*) to 2012 (*z'=-0.01*) since, considering the liquidation in 2014, a worse value would be expected.
This "improvement" is due to a very significant increase in the coefficients $x_3$ and $x_4$.

Regarding the $x_3$ coefficient, the increase is mainly due to a significant increase in EBIT, which is greater than the slight decrease in total assets.

**Evolution of a key variable: OPERATING MARGIN (2010 - 2012)**
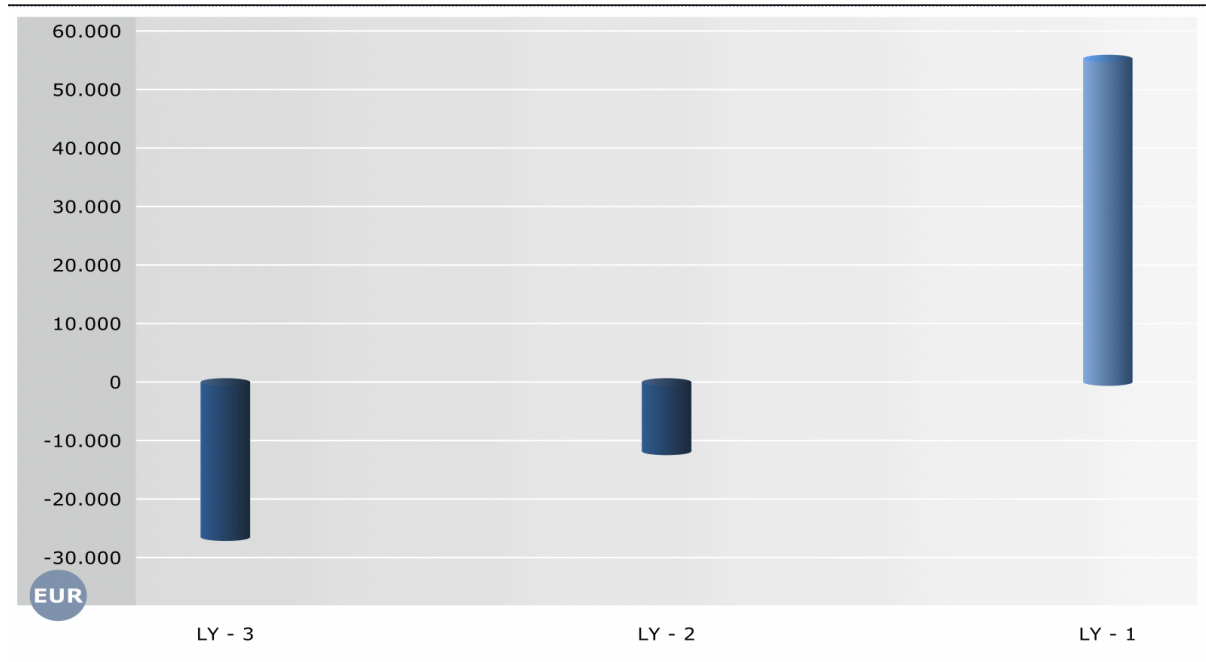


*Figure 9 - AIDA*

In fact, as it is possible to see in this graph, in 2010 and 2011 the EBIT was negative, while in 2012 it turns out to be a positive value. This increase is reflected in the coefficient $x_3$ which is positive in 2012 and negative in the other two years.

Regarding the $x_4$ coefficient, the increase is due to the rise in the book value of common equity and the simultaneous decrease in total liabilities.

For this reason, in the last year of the analysis the Z-Score presents a slight improvement.

**Ohlson O-score Model - 3 L WIND SRL**

| | | Inputs | |
|---|---|---|---|
| | | **2012** | **2011** |
| TA | **Total assets** | 614.360,00 € | 734.819,00 € |
| GNP | **Gross National Product price index level** | 1.702.138.910,81 € | 1.600.631.743,33 € |
| TL | **Total liabilities** | 534.479,00 € | 734.279,00 € |
| WC | **Working capital** | -307.675,00 € | -415.574,00 € |
| NI | **Net income** | 34.341,00 € | -38.927,00 € |
| NI_t-1 | **Net income (t-1)** | -38.927,00 € | -33.320,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | 150.165,00 € | -3.745,00 € |

| Variables | Coefficients | Values | |
|---|---|---|---|
| | -1,32 | | |
| $o_1$ | -0,407 | -7,93 | -7,69 |
| $o_2$ | 6,03 | 0,87 | 1,00 |
| $o_3$ | -1,43 | -0,50 | -0,57 |
| $o_4$ | 0,08 | 4,55 | 4,76 |
| $o_5$ | -2,37 | 0,06 | -0,05 |
| $o_6$ | -1,83 | 0,28 | -0,01 |
| $o_7$ | 0,285 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 |
| $o_9$ | -0,52 | -1,00 | -0,08 |
| | **T** | **8,39** | **9,48** |
| | Default probability | **99,98%** | **99,99%** |

*Figure 10 – Own elaboration*

This situation is confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in 2012 and 2011 the probability of bankruptcy turns out to be almost 100% in both years.

Also in this case, in 2012 is possible to see a slight improvement because of the increase of EBITDA and Net income values from 2011 to 2012.

However, due to the lack of data for the 2009 financial statements, it was not possible to apply this model to the year 2010.

In this case, both models have a similar result, and both predicted, in previous years, the liquidation in 2014.

- **8WM1LUC S.R.L.**

It is a one-person company with limited liability based in Milano.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was liquidated in 2016. The cancellation from the commercial register took place on 28/09/2016, while the last available accounting closing date is 31/12/2015.

For this reason, the models will be applied using data from the financial statements of the years 2014, 2013 and 2012.

### Altman Z-Score model (Manufacturing firm) - 8WM1LUC S.R.L.

| | | 2014 | 2013 | 2012 |
|---|---|---|---|---|
| | | **Inputs** | | |
| WC | **Working capital** | 1.282,00 € | -3.156,00 € | -13,00 € |
| TA | **Total assets** | 1.937,00 € | 2.130,00 € | 7.334,00 € |
| RE | **Retained earnings** | -17.756,00 € | -14.212,00 € | -10.656,00 € |
| EBIT | **Earnings before interest, income taxes** | -2.038,00 € | -3.545,00 € | -3.735,00 € |
| BVCE | **Book value of common equity** | 1.282,00 € | -2.756,00 € | 787,00 € |
| TL | **Total liabilities** | 655,00 € | 4.886,00 € | 6.547,00 € |
| S | **Sales** | 0,00 € | 0,00 € | 0,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| $x_1$ | 0,717 | 0,66 | -1,48 | -0,002 |
| $x_2$ | 0,847 | -9,17 | -6,67 | -1,45 |
| $x_3$ | 3,107 | -1,05 | -1,66 | -0,51 |
| $x_4$ | 0,42 | 1,96 | -0,56 | 0,12 |
| $x_5$ | 0,998 | 0,00 | 0,00 | 0,00 |
| | **T** | **-9,74** | **-12,12** | **-2,76** |

*Figure 11 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.
As can be seen from the analysis performed, in all the three years considered, the enterprise has a negative Z-Score. So, the method turns out to have a very good predictive ability.

However, from an economic point of view, it is useful to analyze the increase of Z-Score value from 2013 (*z'=-12.12*) to 2014 (*z'=-9.74*) since, considering the liquidation in 2016, a worse value would be expected.

This slight increase is mainly due to the change in two factors.

As it is possible to see in the graph below, the first is a substantial increase in working capital, that, compared to the previous two years in which it had been negative, in 2014 reaches a positive value. This growth results in an increase in the $x_1$ coefficient, taking into account the simultaneous decrease in total assets.

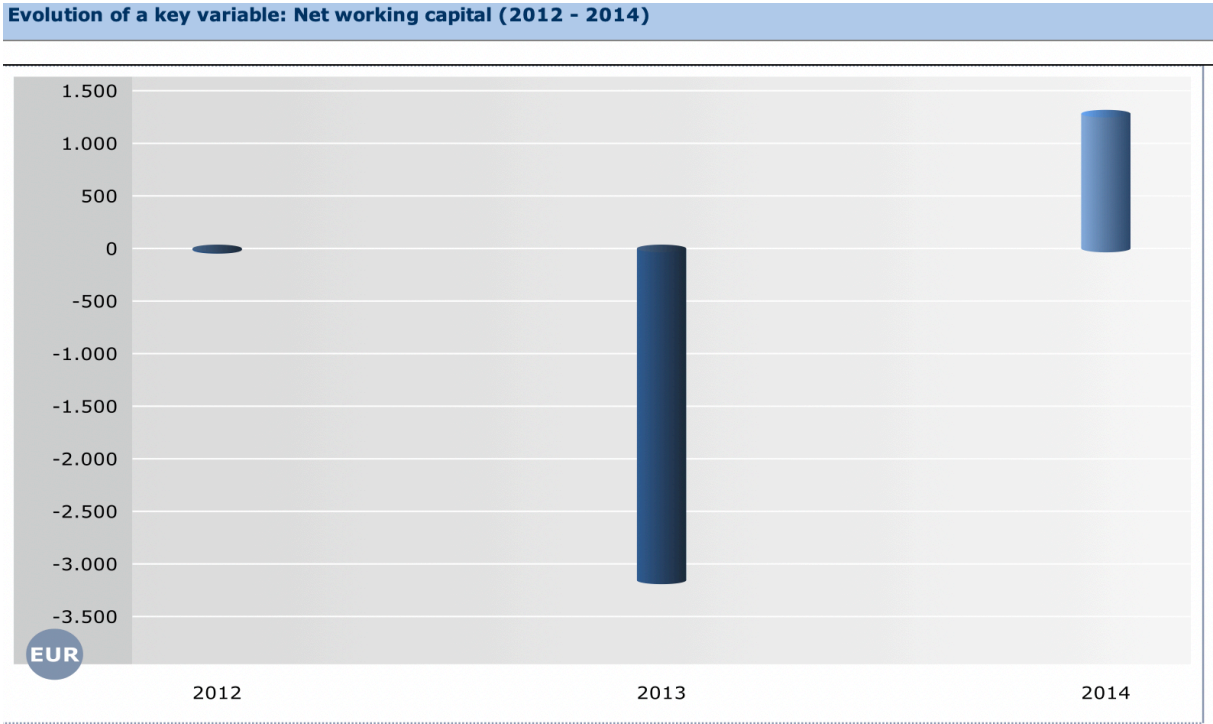**Evolution of a key variable: Net working capital (2012 - 2014)**



*Figure 12  -  AIDA*

The second factor is represented by the simultaneous increase of Book value of common equity and decrease of Total liabilities. The change in book value of common equity is particularly significant as it goes from -2.756,00 € in 2013 to 1.282,00 € in 2014. This growth is translated into an increase in the $x_4$ coefficient.

In the graph below it is possible to look at the trend of the book value of common equity.
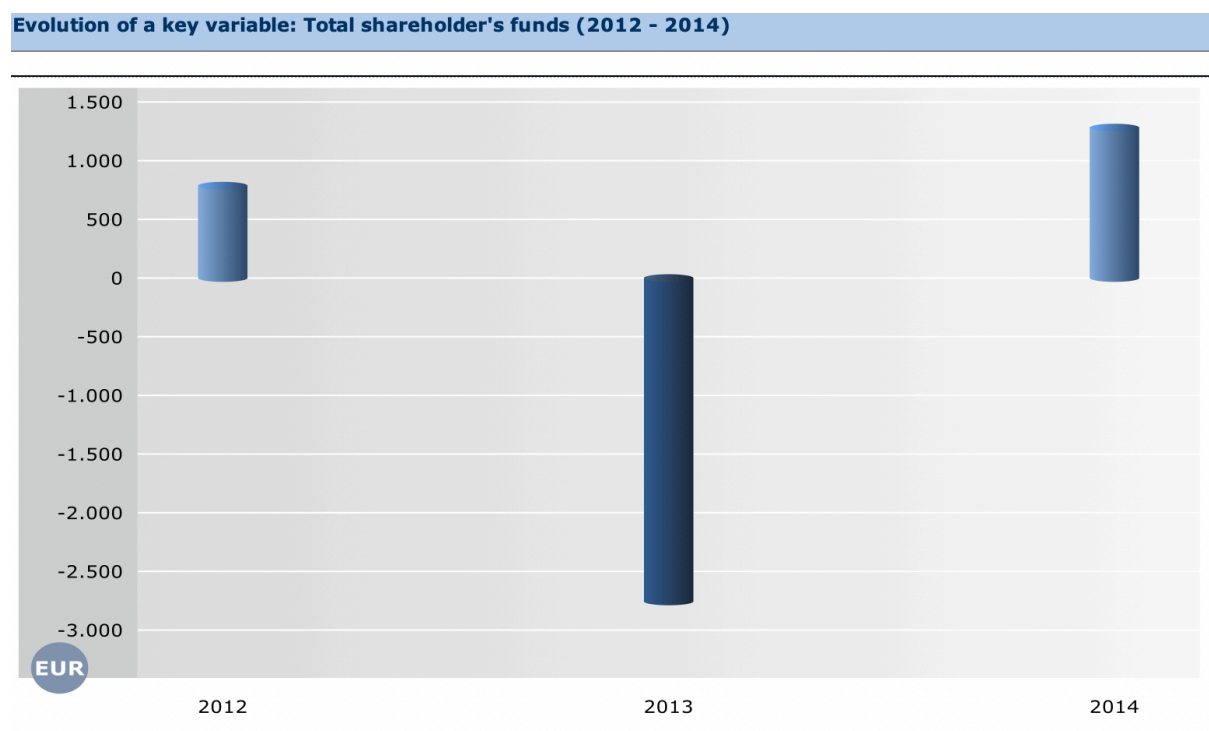
**Evolution of a key variable: Total shareholder's funds (2012 - 2014)**



*Figure 13 - AIDA*

**Ohlson O-score Model - 8WM1LUC S.R.L.**

|  |  | Inputs | | |
|---|---|---|---|---|
|  |  | **2014** | **2013** | **2012** |
| TA | **Total assets** | 1.937,00 € | 2.130,00 € | 7.334,00 € |
| GNP | **Gross National Product price index level** | 1.569.168.207,02 € | 9.127.497.556,94 € | 1.702.138.910,81 € |
| TL | **Total liabilities** | 655,00 € | 4.886,00 € | 6.547,00 € |
| WC | **Working capital** | 1.282,00 € | -3.156,00 € | -13,00 € |
| NI | **Net income** | -2.028,00 € | -3.544,00 € | -3.556,00 € |
| NI_t-1 | **Net income (t-1)** | -3.544,00 € | -3.544,00 € | -3.556,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | -1.638,00 € | -3.145,00 € | -3.335,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
|  | -1,32 |  |  |  |
| $o_1$ | -0,407 | -13,60 | -15,27 | -12,35 |
| $o_2$ | 6,03 | 0,34 | 2,29 | 0,89 |
| $o_3$ | -1,43 | 0,66 | -1,48 | 0,00 |
| $o_4$ | 0,08 | 0,34 | 2,86 | 1,00 |
| $o_5$ | -2,37 | -1,05 | -1,66 | -0,48 |
| $o_6$ | -1,83 | -2,50 | -0,64 | -0,51 |
| $o_7$ | 0,285 | 1,00 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 1,00 | 0,00 |
| $o_9$ | -0,52 | 0,27 | 0,0017 | 0,14 |
|  |  |  |  |  |
| **T** |  | 12,54 | 24,76 | 11,47 |
|  |  |  |  |  |
| Default probability |  | **100,00%** | **100,00%** | **100,00%** |

*Figure 14 – Own elaboration*

This situation is confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in 2014, 2013 and 2012 the probability of bankruptcy turns out to be 100% in all the years.

Also in this case, in 2014 is possible to see a slight improvement because of the decrease of Total liabilities value from 2013 to 2014 that, together with a reduction in total assets, results in a significantly lower coefficient $o_2$.

However, such variations in coefficient values turn out to be ignorable because the default probability does not change.

In this case, both models have a similar result, and both predicted, in previous years, the liquidation in 2014.

- **ABENGOA SOLAR ITALIA S.R.L.**

It is a limited liability company based in Rome.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

*$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$*

The company, according to its current legal status, was liquidated in 2018. The cancellation from the commercial register took place on 29/01/2018, while the last available accounting closing date is 31/12/2016.

For this reason, the models will be applied using data from the financial statements of the years 2015, 2014 and 2013.

**Altman Z-Score model (Manufacturing firm) - ABENGOA SOLAR ITALIA S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2015** | **2014** | **2013** |
| WC | **Working capital** | -17.850,00 € | 313.701,00 € | -133.732,00 € |
| TA | **Total assets** | 13.484,00 € | 2.540.143,00 € | 1.501.623,00 € |
| RE | **Retained earnings** | 0,00 € | 0,00 € | 0,00 € |
| EBIT | **Earnings before interest, income taxes** | -183.491,00 € | -208.775,00 € | -353.859,00 € |
| BVCE | **Book value of common equity** | -15.750,00 € | 2.461.546,00 € | 1.215.192,00 € |
| TL | **Total liabilities** | 29.234,00 € | 78.597,00 € | 286.431,00 € |
| S | **Sales** | 0,00 € | 0,00 € | 0,00 € |

| **Variables** | **Coefficients** | **Values** | | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -1,32 | 0,12 | -0,09 |
| $x_2$ | 0,847 | 0,00 | 0,00 | 0,00 |
| $x_3$ | 3,107 | -13,61 | -0,08 | -0,24 |
| $x_4$ | 0,42 | -0,54 | 31,32 | 4,24 |
| $x_5$ | 0,998 | 0,00 | 0,00 | 0,00 |
| | **T** | **-43,46** | **12,99** | **0,99** |

*Figure 15 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.

As can be seen from the analysis performed, the enterprise in 2013 and 2015, is located in the distress zone, while in 2014 is located in the safe zone.

It is useful to analyze the decrease of Z-Score value from 2014 (*z'=12.99*) to 2015 (*z'=-43.46*) from an economic point of view. This worsening is due to a sharp decrease in working capital, which reaches negative values in 2015. This trend is reflected in a negative $x_1$ coefficient. In fact, although there is a significant decrease in total assets, since working capital reaches a negative amount, the $x_1$ coefficient turns out to be a negative value.

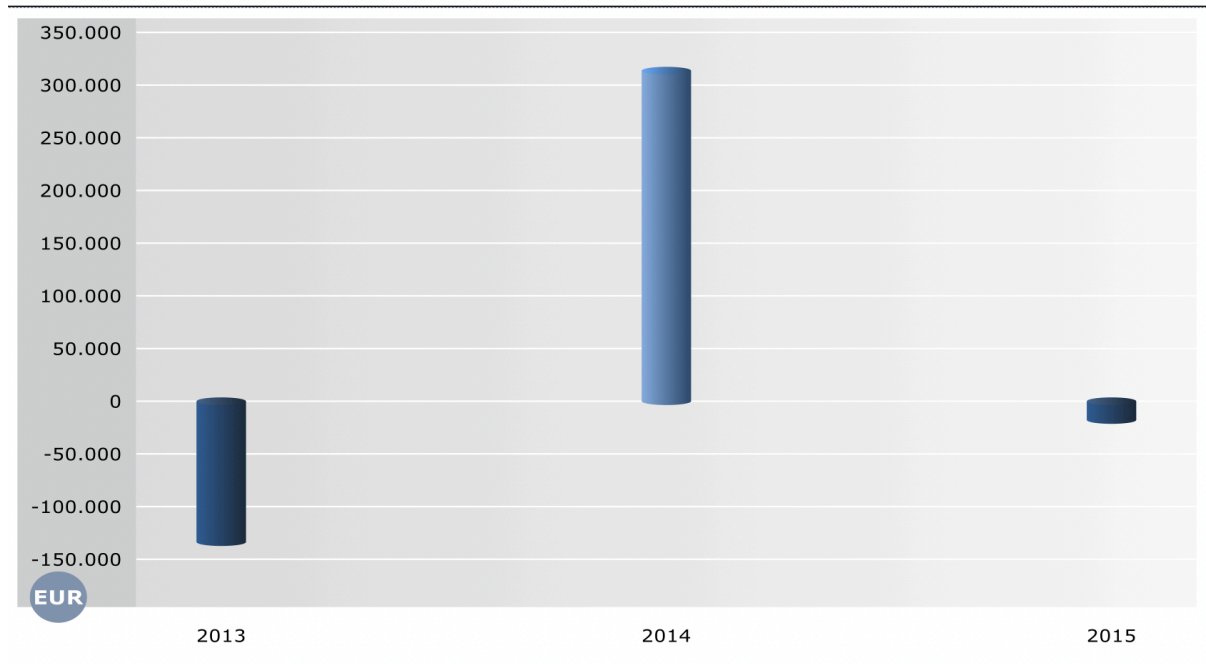**Evolution of a key variable: Net working capital (2013 - 2015)**



*Figure 16 - AIDA*

Another factor contributing to the decline in z-score is the decrease in book value of common equity, which results in a negative $x_4$ coefficient.

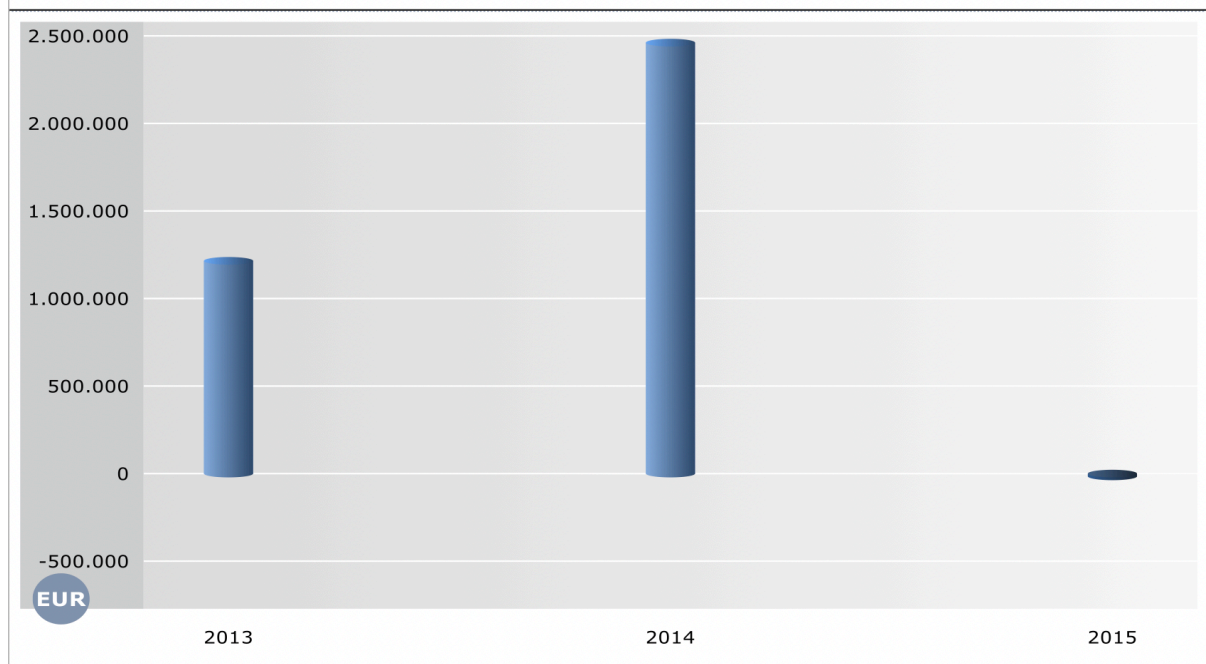**Evolution of a key variable: Total shareholder's funds (2013 - 2015)**



*Figure 17 - AIDA*

**Ohlson O-score Model - ABENGOA SOLAR ITALIA S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2015 | 2014 | 2013 |
| TA | Total assets | 13.484,00 € | 2.540.143,00 € | 1.501.623,00 € |
| GNP | Gross National Product price index level | 1.789.303.571,43 € | 1.569.168.207,02 € | 9.127.497.556,94 € |
| TL | Total liabilities | 29.234,00 € | 78.597,00 € | 286.431,00 € |
| WC | Working capital | -17.850,00 € | 313.701,00 € | -133.732,00 € |
| NI | Net income | -2.854.899,00 € | -543.644,00 € | -499.412,00 € |
| NI_t-1 | Net income (t-1) | -543.644,00 € | -499.412,00 € | -361.273,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | -183.386,00 € | -206.965,00 € | -343.083,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -11,80 | -6,43 | -8,71 |
| $o_2$ | 6,03 | 2,17 | 0,03 | 0,19 |
| $o_3$ | -1,43 | -1,32 | 0,12 | -0,09 |
| $o_4$ | 0,08 | 2,56 | 0,14 | 2,00 |
| $o_5$ | -2,37 | -211,72 | -0,21 | -0,33 |
| $o_6$ | -1,83 | -6,27 | -2,63 | -1,20 |
| $o_7$ | 0,285 | 1,00 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 1,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | -0,68 | -0,04 | -0,16 |
| | T | 530,84 | 6,95 | 7,01 |
| | Default probability | 100,00% | 99,90% | 99,91% |

*Figure 18 – Own elaboration*

The application of the O-Score model shows that in 2015, 2014 and 2013 the probability of bankruptcy turns out to be very close to 100% in all the years.

In this case, in 2014 only the O-Score model predicted the liquidation in 2018, while in the other years under analysis, the two models presented the same result.

● **ACQUALEO SRL**

It is a limited liability company based in Brescia.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was liquidated in 2018. The winding up and liquidation took place on 01/08/2018, while the last available accounting closing date is 31/12/2019.

For this reason, the models will be applied using data from the financial statements of the years 2017, 2016 and 2015.

**Altman Z-Score model (Manufacturing firm) - ACQUALEO SRL**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2017** | **2016** | **2015** |
| WC | **Working capital** | -3.401,00 € | -4.371,00 € | 279,00 € |
| TA | **Total assets** | 6.186,00 € | 4.655,00 € | 5.672,00 € |
| RE | **Retained earnings** | -22.899,00 € | -18.248,00 € | -6.090,00 € |
| EBIT | **Earnings before interest, income taxes** | -502,00 € | -4.650,00 € | -12.158,00 € |
| BVCE | **Book value of common equity** | -3.401,00 € | -2.898,00 € | 1.752,00 € |
| TL | **Total liabilities** | 9.587,00 € | 7.553,00 € | 3.920,00 € |
| S | **Sales** | 0,00 € | 0,00 € | 0,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -0,55 | -0,94 | 0,05 |
| $x_2$ | 0,847 | -3,70 | -3,92 | -1,07 |
| $x_3$ | 3,107 | -0,08 | -1,00 | -2,14 |
| $x_4$ | 0,42 | -0,35 | -0,38 | 0,45 |
| $x_5$ | 0,998 | 0,00 | 0,00 | 0,00 |
| **T** | | **-3,93** | **-7,26** | **-7,35** |

*Figure 19 – Own elaboration*

In this variant of the model, the distress zone is represented by the values $z' < 1.23$.

As can be seen from the analysis performed, in all the three years considered, the enterprise has a negative Z-Score. So, the method turns out to have a very good predictive ability.

However, from an economic point of view, it is useful to analyze the increase of Z-Score value from 2016 ($z'=-7.26$) to 2017 ($z'=-3.93$) since, considering the liquidation in 2018, a worse value would be expected.

This improvement is due to a significant increase of EBIT which results in a consequent rise of $x_3$ coefficient.

**Ohlson O-score Model - ACQUALEO SRL**

| Variable | Description | Inputs 2017 | 2016 | 2015 |
|---|---|---|---|---|
| TA | Total assets | 6.186 | 4.655 | 5.672 |
| GNP | Gross National Product price index level | 1.657.005.758,16 | 1.759.814.781,19 | 1.789.303.571,43 |
| TL | Total liabilities | 9.587 | 7.553 | 3.920 |
| WC | Working capital | -3.401 | -4.371 | 279 |
| NI | Net income | -502 | -4.650 | -12.158 |
| NI_t-1 | Net income (t-1) | -4.650,00 € | -12.158,00 € | -846,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | -502 | -4.650 | -12.158 |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -12,50 | -12,84 | -12,66 |
| $o_2$ | 6,03 | 1,55 | 1,62 | 0,69 |
| $o_3$ | -1,43 | -0,55 | -0,94 | 0,05 |
| $o_4$ | 0,08 | 1,54 | 2,38 | 0,93 |
| $o_5$ | -2,37 | -0,08 | -1,00 | -2,14 |
| $o_6$ | -1,83 | -0,05 | -0,62 | -3,10 |
| $o_7$ | 0,285 | 1,00 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 1,00 | 1,00 | 0,00 |
| $o_9$ | -0,52 | 0,81 | 0,45 | -0,87 |
| **T** | | 12,46 | 17,05 | 19,50 |
| Default probability | | **100,00%** | **100,00%** | **100,00%** |

*Figure 20 – Own elaboration*

This situation is confirmed by the second model under analysis. In fact, the application of the O-Score model shows that, in all the years, the probability of bankruptcy turns out to be equal to 100%.

In this case, both models have a similar result, and both predicted, in previous years, the liquidation of 2018.

● **ADVISE BROKERAGE PLAN ENERGY S.R.L.**

It is a one-person company with limited liability based in Milano.

For what concerns the industry classification, it presents an *Ateco code* equals to *351400,* which corresponds to firms whose activity is linked to the transmission and distribution of electricity.

Since we are dealing with a *non - manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z'' = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05x_4$

The company, according to its current legal status, was dissolved in 2018 through a voluntary liquidation. The last available accounting closing date is 31/12/2018.

For this reason, the models will be applied using data from the financial statements of the years 2017, 2016 and 2015.

**Altman Z-Score model (Non manufacturing firm) - A.B.P. ENERGY S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2017** | **2016** | **2015** |
| WC | **Working capital** | 121.299,00 € | 126.194,00 € | 81.060,00 € |
| TA | **Total assets** | 434.110,00 € | 428.479,00 € | 169.927,00 € |
| RE | **Retained earnings** | -298.758,00 € | 9.570,00 € | 0,00 € |
| EBIT | **Earnings before interest, income taxes** | 28.124,00 € | -236.221,00 € | 23.198,00 € |
| BVCE | **Book value of common equity** | 68.060,00 € | 70.853,00 € | 71.314,00 € |
| TL | **Total liabilities** | 665.984,00 € | 669.176,00 € | 102.297,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 6,56 | 0,28 | 0,29 | 0,48 |
| $x_2$ | 3,26 | -0,69 | 0,02 | 0,00 |
| $x_3$ | 6,72 | 0,06 | -0,55 | 0,14 |
| $x_4$ | 1,05 | 0,10 | 0,11 | 0,70 |
| $x_5$ | | | | |
| **T** | | **0,13** | **-1,59** | **4,78** |

*Figure 21 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z'' < 1.1*.

As can be seen from the analysis performed, in 2015 the enterprise is located in the safe zone, while in 2016 and 2017 is in the distressed one.

However, from an economic point of view, it is useful to analyze the increase of Z-Score value from 2016 (*z''=-1.59*) to 2017 (*z''=0.13*) since, considering the liquidation in 2018, a worse value would be expected.

This improvement is due to a decrease of the retained earnings that in 2017 reach a negative value. This reduction results in a negative $x_2$ coefficient.

Another factor driving this increase is the growth in EBIT in 2017 which, as can be seen from the chart below, turns out to be positive again after the net decrease in the previous year.
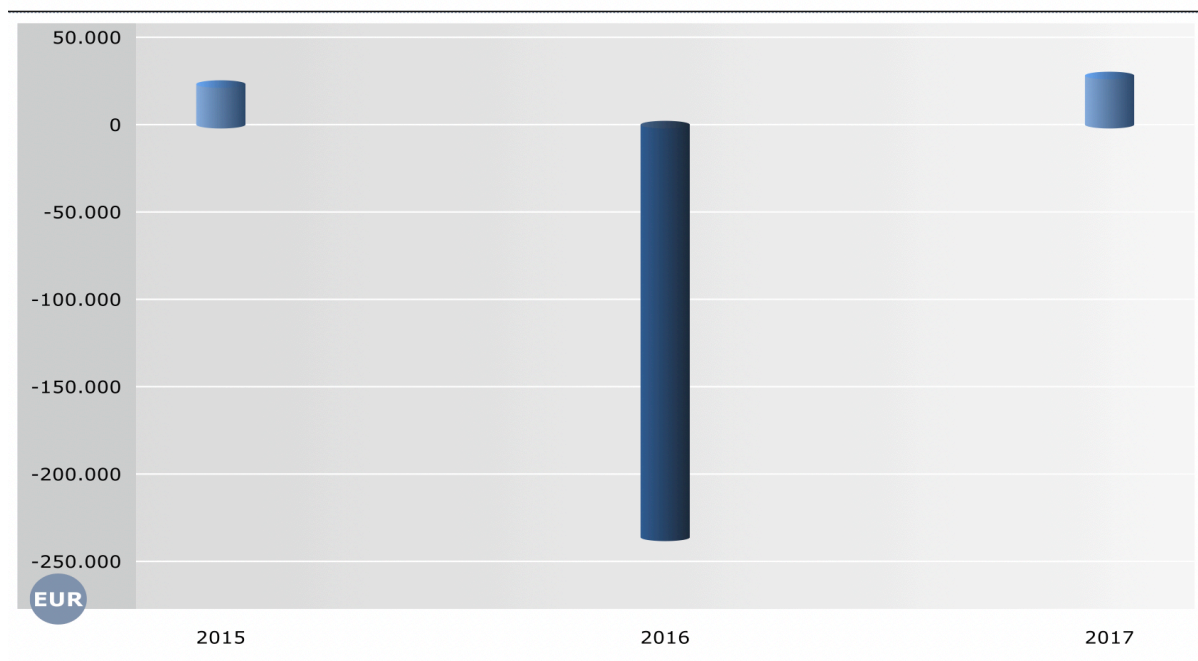
*Figure 22 - AIDA*

**Ohlson O-score Model -  A.B.P. ENERGY S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2017** | **2016** | **2015** |
| TA | **Total assets** | 434.110,00 € | 428.479,00 € | 169.927,00 € |
| GNP | **Gross National Product price index level** | 1.657.005.758,16 € | 1.759.814.781,19 € | 1.789.303.571,43 € |
| TL | **Total liabilities** | 665.984,00 € | 669.176,00 € | 102.297,00 € |
| WC | **Working capital** | 121.299,00 € | 126.194,00 € | 81.060,00 € |
| NI | **Net income** | 8.824,00 € | -308.327,00 € | 9.570,00 € |
| NI_t-1 | **Net income (t-1)** | -308.327,00 € | 9.570,00 € | -2.793,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | 28.124,00 € | -145.194,00 € | 24.205,00 € |

| **Variables** | **Coefficients** | **Values** | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -8,25 | -8,32 | -9,26 |
| $o_2$ | 6,03 | 1,53 | 1,56 | 0,60 |
| $o_3$ | -1,43 | 0,28 | 0,29 | 0,48 |
| $o_4$ | 0,08 | 0,72 | 0,68 | 0,43 |
| $o_5$ | -2,37 | 0,02 | -0,72 | 0,06 |
| $o_6$ | -1,83 | 0,04 | -0,22 | 0,24 |
| $o_7$ | 0,285 | 0,00 | 0,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | 1,00 | -1,00 | 1,00 |
| | **T** | 10,30 | 13,74 | 4,63 |
| | **Default probability** | **100,00%** | **100,00%** | **99,03%** |

*Figure 23 – Own elaboration*

This situation turns out to be confirmed, for 2017 and 2016, by the second model under analysis. In fact, the application of the O-Score model shows that in these two years the probability of bankruptcy turns out to be 100%.

In this case, both models have a similar result, and both predicted, in 2017 and 2016, the future liquidation. However, according to the O-Score model, a very high probability (99%) of default is also shown in 2015, which is not confirmed by the Altman Z-Score model.

● **ALGAE FACTOR S.R.L.**

It is a limited liability company based in Saluzzo.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm,* the formula of the Alman Z-score model to be applied is the following:

*z' = 0.717x₁ + 0.847x₂ + 3.107x₃ + 0.420x₄ + 0.998x₅*

The company, according to its current legal status, was dissolved in 2018. The conclusion of the liquidation took place on 21/12/2018, while the last available accounting closing date is 31/12/2017.

For this reason, the models will be applied using data from the financial statements of the years 2016, 2015 and 2014.

**Altman Z-Score model (Manufacturing firm) - ALGAE FACTOR SRL**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2016** | **2015** | **2014** |
| WC | **Working capital** | 232.863,00 € | 232.565,00 € | 229.796,00 € |
| TA | **Total assets** | 481.497,00 € | 1.085.848,00 € | 1.145.125,00 € |
| RE | **Retained earnings** | 0,00 € | 0,00 € | 0,00 € |
| EBIT | **Earnings before interest, income taxes** | -4.503,00 € | -1.892,00 € | 580,00 € |
| BVCE | **Book value of common equity** | -375.944,00 € | 194.889,00 € | 196.897,00 € |
| TL | **Total liabilities** | 857.441,00 € | 890.959,00 € | 948.228,00 € |
| S | **Sales** | 0,00 € | 0,00 € | 0,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| x₁ | 0,717 | 0,48 | 0,21 | 0,20 |
| x₂ | 0,847 | 0,00 | 0,00 | 0,00 |
| x₃ | 3,107 | -0,01 | -0,00174 | 0,0005 |
| x₄ | 0,42 | -0,44 | 0,22 | 0,21 |
| x₅ | 0,998 | 0,00 | 0,00 | 0,00 |
| | **T** | **0,13** | **0,24** | **0,23** |

*Figure 24 – Own elaboration*

In this variant of the model, the distress zone is represented by the values $z' < 1.23$.

As can be seen from the analysis performed, in all the three years considered, the enterprise has a Z-Score lower than that cut-off level. So, the method turns out to have a very good predictive ability.

The result obtained from the analysis appears to be consistent with the liquidation in 2018, as the Z-Score appears to be unchanged between 2014 and 2015 and decreasing in 2016.

This reduction, from an economic point of view, is mainly caused by the decline in Total assets, which results in a ratio $x_1$ doubled compared to the one in 2015, and the decrease in Book value of common equity, which becomes negative in 2016.

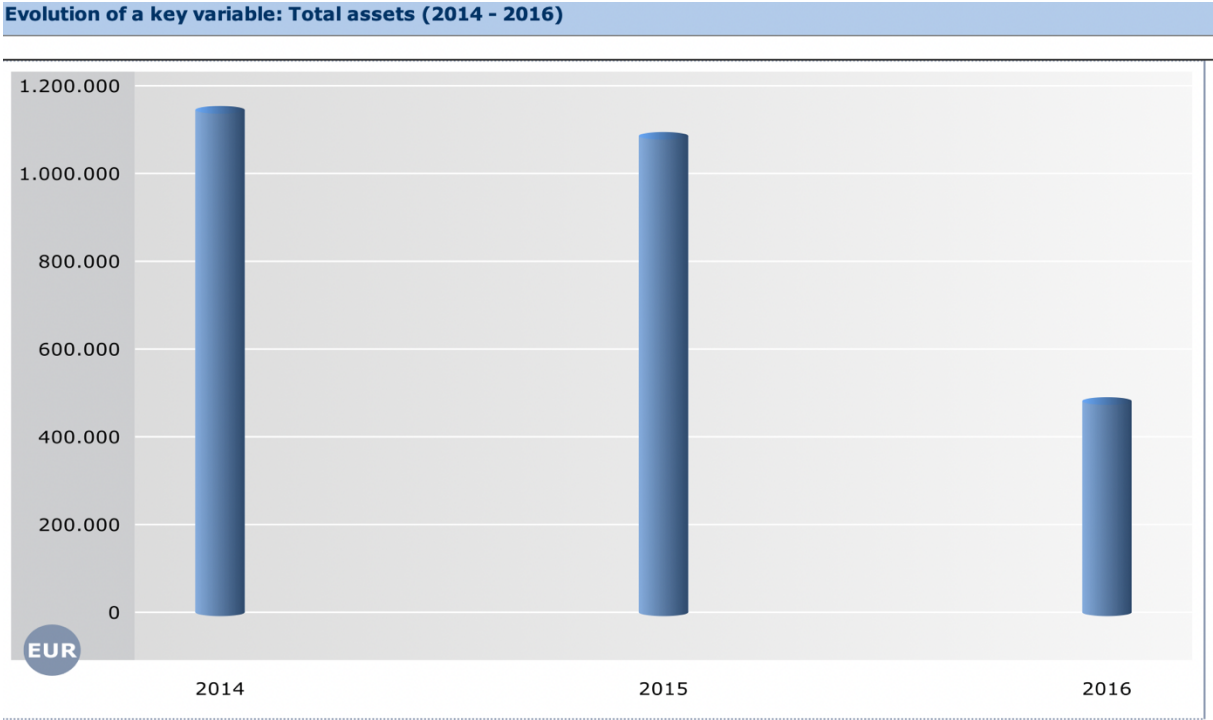The trends of total assets and book value of common equity are shown in the graphs below.



*Figure 25 - AIDA*

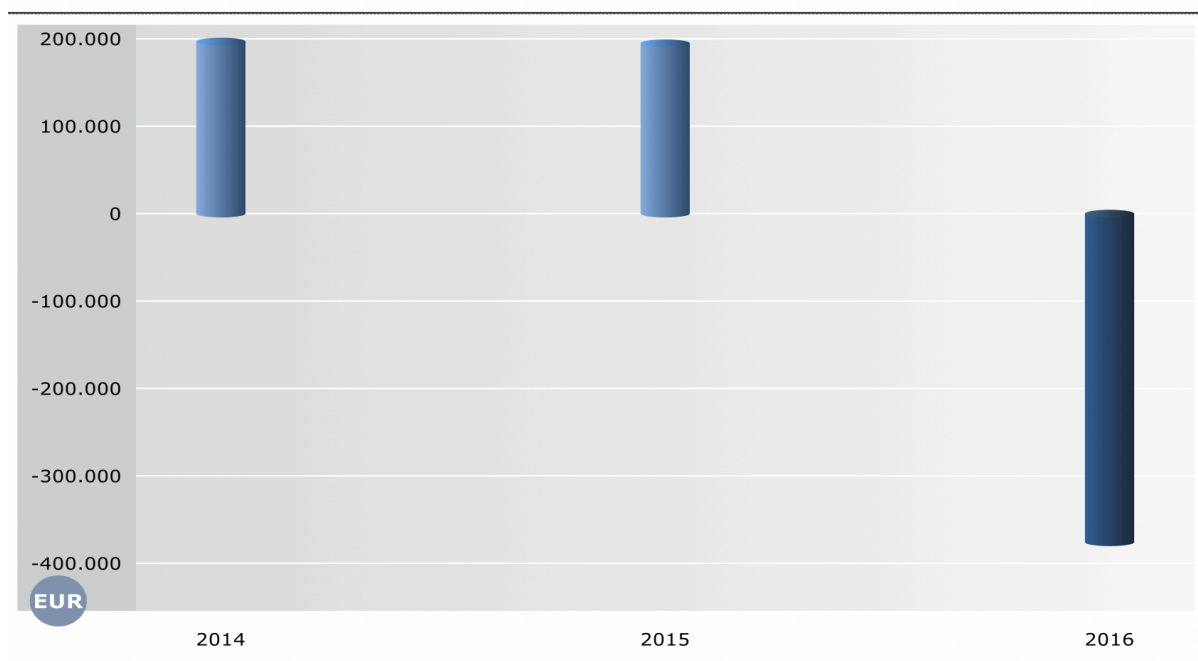**Evolution of a key variable: Total shareholder's funds (2014 - 2016)**

*Figure 26 - AIDA*

**Ohlson O-score Model - ALGAE FACTOR SRL**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2016** | **2015** | **2014** |
| TA | **Total assets** | 481.497 | 1.085.848 | 1.145.125 |
| GNP | **Gross National Product price index level** | 1.759.814.781,19 | 1.789.303.571,43 | 1.569.168.207,02 |
| TL | **Total liabilities** | 857.441 | 890.959 | 948.228 |
| WC | **Working capital** | 232.863 | 232.565 | 229.796 |
| NI | **Net income** | -9.623 | -2.008 | 580 |
| NI_t-1 | **Net income (t-1)** | -2.008,00 € | 580,00 € | -5.790 |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | -4.361 | -114 | 2.358 |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -8,20 | -7,41 | -7,22 |
| $o_2$ | 6,03 | 1,78 | 0,82 | 0,83 |
| $o_3$ | -1,43 | 0,48 | 0,21 | 0,20 |
| $o_4$ | 0,08 | 0,11 | 0,21 | 0,35 |
| $o_5$ | -2,37 | -0,02 | 0,00 | 0,00 |
| $o_6$ | -1,83 | -0,01 | 0,00 | 0,00 |
| $o_7$ | 0,285 | 0,00 | 0,00 | 1,00 |
| $o_8$ | -1,72 | 1,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | -0,65 | -1,00 | 1,00 |
| **T** | | 10,75 | 6,88 | 6,11 |
| **Default probability** | | **100,00%** | **99,90%** | **99,78%** |

*Figure 27 – Own elaboration*

This situation turns out to be confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in all the three years the probability of bankruptcy turns out to be 100% for 2016 and 99% for 2015 and 2014.

In this case, both models have a similar result, and both predicted, in previous years, the liquidation of 2018.

- **A.P.I.C.E. S.R.L.**

It is a limited liability company based in Rome.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

*z' = 0.717x₁ + 0.847x₂ + 3.107x₃ + 0.420x₄ + 0.998x₅*

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was liquidated in 2013. The cancellation from the commercial register took place on 20/12/2013, while the last available accounting closing date is 31/12/2012.

For this reason, the models will be applied using data from the financial statements of the years 2012, 2011 and 2010.

**Altman Z-Score model (Manufacturing firm) - A.P.I.C.E. S.R.L.**

| | | 2012 | 2011 | 2010 |
|---|---|---|---|---|
| WC | Working capital | -86.110,00 € | -30.408,00 € | 79.147,00 € |
| TA | Total assets | 44.173,00 € | 113.106,00 € | 101.568,00 € |
| RE | Retained earnings | -56.985,00 € | 0,00 € | -56.953,00 € |
| EBIT | Earnings before interest, income taxes | -109.076,00 € | -52.619,00 € | -57.671,00 € |
| BVCE | Book value of common equity | -86.110,00 € | 29.128,00 € | 86.113,00 € |
| TL | Total liabilities | 130.283,00 € | 83.978,00 € | 15.455,00 € |
| S | Sales | 0,00 € | 0,00 € | 0,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -1,95 | -0,27 | 0,78 |
| $x_2$ | 0,847 | -1,29 | 0,00 | -0,56 |
| $x_3$ | 3,107 | -2,47 | -0,47 | -0,57 |
| $x_4$ | 0,42 | -0,66 | 0,35 | 5,57 |
| $x_5$ | 0,998 | 0,00 | 0,00 | 0,00 |
| | **T** | **-10,44** | **-1,49** | **0,66** |

*Figure 28 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.

As can be seen from the analysis performed, in all the years taken in consideration, the enterprise has a Z-Score lower than that cut-off level, so the method turns out to have a very good predictive ability.

From an economic point of view, it is interesting to analyze the decrease from 2010, when the company has a positive Z-Score, to 2011 and 2012 when it goes to negative Z-Score values.

This decline is mainly due to a decrease in working capital from a very high value in 2010 to negative amounts in the following two years. This drop results in a negative $x_1$ coefficient. The trend of this factor is illustrated in the graph below.
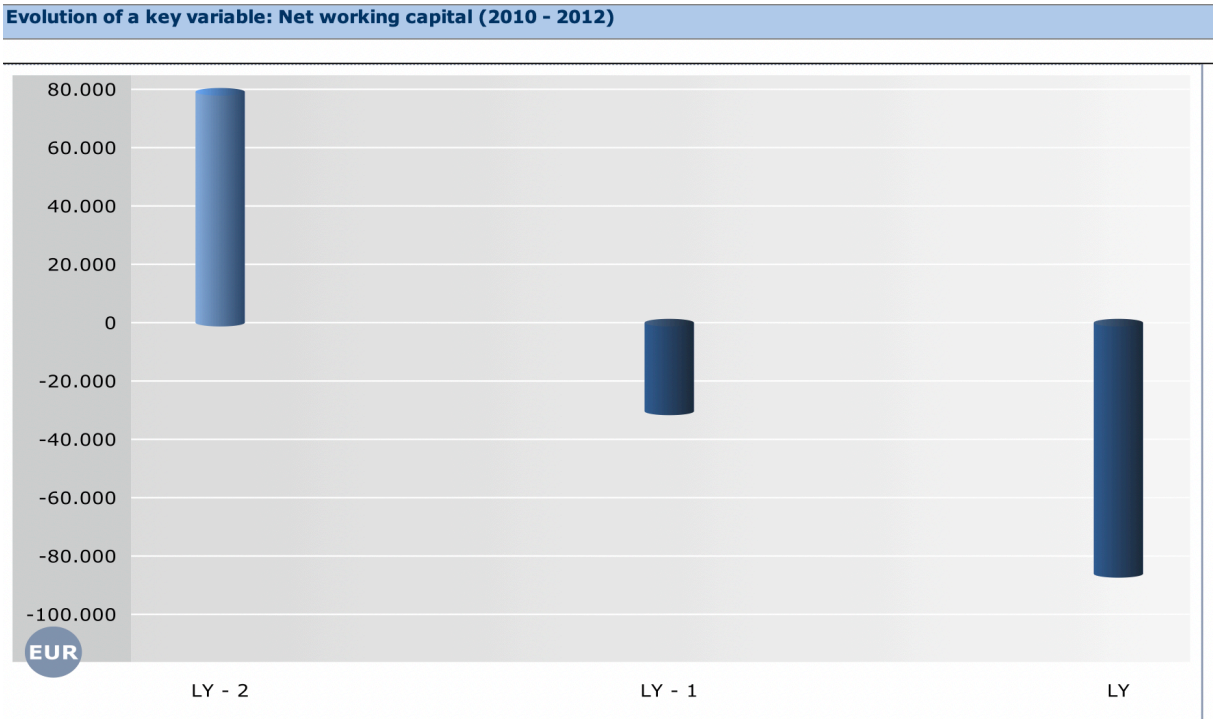


**Evolution of a key variable: Net working capital (2010 - 2012)**

*Figure 29 - AIDA*

Another element to consider is the decrease of the Book value of common equity. This factor still presents a positive value in 2011, although much lower than the one in 2010, while it becomes negative in 2012. This change results in a significant decrease in the $x_4$ coefficient leading to a fall of the total Z-Score.

The trend of this factor is illustrated in the graph below.

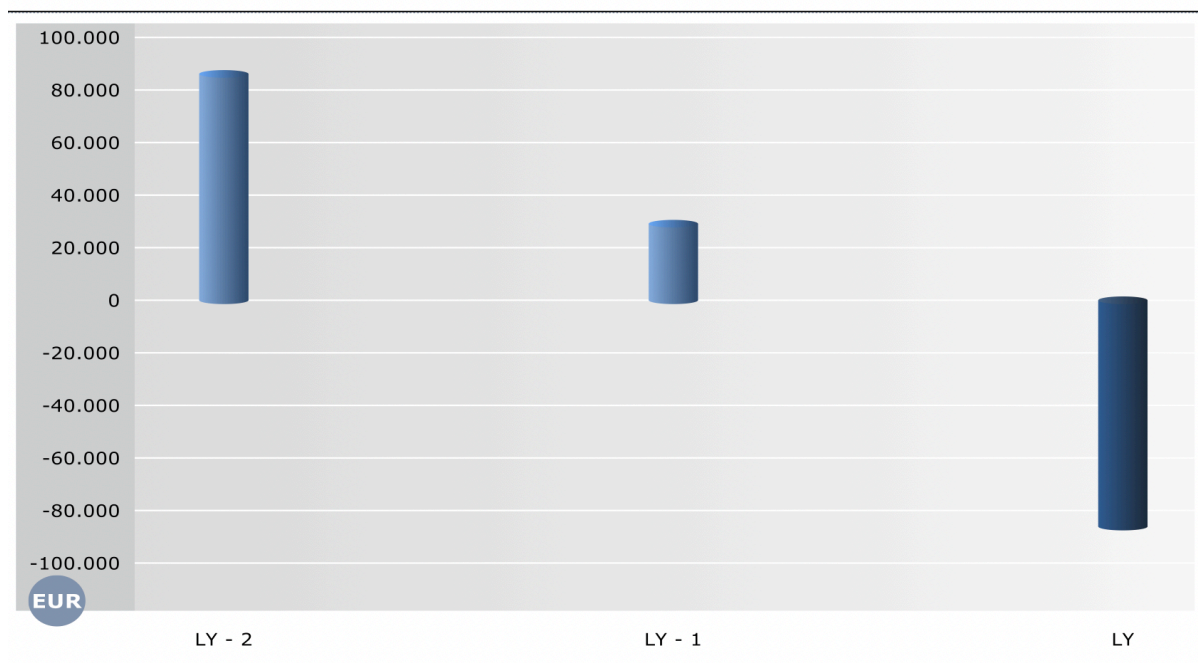**Evolution of a key variable: Total shareholder's funds (2010 - 2012)**



*Figure 30 - AIDA*

**Ohlson O-score Model - A.P.I.C.E. S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2012** | **2011** | **2010** |
| TA | **Total assets** | 44.173,00 € | 113.106,00 € | 101.568,00 € |
| GNP | **Gross National Product price index level** | 1.702.138.910,81 € | 1.600.631.743,33 € | 1.730.853.846,15 € |
| TL | **Total liabilities** | 130.283,00 € | 83.978,00 € | 15.455,00 € |
| WC | **Working capital** | -86.110,00 € | -30.408,00 € | 79.147,00 € |
| NI | **Net income** | -115.238,00 € | -56.985,00 € | -56.934,00 € |
| NI_t-1 | **Net income (t-1)** | -56.985,00 € | -56.934,00 € | -53.959,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | -49.540,00 € | -52.619,00 € | -57.671,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -10,56 | -9,56 | -9,74 |
| $o_2$ | 6,03 | 2,95 | 0,74 | 0,15 |
| $o_3$ | -1,43 | -1,95 | -0,27 | 0,78 |
| $o_4$ | 0,08 | 2,94 | 1,56 | 0,16 |
| $o_5$ | -2,37 | -2,61 | -0,50 | -0,56 |
| $o_6$ | -1,83 | -0,38 | -0,63 | -3,73 |
| $o_7$ | 0,285 | 1,00 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 1,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | -0,34 | 0,00 | -0,03 |
| | **T** | **29,40** | **10,18** | **10,92** |
| | **Default probability** | **100,00%** | **100,00%** | **100,00%** |

*Figure 31 – Own elaboration*

For what concerns the application of the O-Score model, in all the three years under analysis, the enterprise shows a probability of default equal to 100%.

In this case, both models have a similar result, and both predicted, in previous years, the liquidation of 2013.

● **A.S.A.D. S.R.L.**

It is a limited liability company based in Albareto.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was liquidated in 2015. The cancellation from the commercial register took place on 23/11/2015, while the last available accounting closing date is 31/12/2014.

For this reason, the models will be applied using data from the financial statements of the years 2013, 2012 and 2011.

**Altman Z-Score model (Manufacturing firm) - A.S.A.D. S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2013** | **2012** | **2011** |
| WC | **Working capital** | 7.756,00 € | 7.565,00 € | 8.311,00 € |
| TA | **Total assets** | 13.445,00 € | 13.279,00 € | 13.190,00 € |
| RE | **Retained earnings** | -4.322,00 € | -3.689,00 € | -2.497,00 € |
| EBIT | **Earnings before interest, income taxes** | -170,00 € | -746,00 € | -1.418,00 € |
| BVCE | **Book value of common equity** | 7.756,00 € | 7.678,00 € | 8.311,00 € |
| TL | **Total liabilities** | 5.689,00 € | 5.601,00 € | 4.879,00 € |
| S | **Sales** | 0,00 € | 0,00 € | 0,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| $x_1$ | 0,717 | 0,58 | 0,57 | 0,63 |
| $x_2$ | 0,847 | -0,32 | -0,28 | -0,19 |
| $x_3$ | 3,107 | -0,01 | -0,06 | -0,11 |
| $x_4$ | 0,42 | 1,36 | 1,37 | 1,70 |
| $x_5$ | 0,998 | 0,00 | 0,00 | 0,00 |
| | **T** | **0,67** | **0,57** | **0,67** |

*Figure 32 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.

As can be seen from the analysis performed, in all the three years considered, the enterprise has a value that belongs to the distress zone. So, the method turns out to have a very good predictive ability.

However, from an economic perspective, it is useful to analyze the trend of the Z-Score, which from 2011 to 2012 decreases and from 2012 to 2013 increases again, stabilizing at the same level of 2011.

This trend is mainly due to an increase in EBIT over the three years as can also be seen from the graph below. In fact, while it always maintains a negative value, its increase is such that it generates a consequential growth in the x3 coefficient.
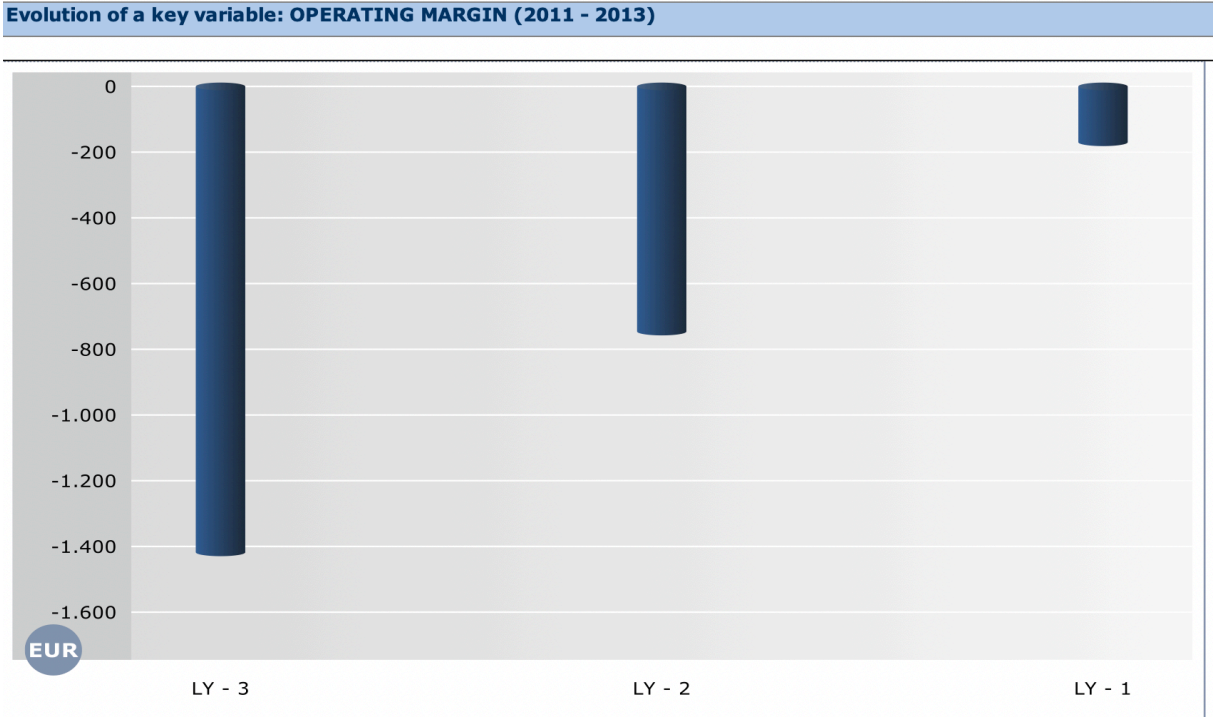


*Figure 33 - AIDA*

**Ohlson O-score Model - A.S.A.D. S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2013 | 2012 | 2011 |
| TA | Total assets | 13.445,00 € | 13.279,00 € | 13.190,00 € |
| GNP | Gross National Product price index level | 9.127.497.556,94 € | 1.702.138.910,81 € | 1.600.631.743,33 € |
| TL | Total liabilities | 5.689,00 € | 5.601,00 € | 4.879,00 € |
| WC | Working capital | 7.756,00 € | 7.565,00 € | 8.311,00 € |
| NI | Net income | 77,00 € | -633,00 € | -1.193,00 € |
| NI_t-1 | Net income (t-1) | -633,00 € | -1.193,00 € | -513,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | -170,00 € | -746,00 € | -1.418,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -13,43 | -11,76 | -11,71 |
| $o_2$ | 6,03 | 0,42 | 0,42 | 0,37 |
| $o_3$ | -1,43 | 0,58 | 0,57 | 0,63 |
| $o_4$ | 0,08 | 0,42 | 0,43 | 0,37 |
| $o_5$ | -2,37 | 0,01 | -0,05 | -0,09 |
| $o_6$ | -1,83 | -0,03 | -0,13 | -0,29 |
| $o_7$ | 0,285 | 1,00 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | -0,78 | 0,31 | -0,40 |
| **T** | | 6,64 | 5,71 | 6,04 |
| Default probability | | **99,87%** | **99,67%** | **99,76%** |

*Figure 34 – Own elaboration*

This situation turns out to be confirmed by the second model under analysis for the entire period taken in consideration. In fact, the application of the O-Score model shows that in those years the probability of bankruptcy is equal to 99%.

In this case, both models have a similar result, and both predicted, in previous years, the liquidation of 2015.

## • ENERGIE RINNOVABILI ITALIA S.R.L.

It is a limited liability company based in San Giovanni Teatino.

For what concerns the industry classification, it presents an *Ateco code* equals to *271100,* which corresponds to firms whose activity is linked to the *manufacture of electric motors, generators and transformers*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was dissolved in 2015. The conclusion of liquidation took place on 21/12/2015, while the last available accounting closing date is 31/12/2014.

For this reason, the models will be applied using data from the financial statements of the years 2014, 2013 and 2012.

**Altman Z-Score model (Manufacturing firm) - ERI S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2014** | **2013** | **2012** |
| WC | **Working capital** | -246.401,00 € | -239.700,00 € | -202.940,00 € |
| TA | **Total assets** | 318.374,00 € | 318.793,00 € | 280.552,00 € |
| RE | **Retained earnings** | -150,00 € | -140,00 € | -100,00 € |
| EBIT | **Earnings before interest, income taxes** | -6.702,00 € | -6.011,00 € | -6.041,00 € |
| BVCE | **Book value of common equity** | 17.149,00 € | 23.850,00 € | 23.860,00 € |
| TL | **Total liabilities** | 301.225,00 € | 294.943,00 € | 256.692,00 € |
| S | **Sales** | 0,00 € | 0,00 € | 0,00 € |

| **Variables** | **Coefficients** | | **Values** | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -0,77 | -0,75 | -0,72 |
| $x_2$ | 0,847 | -0,00047 | -0,00044 | -0,00036 |
| $x_3$ | 3,107 | -0,02 | -0,02 | -0,02 |
| $x_4$ | 0,42 | 0,06 | 0,08 | 0,09 |
| $x_5$ | 0,998 | 0,00 | 0,00 | 0,00 |
| **T** | | **-0,60** | **-0,56** | **-0,55** |

*Figure 35 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.

As can be seen from the analysis performed, in all the years considered, the enterprise has a negative Z-Score. So, the method turns out to have a very good predictive ability.

From an economic point of view, it is interesting to analyze the trend of the Z-Score which appears to be consistent with the subsequent liquidation of the enterprise. The gradual decrease in value is mainly caused by a slight fall of Working capital and a simultaneous increase in Total assets, resulting in a reduction in the $x_1$ coefficient.

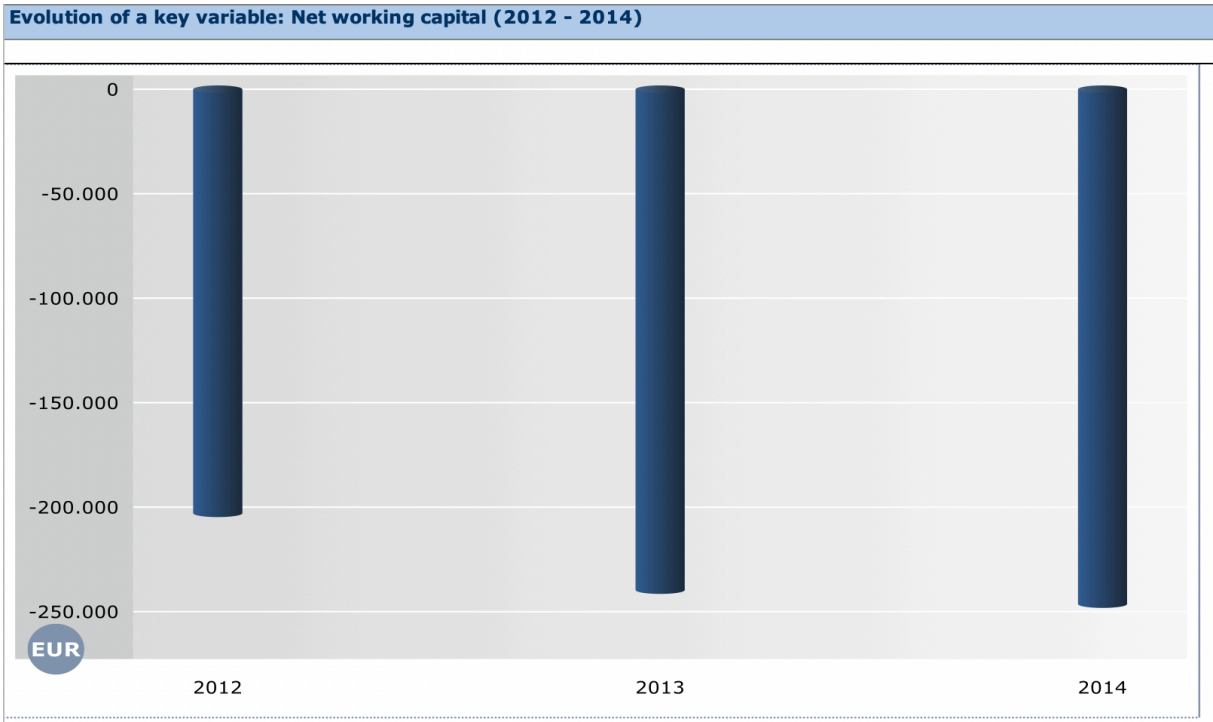In the graphs below it is possible to look at the trend of these factors.

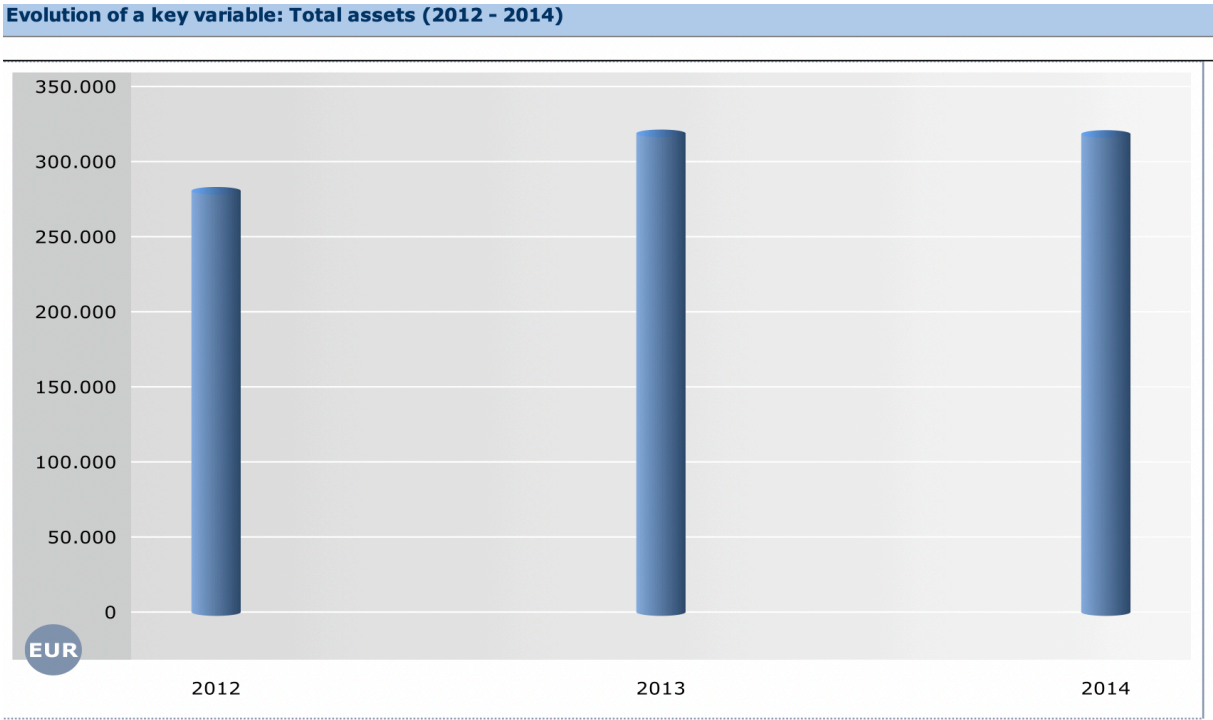**Evolution of a key variable: Net working capital (2012 - 2014)**



*Figure 36 - AIDA*

**Evolution of a key variable: Total assets (2012 - 2014)**



*Figure 37 - AIDA*

**Ohlson O-score Model - ERI S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2014** | **2013** | **2012** |
| TA | **Total assets** | 318.374,00 € | 318.793,00 € | 280.552,00 € |
| GNP | **Gross National Product price index level** | 1.569.168.207,02 € | 9.127.497.556,94 € | 1.702.138.910,81 € |
| TL | **Total liabilities** | 301.225,00 € | 294.943,00 € | 256.692,00 € |
| WC | **Working capital** | -246.401,00 € | -239.700,00 € | -202.940,00 € |
| NI | **Net income** | -6.701,00 € | -6.010,00 € | -6.040,00 € |
| NI_t-1 | **Net income (t-1)** | -6.010,00 € | -6.040,00 € | 0,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | -6.702,00 € | -6.011,00 € | -6.041,00 € |

| **Variables** | **Coefficients** | **Values** | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -8,50 | -10,26 | -8,71 |
| $o_2$ | 6,03 | 0,95 | 0,93 | 0,91 |
| $o_3$ | -1,43 | -0,77 | -0,75 | -0,72 |
| $o_4$ | 0,08 | 5,56 | 5,26 | 4,76 |
| $o_5$ | -2,37 | -0,02 | -0,02 | -0,02 |
| $o_6$ | -1,83 | -0,02 | -0,02 | -0,02 |
| $o_7$ | 0,285 | 1,00 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | -0,05 | 0,00 | 0,00 |
| **T** | | 9,80 | 10,30 | 9,54 |
| **Default probability** | | **99,99%** | **100,00%** | **99,99%** |

*Figure 38 – Own elaboration*

This situation turns out to be confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in those years the probability of bankruptcy is equal to 100%.

In this case, both models have a similar result, and both predicted, in previous years, the liquidation of 2015.

● **SIAMO ENERGIA & PARTNERS S.R.L.**

It is a limited liability company based in Montecatini Terme.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was failed in 2020. The bankruptcy took place on 09/09/2020, while the last available accounting closing date is 31/12/2016.

For this reason, the models will be applied using data from the financial statements of the years 2016, 2015 and 2014.

**Altman Z-Score model (Manufacturing firm) - SIAMO ENERGIA & PARTNERS S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2016** | **2015** | **2014** |
| WC | **Working capital** | 1.486.478,00 € | 1.496.296,00 € | 503.816,00 € |
| TA | **Total assets** | 1.967.475,00 € | 1.944.340,00 € | 1.957.071,00 € |
| RE | **Retained earnings** | -59.198,00 € | -35.972,00 € | -15.104,00 € |
| EBIT | **Earnings before interest, income taxes** | 20.905,00 € | -23.131,00 € | -17.017,00 € |
| BVCE | **Book value of common equity** | 520.308,00 € | 501.176,00 € | 774.028,00 € |
| TL | **Total liabilities** | 1.447.167,00 € | 1.443.164,00 € | 1.183.043,00 € |
| S | **Sales** | 430.829,00 € | 114.597,00 € | 23.268,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| $x_1$ | 0,717 | 0,76 | 0,77 | 0,26 |
| $x_2$ | 0,847 | -0,03 | -0,02 | -0,01 |
| $x_3$ | 3,107 | 0,01 | -0,01 | -0,01 |
| $x_4$ | 0,42 | 0,36 | 0,35 | 0,65 |
| $x_5$ | 0,998 | 0,22 | 0,06 | 0,01 |
| | **T** | **0,92** | **0,70** | **0,44** |

*Figure 39 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.

As can be seen from the analysis performed, in all the three years considered, the enterprise has a Z-Score that belong to the distress zone. So, the method turns out to have a very good predictive ability.

However, from an economic point of view, it is useful to analyze the progressive increase of Z-Score value from 2014 (*z'=0.44*) to 2016 (*z'=0.92*) since, considering the bankruptcy in 2020, worse values would be expected.

These improvements are due to a gradual increase in sales in the years under consideration, resulting in an increase in the $x_5$ coefficient.

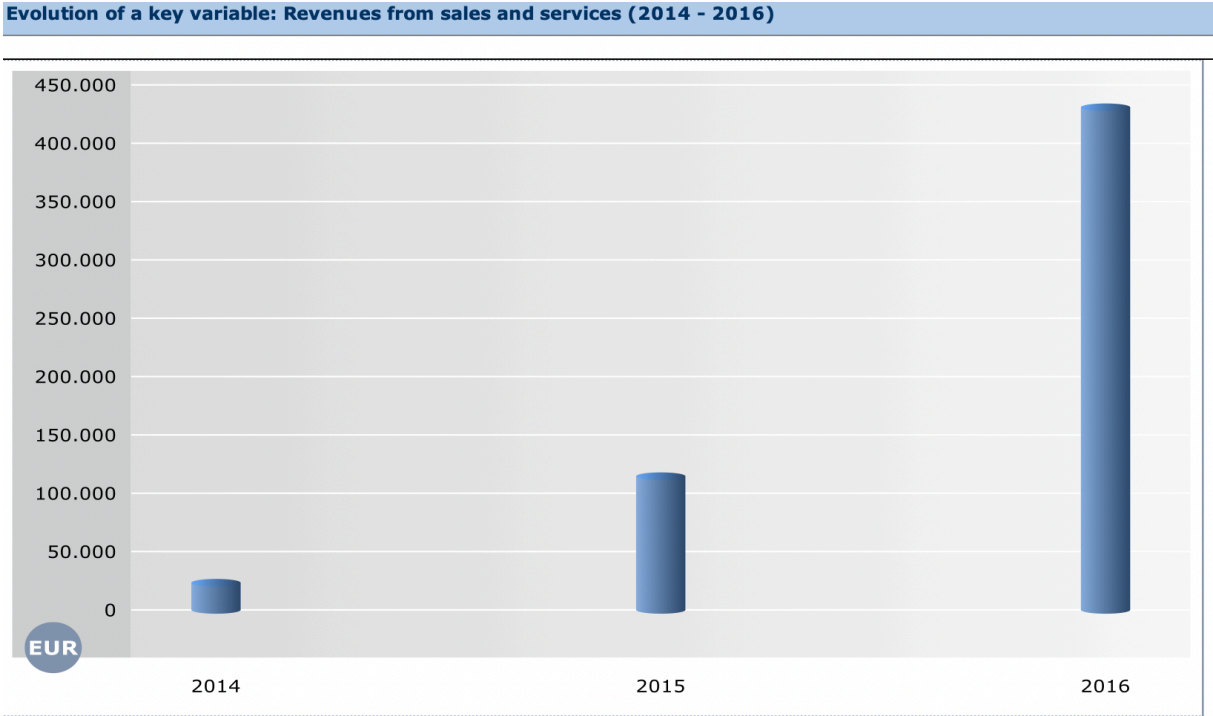In the graph below it is possible to look at the trend of this factor.

**Evolution of a key variable: Revenues from sales and services (2014 - 2016)**



*Figure 40 - AIDA*

The trend of EBIT should also be taken into account, particularly from 2015 to 2016. In fact, as can be seen in the graph below, in 2016 there is a sizeable rise that causes the value to change to positive. This evolution translates into an increase in the $x_3$ coefficient enough to become positive in 2016.
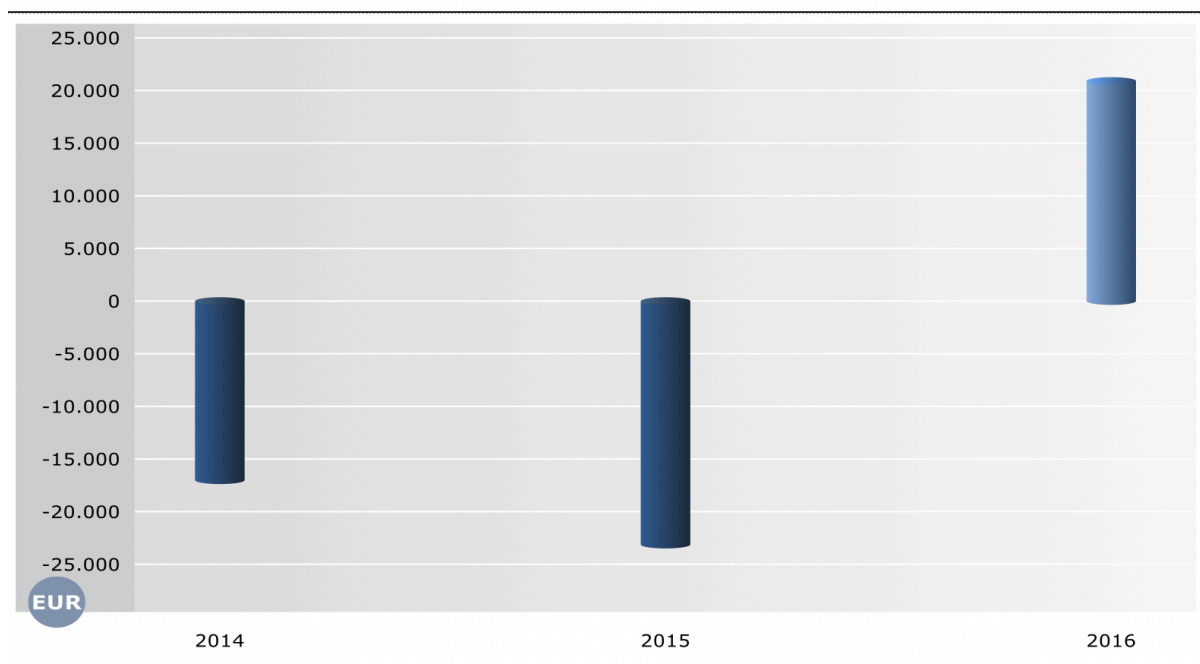
*Figure 41 – AIDA*

So, in the last balance sheet year we can see a concrete improvement in the structural indices. However, it turns out not to be enough to fix an already failing situation.

**Ohlson O-score Model - SIAMO ENERGIA & PARTNERS S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2016 | 2015 | 2014 |
| TA | Total assets | 1.967.475,00 € | 1.944.340,00 € | 1.957.071,00 € |
| GNP | Gross National Product price index level | 1.759.814.781,19 | 1.789.303.571,43 | 1.569.168.207,02 € |
| TL | Total liabilities | 1.447.167,00 € | 1.443.164,00 € | 1.183.043,00 € |
| WC | Working capital | 1.486.478,00 € | 1.496.296,00 € | 503.816,00 € |
| NI | Net income | 19.131,00 € | -23.225,00 € | -8.131,00 € |
| NI_t-1 | Net income (t-1) | -23.225,00 € | -8.131,00 € | -12.738,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | 44.567,00 € | -4.954,00 € | -1.577,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -6,80 | -6,82 | -6,69 |
| $o_2$ | 6,03 | 0,74 | 0,74 | 0,60 |
| $o_3$ | -1,43 | 0,76 | 0,77 | 0,26 |
| $o_4$ | 0,08 | 0,10 | 0,10 | 0,16 |
| $o_5$ | -2,37 | 0,01 | -0,01 | -0,0042 |
| $o_6$ | -1,83 | 0,03 | -0,0034 | -0,0013 |
| $o_7$ | 0,285 | 1,00 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | 1,00 | -0,48 | 0,22 |
| | | | | |
| T | | 4,49 | 5,41 | 4,87 |
| | | | | |
| Default probability | | 98,90% | 99,56% | 99,24% |

*Figure 42 – Own elaboration*

This situation turns out to be confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in those years the probability of bankruptcy is

equal to 99% and 98%. Just as with the previous model, a very slight improvement can be seen in the last year due to an increase in Net income and EBITDA both of which turn out to reach a positive value.

In this case, both models have a similar result, and both predicted, in previous years, the bankruptcy of 2020.

- **EIFFEL S.R.L.**

It is a limited liability company based in Pescara.

For what concerns the industry classification, it presents an *Ateco code* equals to *351400,* which corresponds to firms whose activity is linked to the *trade of electricity*.

Since we are dealing with a *non - manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

*z" = 6.56x₁ + 3.26x₂ + 6.72x₃ + 1.05x₄*

The company, according to its current legal status, was failed in 2017. The conclusion of the liquidation took place on 20/10/2017, while the last available accounting closing date is 31/12/2016.

For this reason, the models will be applied using data from the financial statements of the years 2016, 2015 and 2014.

**Altman Z-Score model (Non manufacturing firm) - EIFFEL S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2016 | 2015 | 2014 |
| WC | **Working capital** | -411.913,00 € | -54.759,00 € | -372.326,00 € |
| TA | **Total assets** | 417.366,00 € | 585.432,00 € | 607.820,00 € |
| RE | **Retained earnings** | 0,00 € | -254.769,00 € | -304.842,00 € |
| EBIT | **Earnings before interest, income taxes** | -333.488,00 € | 599.121,00 € | 236.747,00 € |
| BVCE | **Book value of common equity** | -329.394,00 € | 31.976,00 € | -244.269,00 € |
| TL | **Total liabilities** | 746.760,00 € | 553.456,00 € | 852.089,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 6,56 | -0,99 | -0,09 | -0,61 |
| $x_2$ | 3,26 | 0,00 | -0,44 | -0,50 |
| $x_3$ | 6,72 | -0,80 | 1,02 | 0,39 |
| $x_4$ | 1,05 | -0,44 | 0,06 | -0,29 |
| $x_5$ | | | | |
| **T** | | **-12,31** | **4,75** | **-3,52** |

*Figure 43 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z"< 1.1*.

As can be seen from the analysis performed, in 2014 and 2016 the enterprise has a negative Z-Score. So, in those years, the method turns out to have a very good predictive ability.

However, it is important to analyze from an economic point of view, the performance of the Z-Score as it appears to be settled in the safe zone in 2015. This is an atypical result that needs to be studied in order to understand whether it is an anomaly in the model or an actual recovery of the firm with a consequent spillover in the following year.

As can be seen, in 2015 all the coefficients of the model increase, and this generates an improvement in the value of the Z-Score. In particular, this is due to a rise in Working capital, EBIT and Book value of common equity, signs that suggest that the company is actually recovering in that year.

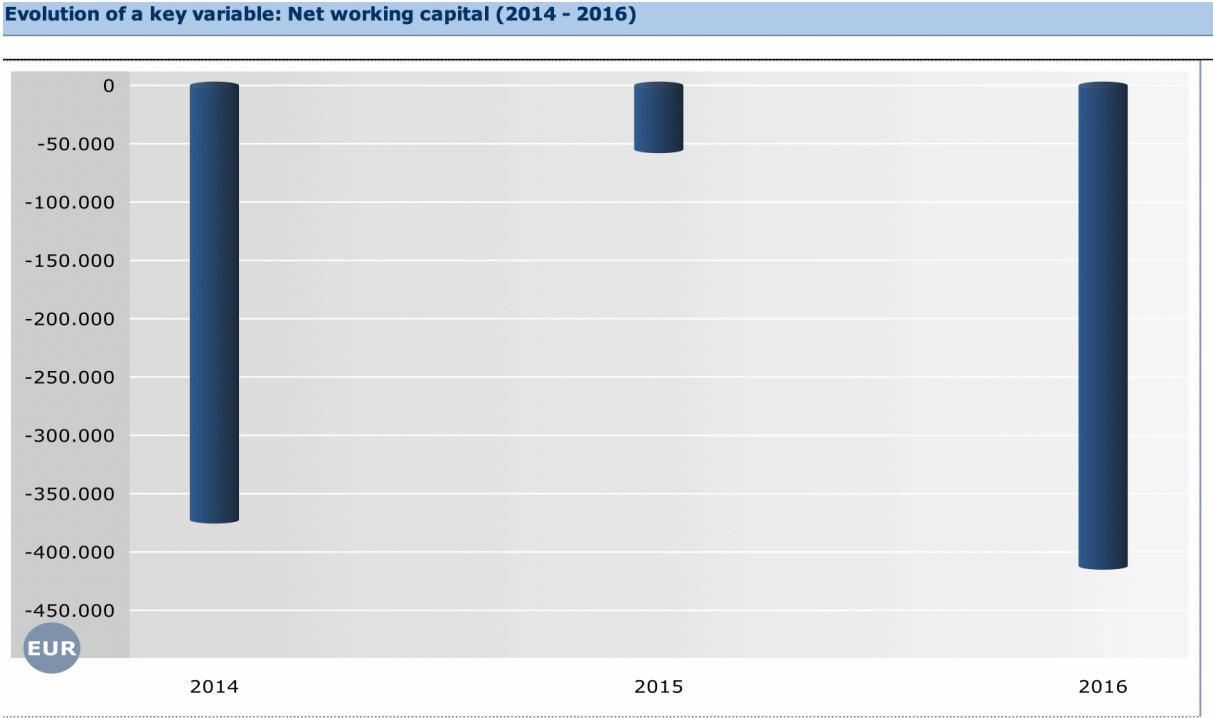In the graphs below it is possible to look at the trend of these factors.

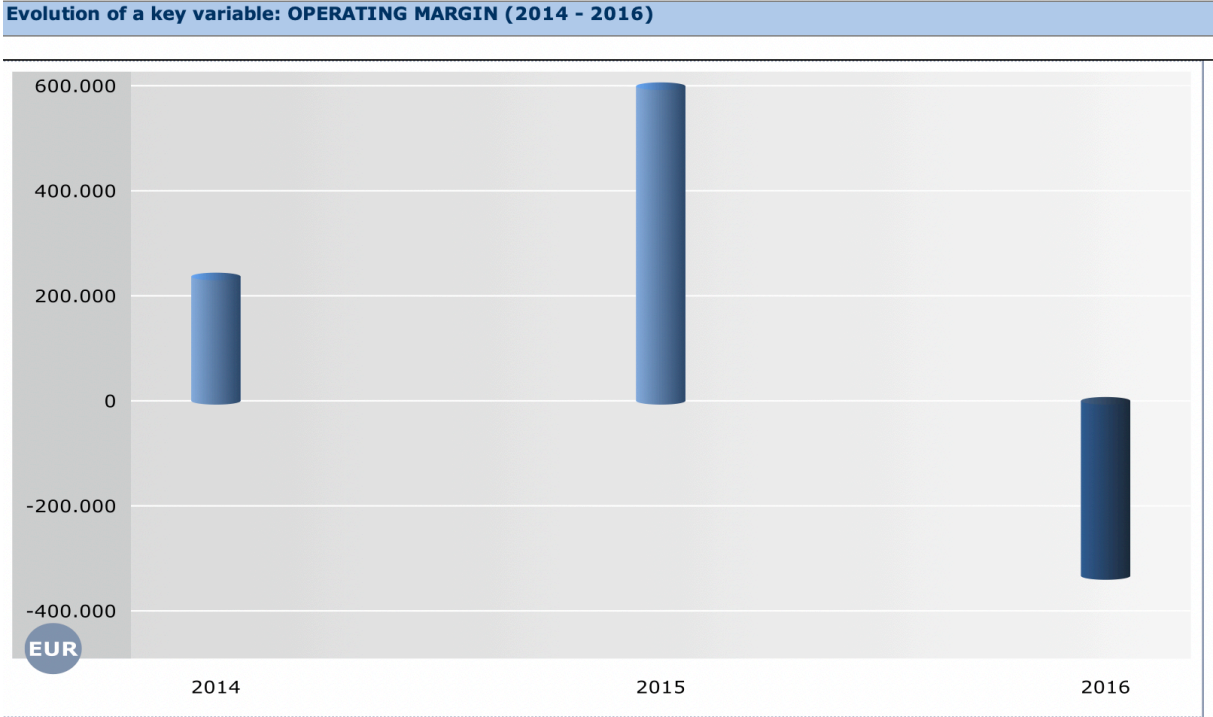**Evolution of a key variable: Net working capital (2014 - 2016)**



*Figure 44 - AIDA*

**Evolution of a key variable: OPERATING MARGIN (2014 - 2016)**
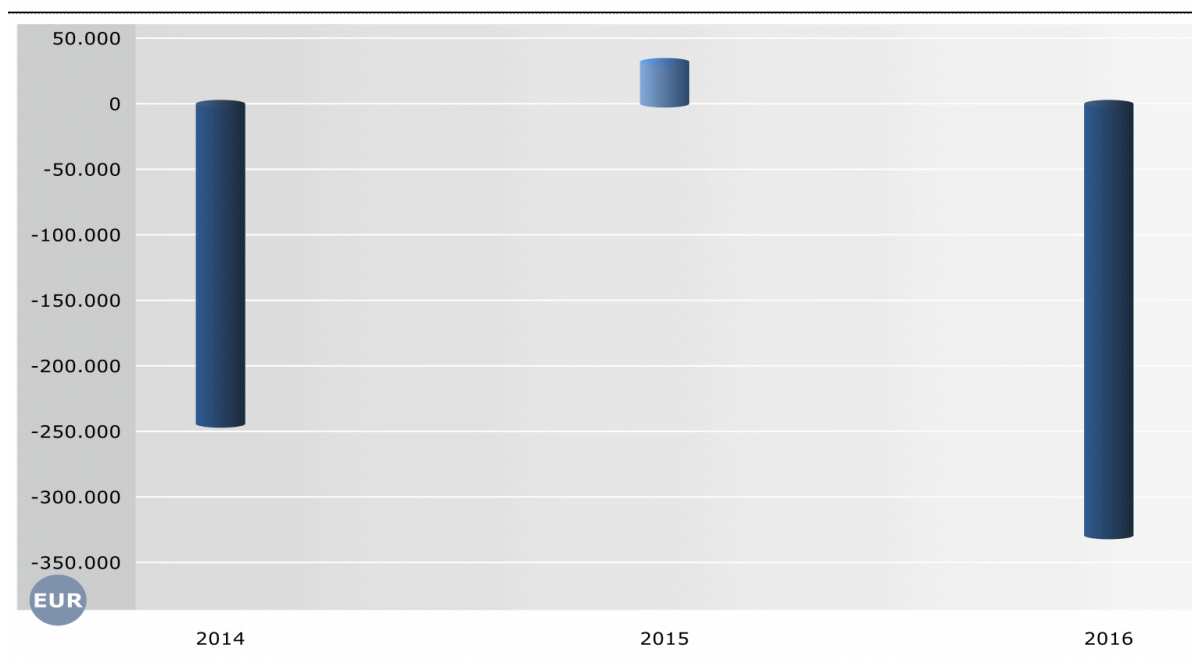


*Figure 45 - AIDA*

Figure 46 - AIDA

As for 2016, the company again reaches a negative value of the Z-Score whose evolution is consistent with the liquidation of 2017.

The determining drivers that caused this sharp decrease turn out to be the same factors listed above. This means that the slight improvement in 2015 was not enough to result in the bailout of a company with an overstressed situation.

### Ohlson O-score Model - EIFFEL S.R.L.

| | | Inputs | | |
|---|---|---|---|---|
| | | **2016** | **2015** | **2014** |
| TA | **Total assets** | 417.366,00 € | 585.432,00 € | 607.820,00 € |
| GNP | **Gross National Product price index level** | 1.759.814.781,19 | 1.789.303.571,43 | 1.569.168.207,02 |
| TL | **Total liabilities** | 746.760,00 € | 553.456,00 € | 852.089,00 € |
| WC | **Working capital** | -411.913,00 € | -54.759,00 € | -372.326,00 € |
| NI | **Net income** | -406.814,00 € | 276.248,00 € | 50.573,00 € |
| NI_t-1 | **Net income (t-1)** | 276.248,00 € | 50.573,00 € | -271.437,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | -305.026,00 € | 625.627,00 € | 253.153,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -8,35 | -8,02 | -7,86 |
| $o_2$ | 6,03 | 1,79 | 0,95 | 1,40 |
| $o_3$ | -1,43 | -0,99 | -0,09 | -0,61 |
| $o_4$ | 0,08 | 2,33 | 1,14 | 1,92 |
| $o_5$ | -2,37 | -0,97 | 0,47 | 0,08 |
| $o_6$ | -1,83 | -0,41 | 1,13 | 0,30 |
| $o_7$ | 0,285 | 0,00 | 0,00 | 0,00 |
| $o_8$ | -1,72 | 1,00 | 1,00 | 1,00 |
| $o_9$ | -0,52 | -1,00 | 0,69 | 1,00 |
| **T** | | 16,32 | 2,61 | 8,38 |
| Default probability | | **100,00%** | **93,12%** | **99,98%** |

Figure 47 – Own elaboration

This situation is confirmed by the second model under analysis. In particular, even with O-Score model a slight improvement can be seen in 2015 with a default probability equal to 93%. This improvement is mainly generated by a significant increase in Net Income and EBITDA. The situation worsens again in 2016 with these two factors both standing at negative values, causing a default probability equal to 100%.

Making a comparison between the two models, the Ohlson seems to have a better predictive ability since it signals only a slight improvement, while the Altman brings to a result that is less consistent with the subsequent failure of the enterprise.

- **MOBILSERVICE S.R.L.**

It is a one-person company with limited liability based in Colleferro.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

*z' = 0.717x₁ + 0.847x₂ + 3.107x₃ + 0.420x₄ + 0.998x₅*

The company, according to its current legal status, was failed in 2007. The insolvency status was acknowledged on 08/13/2007, while the last available accounting closing date is 31/12/2006.

For this reason, the models will be applied using data from the financial statements of the years 2006, 2005 and 2004.

**Altman Z-Score model (Manufacturing firm) - MOBILSERVICE S.R.L.**

|  |  | Inputs | | |
|---|---|---|---|---|
|  |  | **2006** | **2005** | **2004** |
| WC | **Working capital** | -7.557.870,00 € | -4.529.067,00 € | -1.986.911,00 € |
| TA | **Total assets** | 60.656.434,00 € | 69.245.710,00 € | 72.722.982,00 € |
| RE | **Retained earnings** | 0,00 € | 0,00 € | 0,00 € |
| EBIT | **Earnings before interest, income taxes** | 1.749.562,00 € | -5.436.929,00 € | 6.561.582,00 € |
| BVCE | **Book value of common equity** | 729.665,00 € | -10.856.247,00 € | 742.973,00 € |
| TL | **Total liabilities** | 59.926.769,00 € | 80.101.957,00 € | 71.980.009,00 € |
| S | **Sales** | 14.466.904,00 € | 13.885.360,00 € | 15.949.132,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -0,12 | -0,07 | -0,03 |
| $x_2$ | 0,847 | 0,00 | 0,00 | 0,00 |
| $x_3$ | 3,107 | 0,03 | -0,08 | 0,09 |
| $x_4$ | 0,42 | 0,01 | -0,14 | 0,01 |
| $x_5$ | 0,998 | 0,24 | 0,20 | 0,22 |
|  | **T** | **0,24** | **-0,15** | **0,48** |

*Figure 48 – Own elaboration*

In this variant of the model, the distress zone is represented by values *z' < 1.23*.

As can be seen from the analysis performed, in all the three years considered, the company shows values of the Z-Score belonging to the distress zone. Thus, the method turns out to have an excellent predictive ability.

However, it is useful to analyze from an economic point of view the evolution of the value.

In particular, after an expected decrease in the Z-Score from 2004 to 2005, a slight improvement can be seen in 2006 with a Z-Score again positive although still belonging to the distress zone.

This improvement can be attributed to an increase in EBIT in the last year which, as can also be seen from the graph below, is stabilizing again at a positive value. This results in an increase of the $x_3$ coefficient.

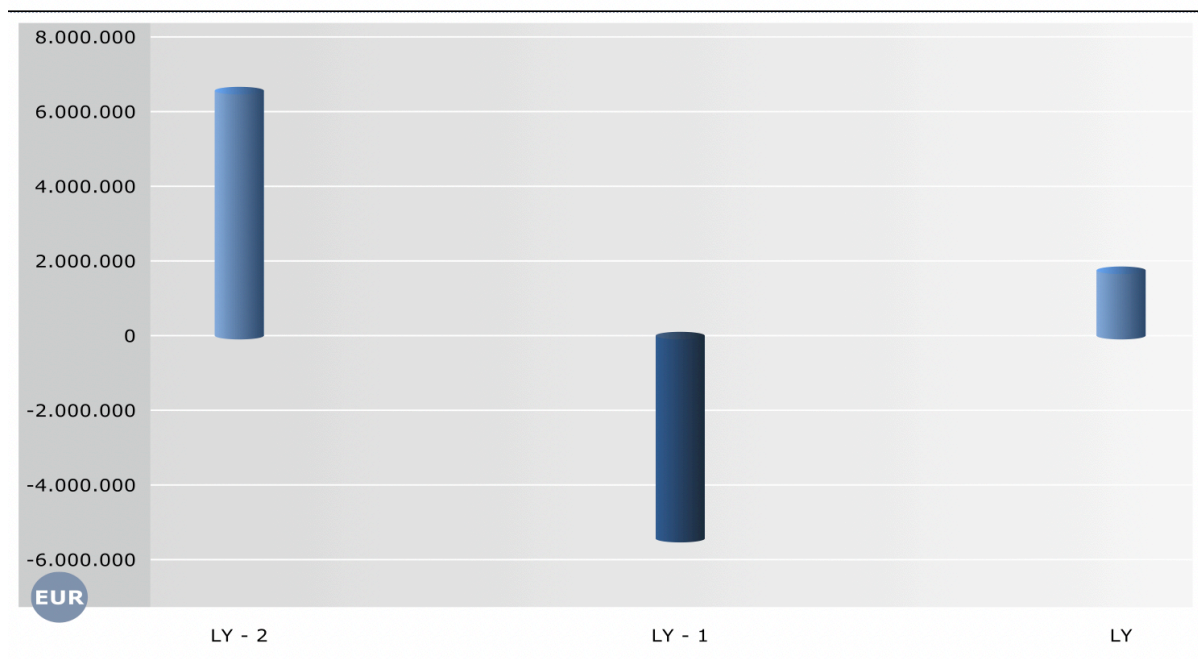**Evolution of a key variable: OPERATING MARGIN (2004 - 2006)**



*Figure 49 - AIDA*

Another driving factor is the increase in the Book value of common equity, which, following the same trend, also settles on a positive value.

The graph below shows its evolution.

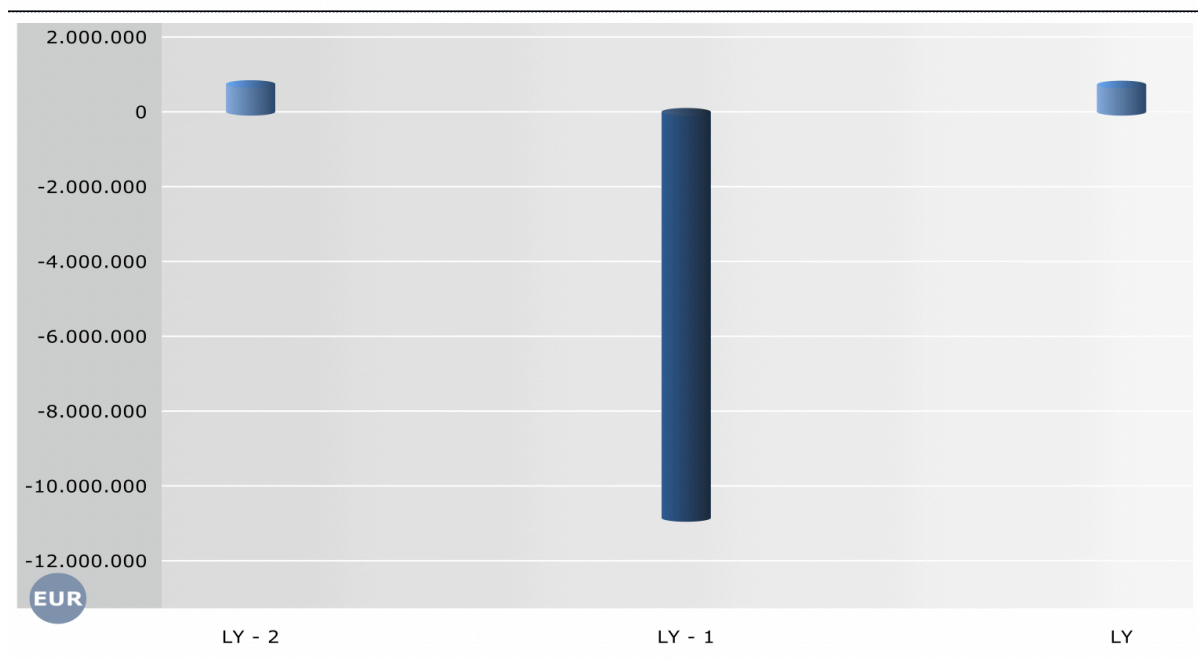**Evolution of a key variable: Total shareholder's funds (2004 - 2006)**



*Figure 50 - AIDA*

**Ohlson O-score Model - MOBILSERVICE S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2006 | 2005 | 2004 |
| TA | Total assets | 60.656.434,00 € | 69.245.710,00 € | 72.722.982,00 € |
| GNP | Gross National Product price index level | 1.573.630.191,06 € | 1.560.129.256,77 € | 1.320.855.874,04 € |
| TL | Total liabilities | 59.926.769,00 € | 80.101.957,00 € | 71.980.009,00 € |
| WC | Working capital | -7.557.870,00 € | -4.529.067,00 € | -1.986.911,00 € |
| NI | Net income | -13.308,00 € | -11.599.215,00 € | 572.286,00 € |
| NI_t-1 | Net income (t-1) | -11.599.215,00 € | 572.286,00 € | -72.260,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | 6.745.820,00 € | 3.646.696,00 € | 11.237.387,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -3,26 | -3,11 | -2,90 |
| $o_2$ | 6,03 | 0,99 | 1,16 | 0,99 |
| $o_3$ | -1,43 | -0,12 | -0,07 | -0,03 |
| $o_4$ | 0,08 | 1,79 | 1,39 | 1,18 |
| $o_5$ | -2,37 | 0,00 | -0,17 | 0,0079 |
| $o_6$ | -1,83 | 0,11 | 0,0455 | 0,1561 |
| $o_7$ | 0,285 | 0,00 | 0,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 1,00 | 0,00 |
| $o_9$ | -0,52 | 1,00 | -1,00 | 1,00 |
| **T** | | 5,56 | 6,24 | 5,42 |
| Default probability | | **99,62%** | **99,81%** | **99,56%** |

*Figure 51 – Own elaboration*

This situation turns out to be confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in those years the probability of bankruptcy is approximately 100%.

In this case, both models have a similar result, and both predicted, in previous years, the bankruptcy of 2007.

● **FRI-EL POWER TRADING S.R.L.**

It is a one-person company with limited liability based in Bolzano.
For what concerns the industry classification, it presents an *Ateco code* equals to *351400,* which corresponds to firms whose activity is linked to the *trade of electricity*.

Since we are dealing with a *non - manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:
$z'' = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05x_4$

The company, according to its current legal status, was failed in 2016. The conclusion of the liquidation took place on 07/12/2016, while the last available accounting closing date is 31/12/2015.

For this reason, the models will be applied using data from the financial statements of the years 2015, 2014 and 2013.

**Altman Z-Score model (Non manufacturing firm) - FRI-EL POWER TRADING S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2015** | **2014** | **2013** |
| WC | **Working capital** | 273.782,00 € | 227.434,00 € | 190.754,00 € |
| TA | **Total assets** | 1.781.367,00 € | 2.102.413,00 € | 2.620.244,00 € |
| RE | **Retained earnings** | 130.434,00 € | 93.754,00 € | 63.004,00 € |
| EBIT | **Earnings before interest, income taxes** | 60.554,00 € | 43.570,00 € | 39.622,00 € |
| BVCE | **Book value of common equity** | 273.782,00 € | 227.434,00 € | 190.754,00 € |
| TL | **Total liabilities** | 1.507.585,00 € | 1.874.979,00 € | 2.429.490,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 6,56 | 0,15 | 0,11 | 0,07 |
| $x_2$ | 3,26 | 0,07 | 0,04 | 0,02 |
| $x_3$ | 6,72 | 0,03 | 0,02 | 0,02 |
| $x_4$ | 1,05 | 0,18 | 0,12 | 0,08 |
| $x_5$ | | | | |
| **T** | | **1,69** | **1,14** | **0,75** |

*Figure 52 – Own elaboration*

In this variant of the model, the distress zone is depicted by the values *z″ < 1.1*, while the grey zone is represented by the values *1.1 < z″ < 2.60* . The firm has a Z-Score belonging to the distress zone only in 2013, while for the following two years the Z-Score settles in the grey zone.

Since these findings are atypical, it is necessary to analyze this evidence from an economic point of view. This gradual improvement in the Z-Score is mainly due to an increase in all the variables involved in the model. In particular, it is appropriate to point out the gradual rise in EBIT and Working capital over the three years, which show a slight improvement of the state of the company, which, however, is not enough to fix a situation of too severe distress.

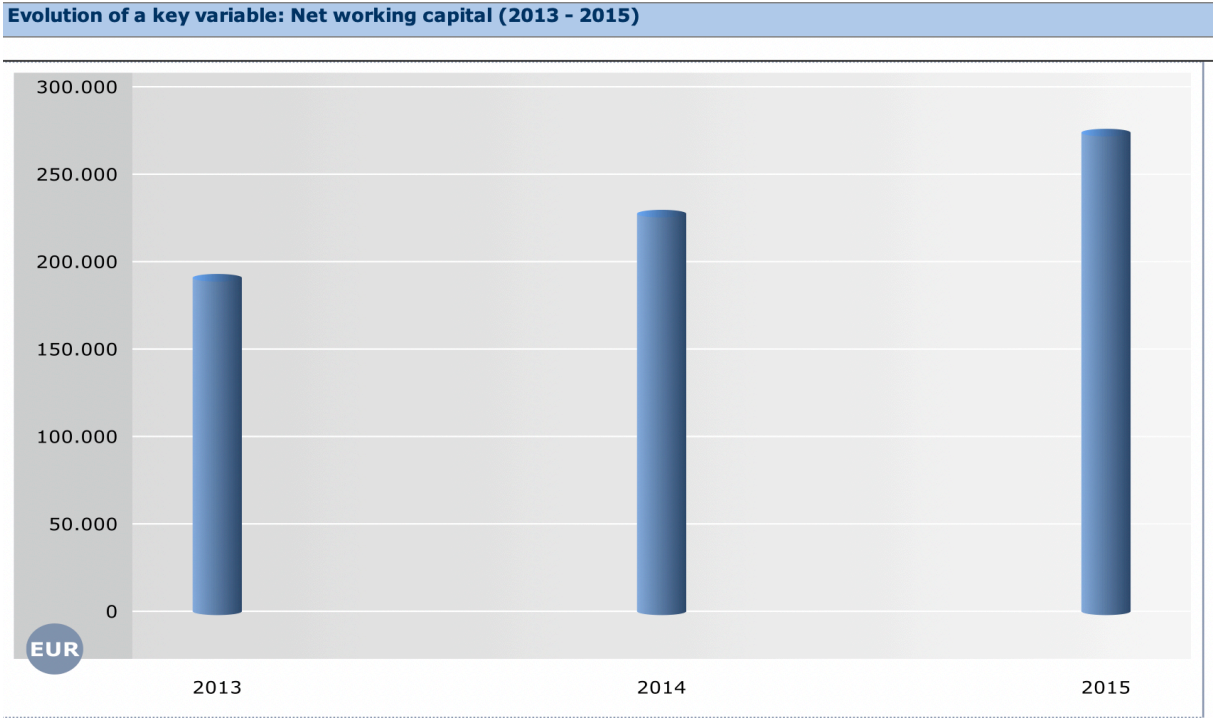It is possible to look at the trend of these factors in the graphs below.

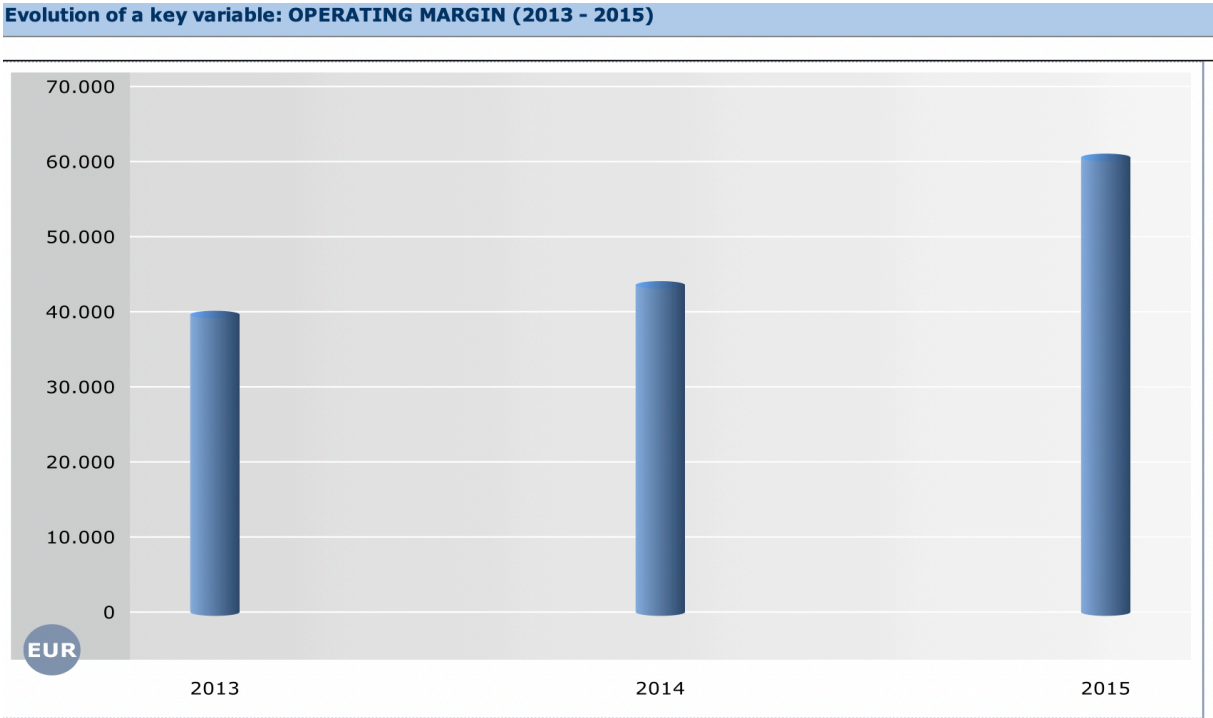**Evolution of a key variable: Net working capital (2013 – 2015)**



*Figure 53 - AIDA*

**Evolution of a key variable: OPERATING MARGIN (2013 – 2015)**



*Figure 54 - AIDA*

**Ohlson O-score Model - FRI-EL POWER TRADING S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2015** | **2014** | **2013** |
| TA | **Total assets** | 1.781.367,00 € | 2.102.413,00 € | 2.620.244,00 € |
| GNP | **Gross National Product price index level** | 1.789.303.571,43 | 1.569.168.207,02 € | 9.127.497.556,94 € |
| TL | **Total liabilities** | 1.507.585,00 € | 1.874.979,00 € | 2.429.490,00 € |
| WC | **Working capital** | 273.782,00 € | 227.434,00 € | 190.754,00 € |
| NI | **Net income** | 46.348,00 € | 36.680,00 € | 30.750,00 € |
| NI_t-1 | **Net income (t-1)** | 36.680,00 € | 30.750,00 € | 24.443,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | 60.554,00 € | 43.570,00 € | 39.622,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -6,91 | -6,62 | -8,16 |
| $o_2$ | 6,03 | 0,85 | 0,89 | 0,93 |
| $o_3$ | -1,43 | 0,15 | 0,11 | 0,07 |
| $o_4$ | 0,08 | 0,85 | 0,89 | 0,93 |
| $o_5$ | -2,37 | 0,03 | 0,02 | 0,01 |
| $o_6$ | -1,83 | 0,04 | 0,02 | 0,02 |
| $o_7$ | 0,285 | 0,00 | 0,00 | 0,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | 0,12 | 0,09 | 0,11 |
| **T** | | 6,25 | 6,54 | 7,44 |
| **Default probability** | | **99,81%** | **99,86%** | **99,94%** |

*Figure 55 – Own elaboration*

With the application of the second model, the situation turns out to be quite different. In fact, according to O-Score model, the firm has a default probability of about 100% in all three years under consideration.

In this case, O-Score model has a higher predictive ability than Z-Score, as the latter shows results that are not entirely consistent with the subsequent failure.

- **VELGA S.R.L.**

It is a limited liability company based in Rome.
For what concerns the industry classification, it presents an *Ateco code* equals to *351300,* which corresponds to firms whose activity is linked to the *distribution of electricity*.

Since we are dealing with a *non - manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

*z'' = 6.56x₁ + 3.26x₂ + 6.72x₃ + 1.05x₄*

The company, according to its current legal status, was liquidated in 2021. The conclusion of the bankruptcy took place on 26/05/2021, while the last available accounting closing date is 31/12/2019.

For this reason, the models will be applied using data from the financial statements of the years 2019, 2018 and 2017.

**Altman Z-Score model (Non manufacturing firm) - VELGA S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2019 | 2018 | 2017 |
| WC | **Working capital** | -82.530,00 € | 3.864.037,00 € | 2.256.806,00 € |
| TA | **Total assets** | 22.935.343,00 € | 19.480.445,00 € | 11.933.144,00 € |
| RE | **Retained earnings** | -78.560,00 € | -78.560,00 € | 0,00 € |
| EBIT | **Earnings before interest, income taxes** | 1.419.260,00 € | 580.421,00 € | -105.415,00 € |
| BVCE | **Book value of common equity** | 1.032.533,00 € | 945.005,00 € | 716.935,00 € |
| TL | **Total liabilities** | 21.902.810,00 € | 18.535.440,00 € | 11.216.209,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 6,56 | -0,004 | 0,198 | 0,189 |
| $x_2$ | 3,26 | -0,003 | -0,004 | 0,000 |
| $x_3$ | 6,72 | 0,062 | 0,030 | -0,009 |
| $x_4$ | 1,05 | 0,047 | 0,051 | 0,064 |
| $x_5$ | | | | |
| **T** | | **0,43** | **1,54** | **1,25** |

*Figure 56 – Own elaboration*

In this variant of the model, the distress zone is depicted by the values *z″ < 1.1* while the grey zone is represented by the values *1.1 < z″ < 2.60* . In 2017 and 2018 the firm belongs to the grey zone while, coherently with the bankruptcy of 2021, in 2019 the Z-Score lies in the distress zone.

However, from an economic point of view, it is worth analyzing the value evolution in detail. In fact, from 2017 to 2018 a slight improvement in the Z-Score can be observed and then, in 2019, it worsens significantly.

The main driver is the trend of Working capital, which in 2018 increases compared to the previous year and then in 2019 decreases again and reaches a negative value, as it is possible to see in the graph below. This results in a negative $x_1$ coefficient.
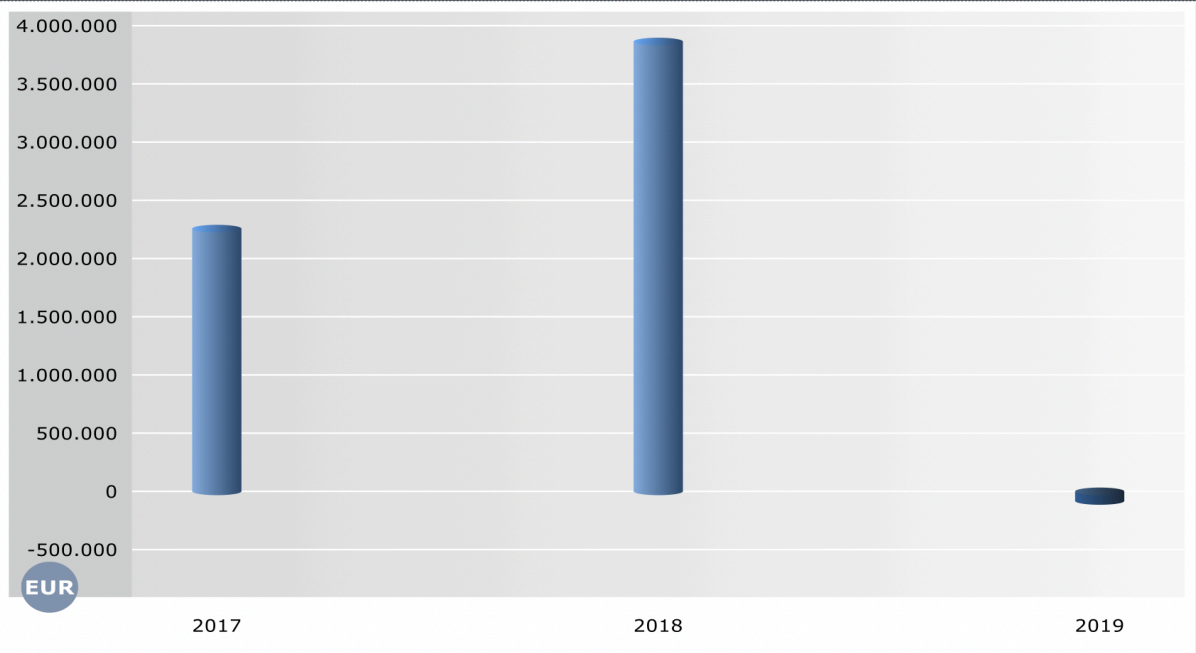
*Figure 57 - AIDA*

The trend of EBIT over the three-year period is also significant, rising sharply from 2017 to 2019, an improvement that nevertheless fails to offset a crisis situation that is no longer sustainable.

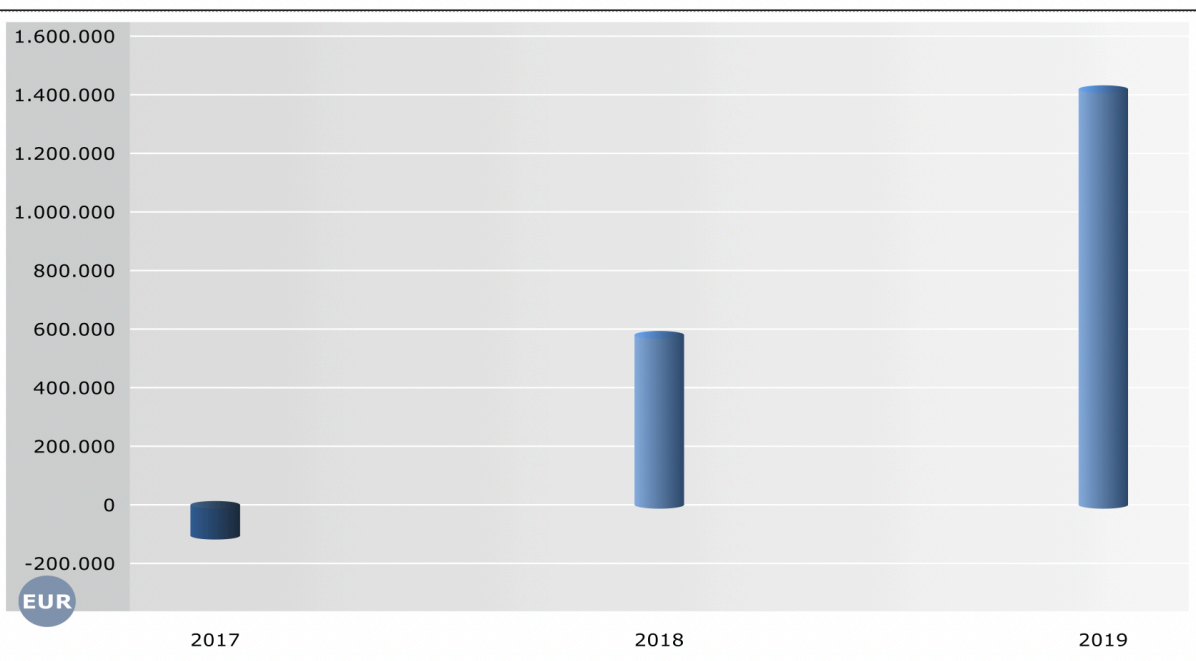**Evolution of a key variable: OPERATING MARGIN (2017 - 2019)**



*Figure 58 - AIDA*

**Ohlson O-score Model - VELGA S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2019 | 2018 | 2017 |
| TA | Total assets | 22.935.343,00 € | 19.480.445,00 € | 11.933.144,00 € |
| GNP | Gross National Product price index level | 1.859.901.741,85 € | 1.763.703.001,03 € | 1.657.005.758,16 € |
| TL | Total liabilities | 21.902.810,00 € | 18.535.440,00 € | 11.216.209,00 € |
| WC | Working capital | -82.530,00 € | 3.864.037,00 € | 2.256.806,00 € |
| NI | Net income | 87.526,00 € | 228.073,00 € | -78.560,00 € |
| NI_t-1 | Net income (t-1) | 228.073,00 € | -78.560,00 € | 87.718,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | 2.246.622,00 € | 592.722,00 € | -79.572,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -4,396 | -4,506 | -4,93 |
| $o_2$ | 6,03 | 0,955 | 0,951 | 0,94 |
| $o_3$ | -1,43 | -0,004 | 0,198 | 0,19 |
| $o_4$ | 0,08 | 1,000 | 0,794 | 0,79 |
| $o_5$ | -2,37 | 0,004 | 0,012 | 0,00 |
| $o_6$ | -1,83 | 0,103 | 0,032 | 0,00 |
| $o_7$ | 0,285 | 0,000 | 0,000 | 0,00 |
| $o_8$ | -1,72 | 0,000 | 0,000 | 0,00 |
| $o_9$ | -0,52 | -0,445 | 1,000 | -1,000 |
| | **T** | **6,35** | **5,42** | **6,67** |
| | Default probability | **99,83%** | **99,56%** | **99,87%** |

*Figure 59 – Own elaboration*

With the application of the second model, the situation turns out to be quite different. In fact, according to O-Score model, the firm has a default probability of about 100% in all three years under consideration.

In this case, O-Score model has higher accuracy relative to predictive ability than Z-Score.

- **BELLATRIX S.R.L.**

It is a limited liability company based in Catanzaro.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

*z' = 0.717x₁ + 0.847x₂ + 3.107x₃ + 0.420x₄ + 0.998x₅*

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was liquidated in 2020. The conclusion of liquidation took place on 17/06/2020, while the last available accounting closing date is 31/12/2018.

For this reason, the models will be applied using data from the financial statements of the years 2018, 2017 and 2016.

**Altman Z-Score model (Manufacturing firm) - BELLATRIX S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2018** | **2017** | **2016** |
| WC | **Working capital** | -52.356,00 € | 193.295,00 € | 489.330,00 € |
| TA | **Total assets** | 217.565,00 € | 1.940.086,00 € | 2.594.221,00 € |
| RE | **Retained earnings** | 0,00 € | -13.576,00 € | -394.257,00 € |
| EBIT | **Earnings before interest, income taxes** | -166.253,00 € | 204.851,00 € | 474.183,00 € |
| BVCE | **Book value of common equity** | -52.416,00 € | 182.643,00 € | 36.423,00 € |
| TL | **Total liabilities** | 269.981,00 € | 1.757.443,00 € | 2.557.798,00 € |
| S | **Sales** | 257.515,00 € | 101.725,00 € | 475.871,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -0,24 | 0,10 | 0,19 |
| $x_2$ | 0,847 | 0,00 | -0,01 | -0,15 |
| $x_3$ | 3,107 | -0,76 | 0,11 | 0,18 |
| $x_4$ | 0,42 | -0,19 | 0,10 | 0,01 |
| $x_5$ | 0,998 | 1,18 | 0,05 | 0,18 |
| | **T** | **-1,45** | **0,49** | **0,76** |

*Figure 60 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.

As can be seen from the analysis performed, in all the three years considered, the enterprise belongs to the distressed zone. Thus, the method turns out to have a very good predictive ability.

From an economic perspective, the trend of the Z-Score, decreasing from 2016 to 2018, appears to be consistent with the 2020 liquidation. This evolution is mainly due to the decrease in three variables (Working capital, EBIT, and Book value of common equity), sufficient to reach negative values in 2018 and consequently cause the Z-Score to decrease.

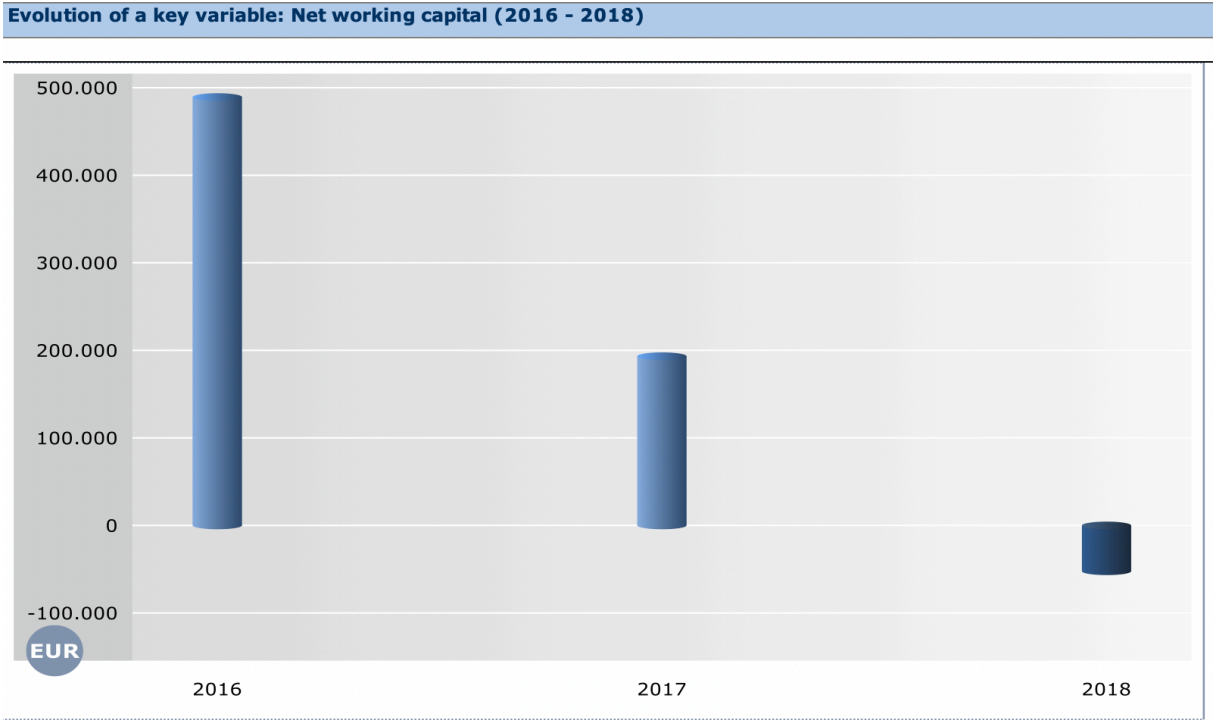The trend of these factors is shown in the graphs below.

**Evolution of a key variable: Net working capital (2016 - 2018)**



*Figure 61 – AIDA*

**Evolution of a key variable: OPERATING MARGIN (2016 - 2018)**



*Figure 62 - AIDA*
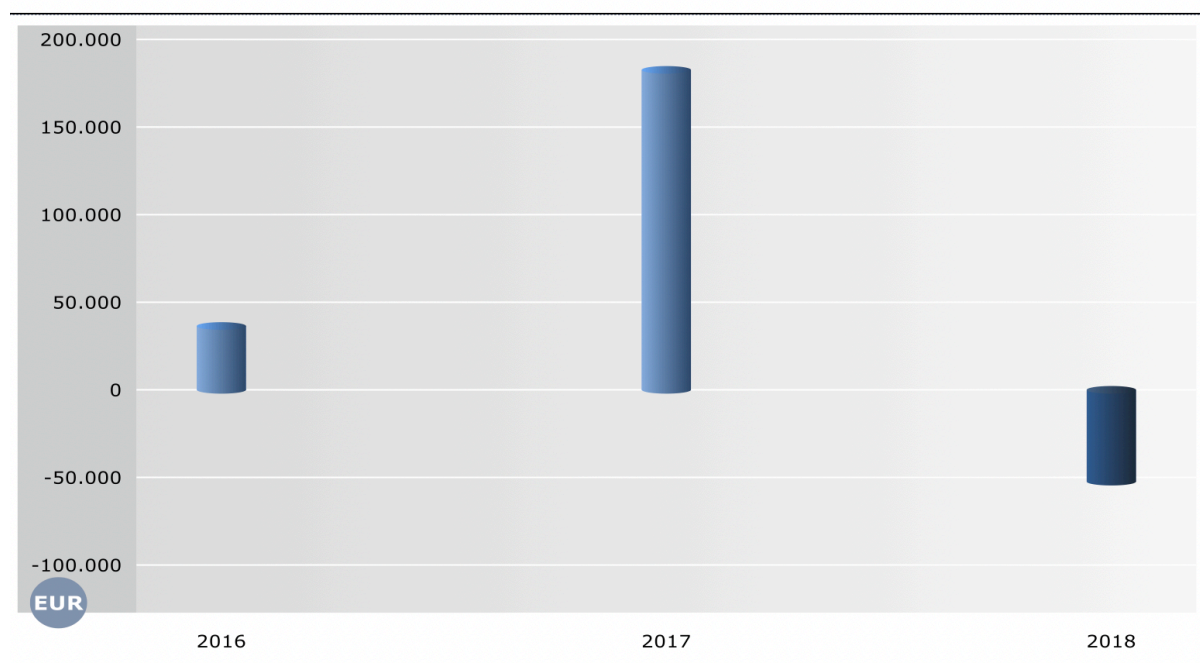
*Figure 63 - AIDA*

**Ohlson O-score Model - BELLATRIX S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2018** | **2017** | **2016** |
| TA | **Total assets** | 217.565,00 € | 1.940.086,00 € | 2.594.221,00 € |
| GNP | **Gross National Product price index level** | 1.763.703.001,03 € | 1.657.005.758,16 € | 1.759.814.781,19 |
| TL | **Total liabilities** | 269.981,00 € | 1.757.443,00 € | 2.557.798,00 € |
| WC | **Working capital** | -52.356,00 € | 193.295,00 € | 489.330,00 € |
| NI | **Net income** | -109.728,00 € | 146.219,00 € | 380.681,00 € |
| NI_t-1 | **Net income (t-1)** | 146.219,00 € | 380.681,00 € | -635.674,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | -166.253,00 € | 287.390,00 € | 562.094,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -9,00 | -6,75 | -6,52 |
| $o_2$ | 6,03 | 1,24 | 0,91 | 0,99 |
| $o_3$ | -1,43 | -0,24 | 0,10 | 0,19 |
| $o_4$ | 0,08 | 1,23 | 0,37 | 0,35 |
| $o_5$ | -2,37 | -0,50 | 0,08 | 0,1467 |
| $o_6$ | -1,83 | -0,62 | 0,16 | 0,2198 |
| $o_7$ | 0,285 | 0,00 | 0,00 | 1,00 |
| $o_8$ | -1,72 | 1,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | -1,00 | -0,44 | 1,00 |
| **T** | | 11,39 | 6,53 | 6,05 |
| Default probability | | **100,00%** | **99,85%** | **99,77%** |

*Figure 64 – Own elaboration*

This situation turns out to be confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in those years the probability of bankruptcy is about 100%.

In this case, both models have a similar result, and both predicted, in previous years, the bankruptcy of 2020.

• **GREEN POWER ENERGY S.R.L.**

It is a limited liability company based in Padova.

For what concerns the industry classification, it presents an *Ateco code* equals to *351400,* which corresponds to firms whose activity is linked to the *trade of electricity*.

Since we are dealing with a *non - manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

*z" = 6.56x₁ + 3.26x₂ + 6.72x₃ + 1.05x₄*

The company, according to its current legal status, was failed in 2021. The conclusion of the liquidation took place on 29/01/2021, while the last available accounting closing date is 31/12/2019.

For this reason, the models will be applied using data from the financial statements of the years 2019, 2018 and 2017.

**Altman Z-Score model (Non manufacturing firm) - GREEN POWER ENERGY S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2019** | **2018** | **2017** |
| WC | **Working capital** | 145.031,00 € | 183.795,00 € | 231.628,00 € |
| TA | **Total assets** | 1.228.596,00 € | 665.994,00 € | 437.196,00 € |
| RE | **Retained earnings** | 0,00 € | 0,00 € | -1.196,00 € |
| EBIT | **Earnings before interest, income taxes** | 127.326,00 € | 18.149,00 € | 223,00 € |
| BVCE | **Book value of common equity** | 147.539,00 € | 78.858,00 € | 45.068,00 € |
| TL | **Total liabilities** | 1.081.057,00 € | 587.136,00 € | 392.128,00 € |

| **Variables** | **Coefficients** | **Values** | | |
|---|---|---|---|---|
| $x_1$ | 6,56 | 0,12 | 0,28 | 0,53 |
| $x_2$ | 3,26 | 0,00 | 0,00 | -0,0027 |
| $x_3$ | 6,72 | 0,10 | 0,03 | 0,0005 |
| $x_4$ | 1,05 | 0,14 | 0,13 | 0,11 |
| $x_5$ | | | | |
| **T** | | **1,61** | **2,13** | **3,59** |

*Figure 65 – Own elaboration*

In this variant of the model, the distress zone is depicted by the values *z" < 1.1* while the grey zone is represented by the values *1.1 < z" < 2.60* . The company belongs to the grey zone in 2018 and 2019, while in 2017 it shows no signs of crisis by presenting a value corresponding to the safe zone.

So, although there is a worsening of the Z-Score in the last year of the available financial statements (2019), in this case the model is not entirely accurate in predicting the liquidation that occurred in 2021.

From an economic point of view, it is useful to analyze this reduction, which turns out to be caused mainly by the decrease in Working capital and the simultaneous growth in Total assets, that together generated a fall in the $x_1$ coefficient. The decrease in this coefficient is so significant that it makes the increase in EBIT, and consequently the one of the $x_3$ coefficient, completely ineffective.

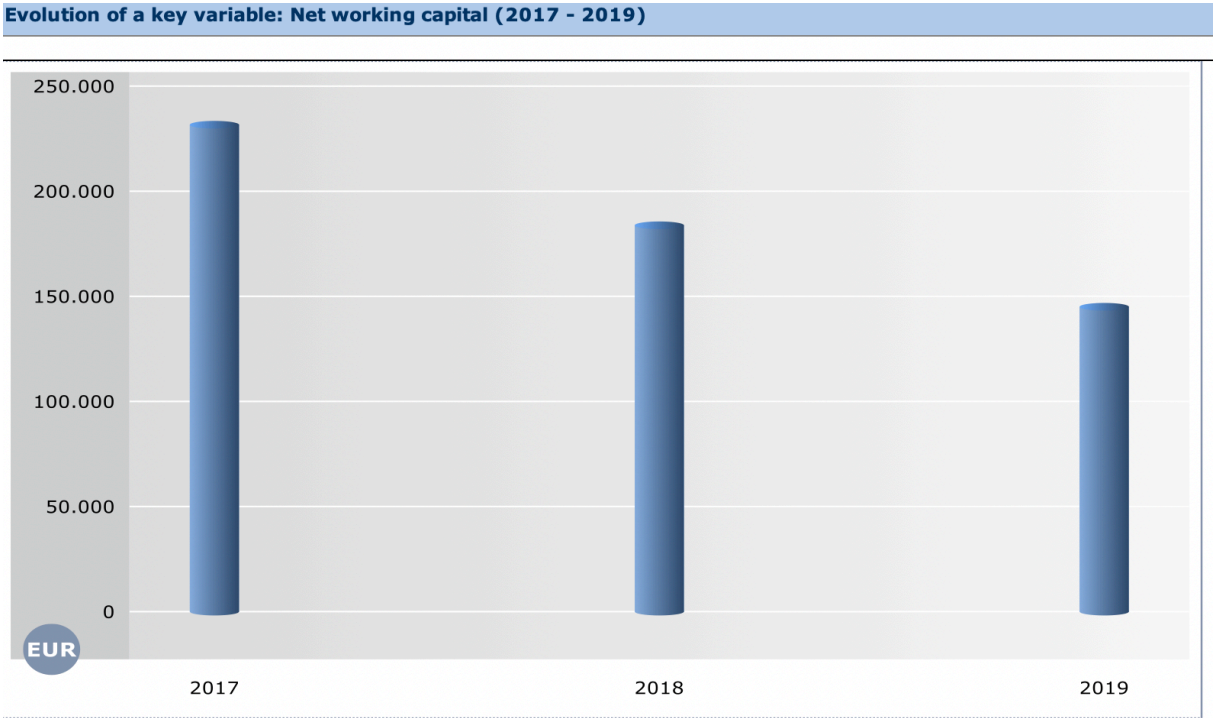The trend of the three factors can be observed in the graphs below.



*Figure 66 - AIDA*
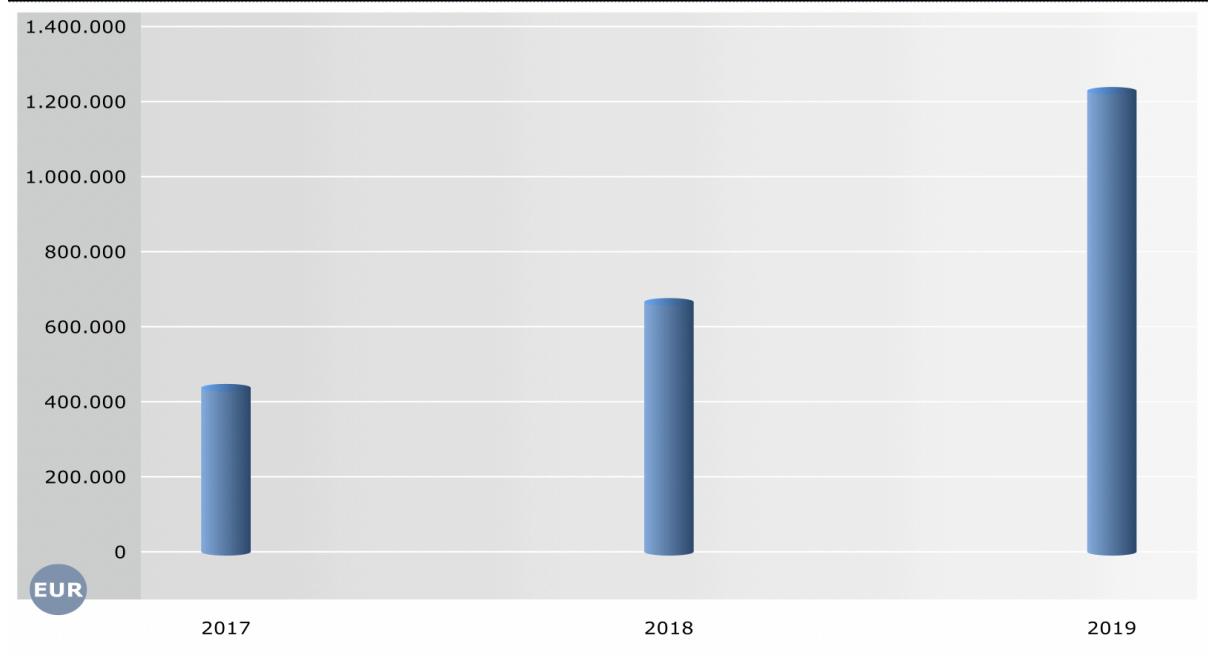
*Figure 67 - AIDA*
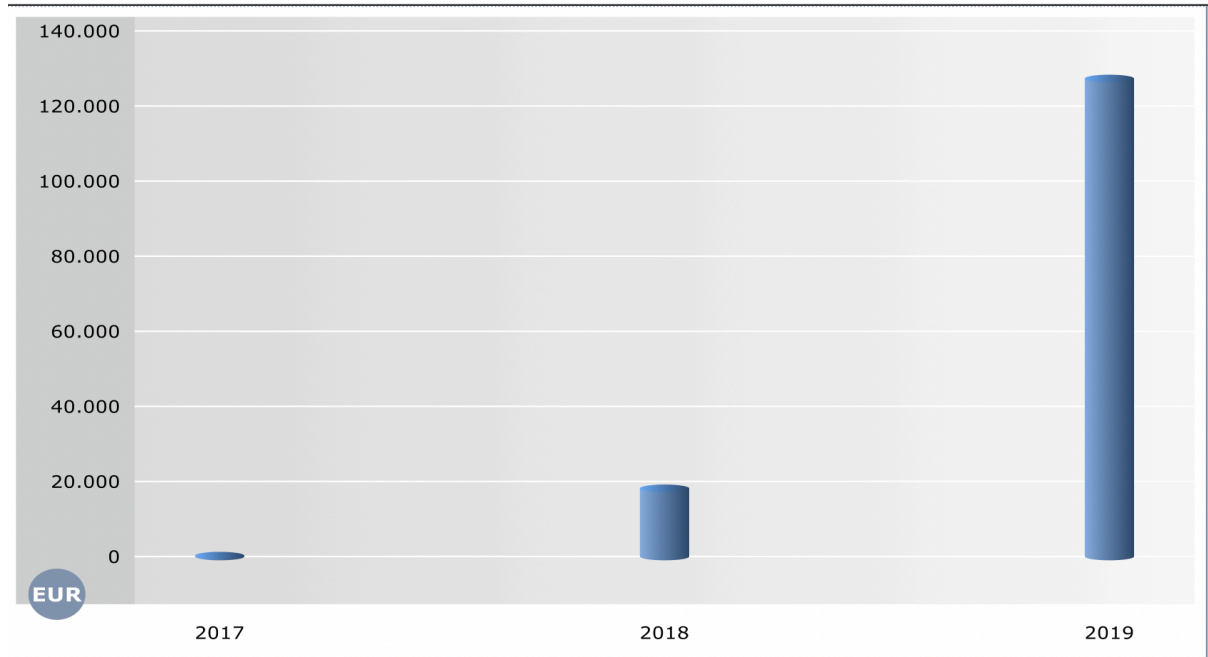
*Figure 68 - AIDA*

**Ohlson O-score Model - GREEN POWER ENERGY S.R.L.**

| | | Inputs | | |
| --- | --- | --- | --- | --- |
| | | 2019 | 2018 | 2017 |
| TA | Total assets | 1.228.596,00 € | 665.994,00 € | 437.196,00 € |
| GNP | Gross National Product price index level | 1.859.901.741,85 € | 1.763.703.001,03 € | 1.657.005.758,16 € |
| TL | Total liabilities | 1.081.057,00 € | 587.136,00 € | 392.128,00 € |
| WC | Working capital | 145.031,00 € | 183.795,00 € | 231.628,00 € |
| NI | Net income | 68.682,00 € | 13.788,00 € | 237,00 € |
| NI_t-1 | Net income (t-1) | 13.788,00 € | 237,00 € | -1.196,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | 127.326,00 € | 23.375,00 € | 2.059,00 € |

| Variables | Coefficients | Values | | |
| --- | --- | --- | --- | --- |
| | -1,32 | | | |
| $o_1$ | -0,407 | -7,322 | -7,882 | -8,24 |
| $o_2$ | 6,03 | 0,880 | 0,882 | 0,90 |
| $o_3$ | -1,43 | 0,118 | 0,276 | 0,53 |
| $o_4$ | 0,08 | 0,862 | 0,671 | 0,40 |
| $o_5$ | -2,37 | 0,056 | 0,021 | 0,03 |
| $o_6$ | -1,83 | 0,118 | 0,040 | 0,06 |
| $o_7$ | 0,285 | 0,000 | 0,000 | 1,00 |
| $o_8$ | -1,72 | 0,000 | 0,000 | 0,00 |
| $o_9$ | -0,52 | 0,666 | 0,966 | 1,000 |
| | | | | |
| | T | 6,17 | 6,24 | 6,30 |
| | | | | |
| | Default probability | 99,79% | 99,81% | 99,82% |

*Figure 69 – Own elaboration*

Applying the O-Score model, it can be seen that in all the three years under consideration the firm has a probability of default of almost 100%.

Making a comparison between the two models, the O-Score method appears to be more consistent with the future failure of the firm than the Z-Score one, which did not fully predict the imminent default.

So, in this case, the O-Score model has a more accurate predictive ability than the Z-Score model.

● **SACH S.R.L.**

It is a limited liability company based in Castelrotto.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was liquidated in 2019. The conclusion of the bankruptcy took place on 17/12/2019, while the last available accounting closing date is 31/12/2017.

For this reason, the models will be applied using data from the financial statements of the years 2017, 2016 and 2015.

### Altman Z-Score model (Manufacturing firm) - SACH S.R.L.

| | | Inputs | | |
|---|---|---|---|---|
| | | 2017 | 2016 | 2015 |
| WC | Working capital | -1.113.188,00 € | -417.060,00 € | -234.474,00 € |
| TA | Total assets | 1.490.381,00 € | 1.562.448,00 € | 1.854.783,00 € |
| RE | Retained earnings | -335.266,00 € | 0,00 € | 0,00 € |
| EBIT | Earnings before interest, income taxes | 43.025,00 € | -286.466,00 € | 56.345,00 € |
| BVCE | Book value of common equity | 10.153,00 € | 9.712,00 € | 100.277,00 € |
| TL | Total liabilities | 1.480.228,00 € | 1.552.736,00 € | 1.754.506,00 € |
| S | Sales | 515.580,00 € | 398.426,00 € | 330.974,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -0,75 | -0,27 | -0,13 |
| $x_2$ | 0,847 | -0,22 | 0,00 | 0,00 |
| $x_3$ | 3,107 | 0,03 | -0,18 | 0,03 |
| $x_4$ | 0,42 | 0,01 | 0,01 | 0,06 |
| $x_5$ | 0,998 | 0,35 | 0,26 | 0,18 |
| | T | -0,29 | -0,50 | 0,21 |

*Figure 70 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z' < 1.23*.
As can be seen from the analysis performed, in all the three years considered, the company shows values of the Z-Score belonging to the distress zone. Thus, the method turns out to have an excellent predictive ability.

However, from an economic point of view it is necessary to analyze the trend of this value. In fact, from 2016 to 2017 it is possible to see a slight improvement in the Z-Score that is not entirely consistent with the company's subsequent bankruptcy. In fact, being the last year of the available financial statements, it would be expected that the value would be even lower.

This improvement is mainly related to the evolution of the $x_3$ and $x_5$ coefficients.
The former settles back to a positive value thanks to the increase in EBIT, which is positive after a sharp decrease in the previous year; the latter owes its considerable rise to the growth in Sales.

So, the growth in the Z-Score is due to a real improvement in the company's crisis. However, it turns out to be insufficiently effective for a distress situation that is too much established.
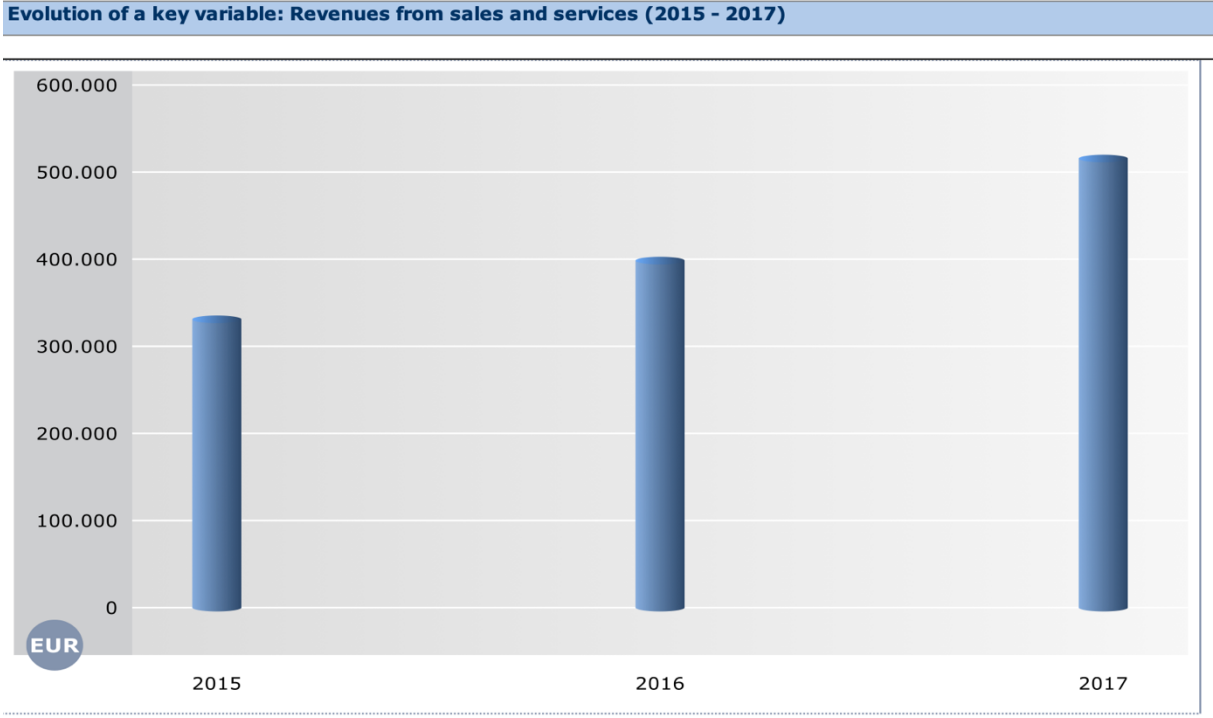
The graphs below show the evolution of these factors.

**Evolution of a key variable: OPERATING MARGIN (2015 - 2017)**



*Figure 71 - AIDA*

**Evolution of a key variable: Revenues from sales and services (2015 - 2017)**



*Figure 72 - AIDA*

**Ohlson O-score Model - SACH S.R.L.**

| Variables | | | Inputs | | |
|---|---|---|---|---|---|
| | | | 2017 | 2016 | 2015 |
| TA | Total assets | | 1.490.381,00 € | 1.562.448,00 € | 1.854.783,00 € |
| GNP | Gross National Product price index level | | 1.657.005.758,16 € | 1.759.814.781,19 € | 1.789.303.571,43 € |
| TL | Total liabilities | | 1.480.228,00 € | 1.552.736,00 € | 1.754.506,00 € |
| WC | Working capital | | -1.113.188,00 € | -417.060,00 € | -234.474,00 € |
| NI | Net income | | 441,00 € | -335.266,00 € | 9.252,00 € |
| NI_t-1 | Net income (t-1) | | -335.266,00 € | 9.252,00 € | 714,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | | 153.069,00 € | -70.600,00 € | 123.462,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -7,01 | -7,03 | -6,87 |
| $o_2$ | 6,03 | 0,99 | 0,99 | 0,95 |
| $o_3$ | -1,43 | -0,75 | -0,27 | -0,13 |
| $o_4$ | 0,08 | 4,00 | 2,33 | 1,47 |
| $o_5$ | -2,37 | 0,00030 | -0,21458 | -0,1808 |
| $o_6$ | -1,83 | 0,10 | -0,05 | -0,0402 |
| $o_7$ | 0,285 | 0,00 | 0,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | 1,00 | -1,00 | 0,86 |
| T | | 8,20 | 9,21 | 7,82 |
| Default probability | | 99,97% | 99,99% | 99,96% |

*Figure 73 – Own elaboration*

This situation turns out to be confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in those years the probability of bankruptcy is almost 100%.

In this case, both models have a similar result, and both predicted, in previous years, the bankruptcy of 2019.

- **ITALIAN JOB S.R.L.**

It is a limited liability company based in Rome.

For what concerns the industry classification, it presents an *Ateco code* equals to *351400,* which corresponds to firms whose activity is linked to the *trade of electricity*.

Since we are dealing with a *non - manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z'' = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05x_4$

The company, according to its current legal status, was liquidated in 2020. The conclusion of the bankruptcy took place on 22/01/2020, while the last available accounting closing date is 31/12/2018.

For this reason, the models will be applied using data from the financial statements of the years 2018, 2017 and 2016.

**Altman Z-Score model (Non manufacturing firm) - ITALIAN JOB S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2018** | **2017** | **2016** |
| WC | **Working capital** | 165.607,00 € | 66.060,00 € | 65.168,00 € |
| TA | **Total assets** | 578.199,00 € | 457.260,00 € | 359.192,00 € |
| RE | **Retained earnings** | 244,00 € | 0,00 € | 0,00 € |
| EBIT | **Earnings before interest, income taxes** | 4.788,00 € | 2.165,00 € | 24.620,00 € |
| BVCE | **Book value of common equity** | 3.734,00 € | 12.451,00 € | 15.492,00 € |
| TL | **Total liabilities** | 574.465,00 € | 444.809,00 € | 343.700,00 € |

| **Variables** | **Coefficients** | | **Values** | |
|---|---|---|---|---|
| $x_1$ | 6,56 | 0,29 | 0,14 | 0,18 |
| $x_2$ | 3,26 | 0,0004 | 0,00 | 0,00 |
| $x_3$ | 6,72 | 0,01 | 0,0047 | 0,07 |
| $x_4$ | 1,05 | 0,01 | 0,03 | 0,05 |
| $x_5$ | | | | |
| **T** | | **1,94** | **1,01** | **1,70** |

*Figure 74 – Own elaboration*

In this variant of the model, the distress zone is represented by the values *z'' < 1.1* while the grey zone is depicted by the values *1.1 < z'' < 2.60* . The enterprise appears to belong to the grey zone in 2016 and 2018 while, in 2017 it falls, although at the limit, of the distress zone.

So, from an economic point of view it is interesting to analyze the value evolution in more detail. In fact, from 2017 to 2018 it is possible to see an improvement in the Z-Score that is not entirely consistent with the company's subsequent bankruptcy. In fact, being the last year of the available financial statements, a value belonging to the distress zone would be expected.

This improvement is mainly due to a large increase in Working capital, that results in a higher $x_1$ coefficient, and a rise in EBIT, that generates a higher $x_3$ coefficient. Also in this case, the actual improvement of the distress situation does not translate into a full recovery given the crisis in an excessively advanced state.

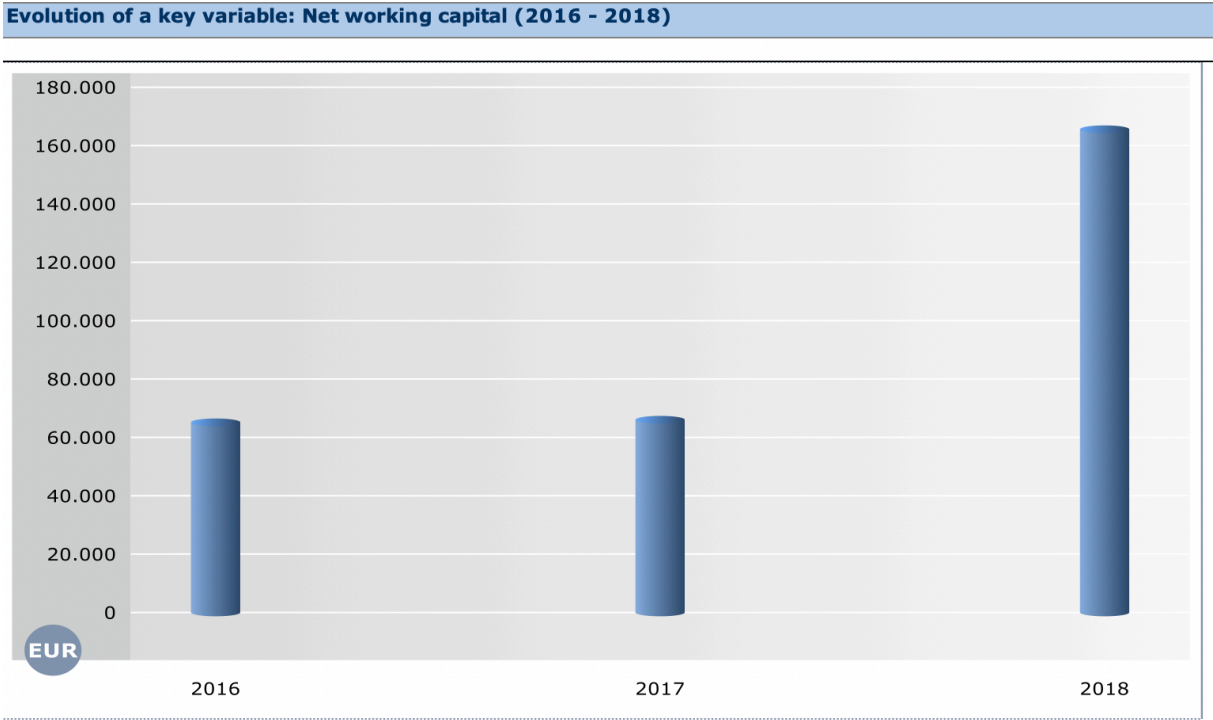The graphs below show the evolution of these factors.

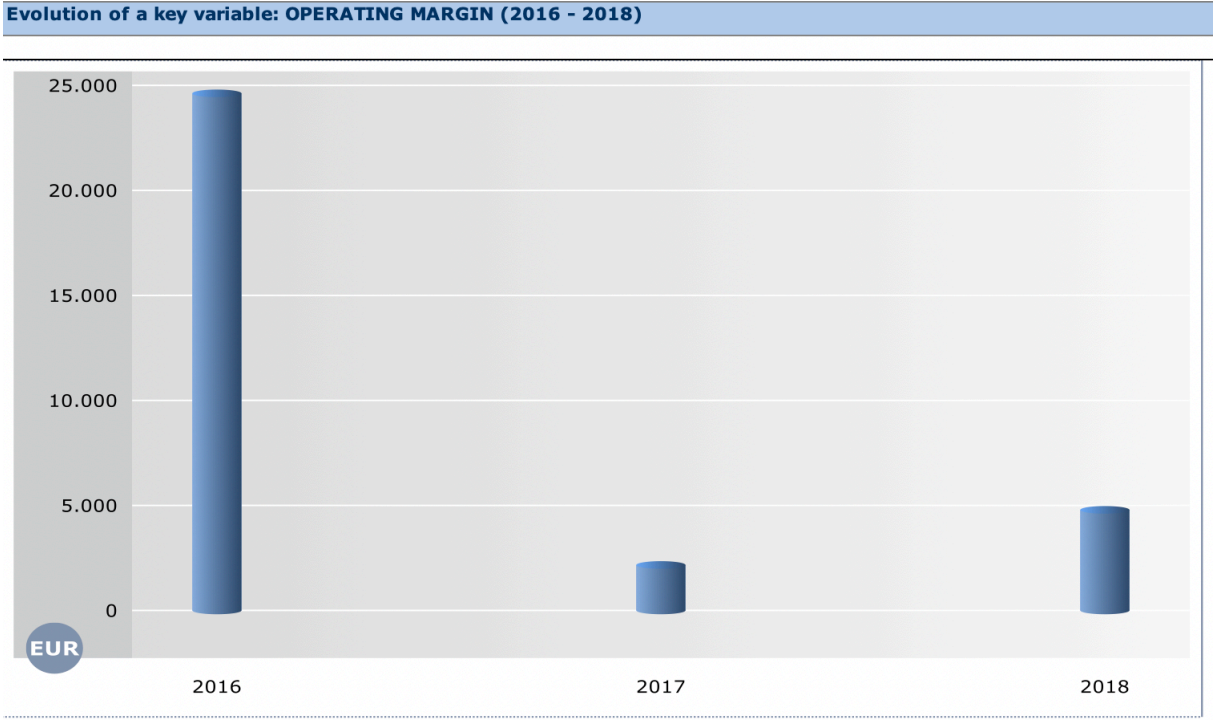**Evolution of a key variable: Net working capital (2016 - 2018)**



*Figure 75 - AIDA*

**Evolution of a key variable: OPERATING MARGIN (2016 - 2018)**



*Figure 76 - AIDA*

**Ohlson O-score Model - ITALIAN JOB S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | **2018** | **2017** | **2016** |
| TA | Total assets | 578.199,00 € | 457.260,00 € | 359.192,00 € |
| GNP | Gross National Product price index level | 1.763.703.001,03 € | 1.657.005.758,16 € | 1.759.814.781,19 € |
| TL | Total liabilities | 574.465,00 € | 444.809,00 € | 343.700,00 € |
| WC | Working capital | 165.607,00 € | 66.060,00 € | 65.168,00 € |
| NI | Net income | -12.003,00 € | -3.041,00 € | 3.840,00 € |
| NI_t-1 | Net income (t-1) | -3.041,00 € | 3.840,00 € | 288,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | 10.924,00 € | 2.335,00 € | 24.910,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -8,023 | -8,195 | -8,497 |
| $o_2$ | 6,03 | 0,994 | 0,973 | 0,957 |
| $o_3$ | -1,43 | 0,286 | 0,144 | 0,181 |
| $o_4$ | 0,08 | 0,671 | 0,840 | 0,800 |
| $o_5$ | -2,37 | -0,021 | -0,007 | 0,011 |
| $o_6$ | -1,83 | 0,019 | 0,005 | 0,072 |
| $o_7$ | 0,285 | 0,000 | 0,000 | 0,000 |
| $o_8$ | -1,72 | 0,000 | 0,000 | 0,000 |
| $o_9$ | -0,52 | -0,596 | -1,000 | 0,860 |
| **T** | | 7,90 | 8,27 | 7,11 |
| Default probability | | **99,96%** | **99,97%** | **99,92%** |

*Figure 77 – Own elaboration*

Applying the O-Score model, it can be seen that in all the three years under consideration the company has a probability of default of almost 100%.

So, in this case, the O-Score model has a more accurate predictive ability than the Z-Score model, which was not entirely accurate in predicting the bankruptcy.

● **NUOVA IRIDE S.R.L.**

It is a limited liability company based in Sandrigo.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was liquidated in 2019. The conclusion of bankruptcy took place on 03/10/2019, while the last available accounting closing date is 31/12/2017.

For this reason, the models will be applied using data from the financial statements of the years 2017, 2016 and 2015.

**Altman Z-Score model (Manufacturing firm) - NUOVA IRIDE S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2017 | 2016 | 2015 |
| WC | Working capital | 326.205,00 € | 509,00 € | 2.210,00 € |
| TA | Total assets | 5.120.472,00 € | 43.177,00 € | 44.370,00 € |
| RE | Retained earnings | -9.621,00 € | -7.920,00 € | -6.040,00 € |
| EBIT | Earnings before interest, income taxes | 236.525,00 € | -1.588,00 € | -1.772,00 € |
| BVCE | Book value of common equity | 548.620,00 € | 40.379,00 € | 42.080,00 € |
| TL | Total liabilities | 4.571.852,00 € | 2.798,00 € | 2.290,00 € |
| S | Sales | 6.109.261,00 € | 0,00 € | 0,00 € |

| Variables | Coefficients | | Values | |
|---|---|---|---|---|
| $x_1$ | 0,717 | 0,06 | 0,01 | 0,05 |
| $x_2$ | 0,847 | -0,0019 | -0,18 | -0,14 |
| $x_3$ | 3,107 | 0,05 | -0,04 | -0,04 |
| $x_4$ | 0,42 | 0,12 | 14,43 | 18,38 |
| $x_5$ | 0,998 | 1,19 | 0,00 | 0,00 |
| | T | 1,43 | 5,80 | 7,51 |

*Figure 78 – Own elaboration*

In this variant of the model, the distress zone is represented by the values $z' < 1.23$ while the grey zone is depicted by the values $1.23 < z' < 2.90$ .
The enterprise appears to belong to the grey zone in 2017 while in 2016 and 2015 it shows no signs of crisis and lies in the safe zone.

So, although the value is decreasing in the three years under consideration, the predictive ability of the Z-Score is not optimal in this case. In fact, according to the model, only in 2017 the firm shows some symptoms of distress.

Given the particularity of the case, it is appropriate to do further analysis. As it is possible to see, in 2017 there is an increase in all variables involved in the model.
In particular, the following trends should be underlined: EBIT reaches a positive amount after presenting negative values in the previous two years; Sales reaches a figure of 6.109.261,00 € after showing values equal to 0 € in the previous two years.
Although these two positive signs that may suggest that the enterprise is performing well, the Z-Score decreases until it reaches an amount belonging to the grey zone. The worsening in the last year is mainly due to the net decrease in the $x_4$ coefficient.

The main cause is the development of the value of total liabilities which increased from 2.798,00 € in 2016 to 4.571.852,00 € in 2017 that makes the two improvements analyzed above completely ineffective.

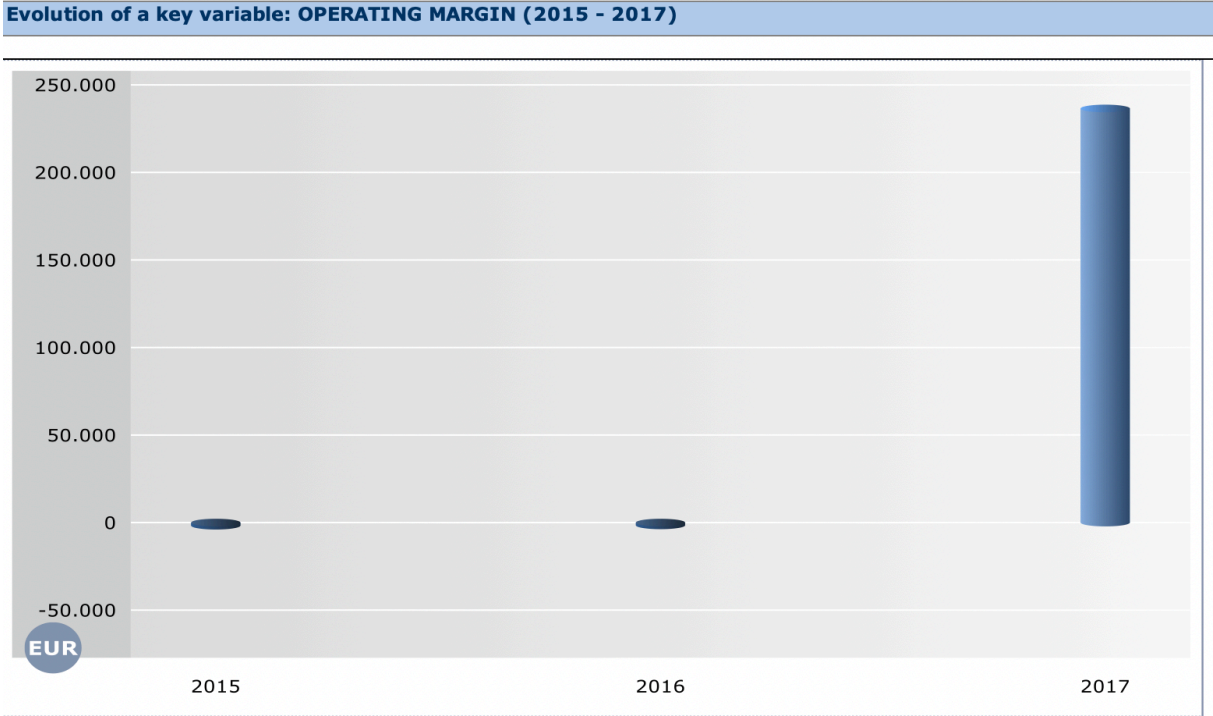The graphs below show the evolution of these factors.
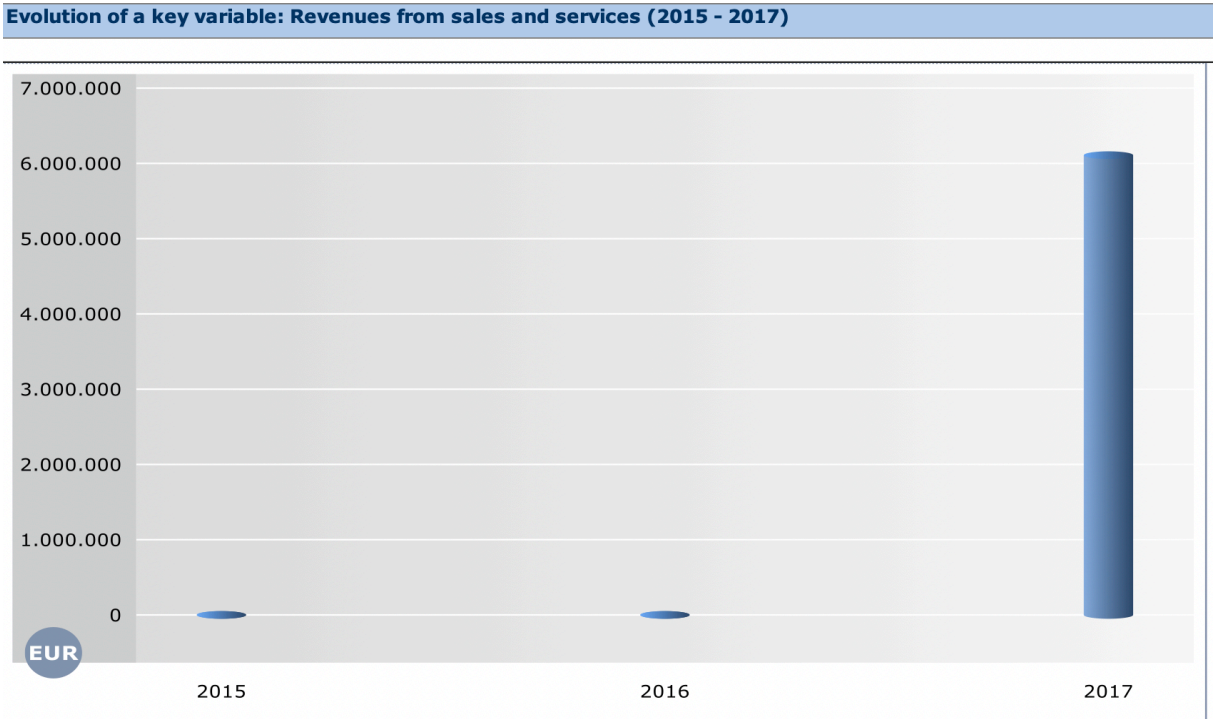


*Figure 79 - AIDA*



*Figure 80 - AIDA*

**Ohlson O-score Model - NUOVA IRIDE S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2017 | 2016 | 2015 |
| TA | Total assets | 5.120.472,00 € | 43.177,00 € | 44.370,00 € |
| GNP | Gross National Product price index level | 1.657.005.758,16 | 1.759.814.781,19 | 1.789.303.571,43 |
| TL | Total liabilities | 4.571.852,00 € | 2.798,00 € | 2.290,00 € |
| WC | Working capital | 326.205,00 € | 509,00 € | 2.210,00 € |
| NI | Net income | 358.242,00 € | -1.701,00 € | -1.881,00 € |
| NI_t-1 | Net income (t-1) | -1.701,00 € | -1.881,00 € | -1.184,00 € |
| EBITDA | Earnings before interest, income taxes, depreciation, amortization | 306.773,00 € | -1.588,00 € | -1.772,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -5,78 | -10,62 | -10,60 |
| $o_2$ | 6,03 | 0,89 | 0,06 | 0,05 |
| $o_3$ | -1,43 | 0,06 | 0,01 | 0,05 |
| $o_4$ | 0,08 | 0,93 | 0,85 | 0,51 |
| $o_5$ | -2,37 | 0,07 | -0,04 | -0,04 |
| $o_6$ | -1,83 | 0,07 | -0,57 | -0,77 |
| $o_7$ | 0,285 | 1,00 | 1,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | 1,00 | 0,05 | -0,23 |
| | T | 5,88 | 4,83 | 5,20 |
| | Default probability | 99,72% | 99,21% | 99,45% |

*Figure 81 – Own elaboration*

Applying the O-Score model, it can be seen that the firm has a probability of default of almost 100% in 2017 and 99% in the previous two years.

So, in this case, the O-Score model has a more accurate predictive ability than the Z-Score model as it is more consistent with the imminent bankruptcy.

Considering that both models have two completely different results in 2015 and 2016, further comments should be provided. The Ohlson model achieves so high values mainly due to the performance of the variables $o_1$ and $o_2$. The former, although it presents a coefficient equal to -0.407, is crucial because the corresponding values reach very high negative quantities that consequently give a considerable positive weight to the whole model due to the high figures of the Gross National Product price index level. The latter presents the coefficient with the highest weight equal to 6.03. The corresponding values turn out to be positive in all three years, still adding a positive weight to the model. Then, the sum of these two variables is always positive and represents an important basis of the final value of the O-score.

- **COGENER SOCIETA' DI SERVIZI ENERGETICI S.R.L.**

It is a limited liability company based in Treviso.

For what concerns the industry classification, it presents an *Ateco code* equals to *351100,* which corresponds to firms whose activity is linked to the *production of electricity*.

Since we are dealing with a *private manufacturing firm*, the formula of the Alman Z-score model to be applied is the following:

$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$

The company, according to its current legal status, was failed in 2017. The conclusion of the liquidation took place on 10/05/2017, while the last available accounting closing date is 31/12/2015.

For this reason, the models will be applied using data from the financial statements of the years 2015, 2014 and 2013.

**Altman Z-Score model (Manufacturing firm) - COGENER S.R.L.**

|  |  | Inputs | | |
|---|---|---|---|---|
|  |  | **2015** | **2014** | **2013** |
| WC | **Working capital** | -401.822,00 € | -488.652,00 € | -508.262,00 € |
| TA | **Total assets** | 460.227,00 € | 571.229,00 € | 606.369,00 € |
| RE | **Retained earnings** | 0,00 € | 0,00 € | 0,00 € |
| EBIT | **Earnings before interest, income taxes** | 297,00 € | -14.894,00 € | -2.960,00 € |
| BVCE | **Book value of common equity** | 20.582,00 € | 25.571,00 € | 36.569,00 € |
| TL | **Total liabilities** | 439.645,00 € | 545.658,00 € | 569.800,00 € |
| S | **Sales** | 333.913,00 € | 126.663,00 € | 247.318,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| $x_1$ | 0,717 | -0,87 | -0,86 | -0,84 |
| $x_2$ | 0,847 | 0,00 | 0,00 | 0,00 |
| $x_3$ | 3,107 | 0,0006 | -0,0261 | -0,0049 |
| $x_4$ | 0,42 | 0,05 | 0,05 | 0,06 |
| $x_5$ | 0,998 | 0,73 | 0,22 | 0,41 |
| **T** |  | **0,12** | **-0,45** | **-0,18** |

*Figure 82 – Own elaboration*

In this variant of the model, the distress zone is represented by values *z' < 1.23*.
As can be seen from the analysis performed, in all the three years considered, the company shows values of the Z-Score belonging to the distress zone. Thus, the method turns out to have an excellent predictive ability.

However, from an economic point of view it is necessary to analyze the value evolution because in 2015 an unexpected improvement can be seen, while, considering that this is the last available financial statements, a lower value would be expected.

This improvement is mainly generated by the increase in sales which, together with the decrease in total assets, produces a rise in the $x_5$ coefficient. So, although there has been a growth in Sales and EBIT that could have predicted an improvement in the condition of the company, the failing situation is too serious to avoid an imminent liquidation.

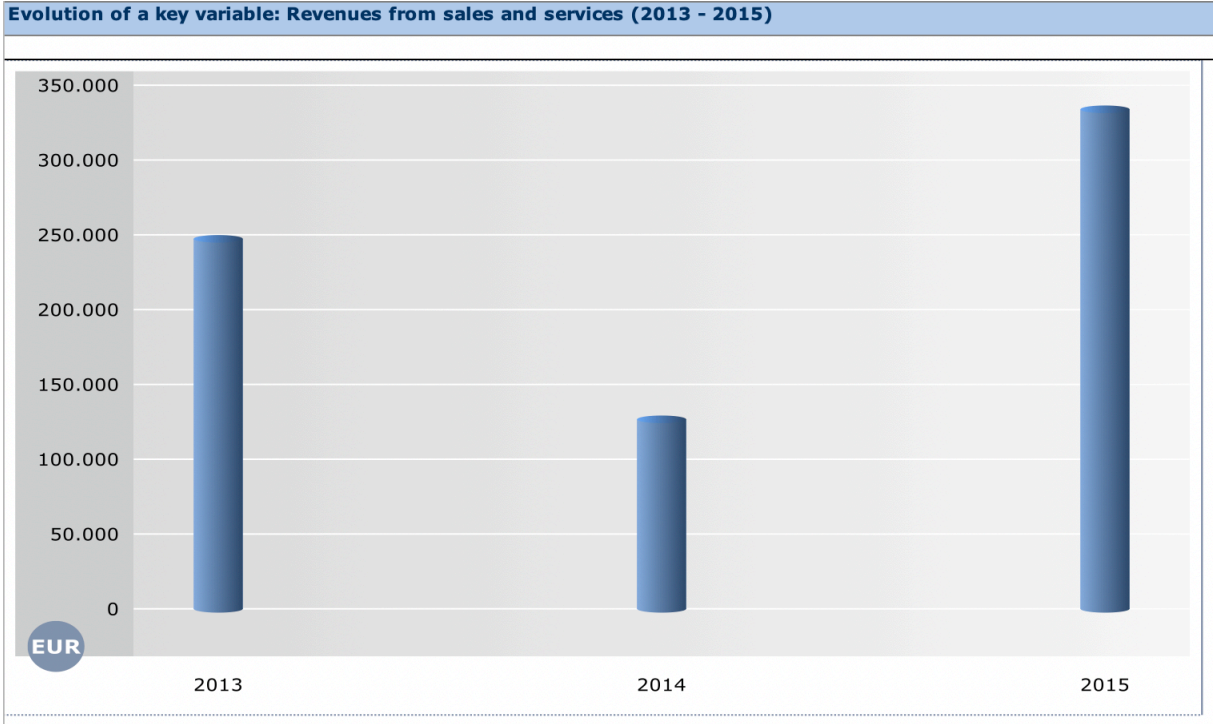The graphs below show the evolution of these factors.



*Figure 83 – AIDA*
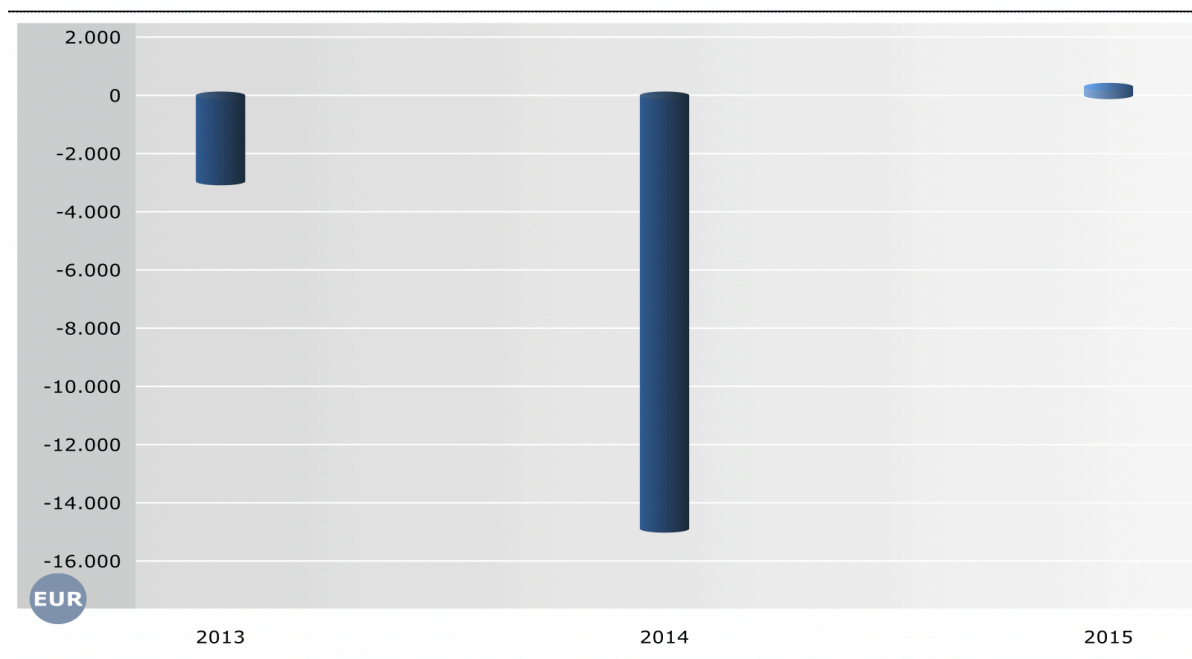
*Figure 84 – AIDA*

**Ohlson O-score Model - COGENER S.R.L.**

| | | Inputs | | |
|---|---|---|---|---|
| | | 2015 | 2014 | 2013 |
| TA | **Total assets** | 460.227,00 € | 571.229,00 € | 606.369,00 € |
| GNP | **Gross National Product price index level** | 1.789.303.571,43 | 1.569.168.207,02 € | 9.127.497.556,94 € |
| TL | **Total liabilities** | 439.645,00 € | 545.658,00 € | 569.800,00 € |
| WC | **Working capital** | -401.822,00 € | -488.652,00 € | -508.262,00 € |
| NI | **Net income** | -4.988,00 € | -10.999,00 € | 33,00 € |
| NI_t-1 | **Net income (t-1)** | -10.999,00 € | 33,00 € | 8.179,00 € |
| EBITDA | **Earnings before interest, income taxes, depreciation, amortization** | 92.135,00 € | 15.719,00 € | 42.959,00 € |

| Variables | Coefficients | Values | | |
|---|---|---|---|---|
| | -1,32 | | | |
| $o_1$ | -0,407 | -8,27 | -7,92 | -9,62 |
| $o_2$ | 6,03 | 0,96 | 0,96 | 0,94 |
| $o_3$ | -1,43 | -0,87 | -0,86 | -0,84 |
| $o_4$ | 0,08 | 11,11 | 10,00 | 9,09 |
| $o_5$ | -2,37 | -0,01 | -0,02 | 0,00 |
| $o_6$ | -1,83 | 0,21 | 0,03 | 0,00 |
| $o_7$ | 0,285 | 0,00 | 0,00 | 1,00 |
| $o_8$ | -1,72 | 0,00 | 0,00 | 0,00 |
| $o_9$ | -0,52 | 0,38 | -1,00 | -0,99 |
| | **T** | 9,39 | 10,20 | 10,99 |
| | **Default probability** | **99,99%** | **100,00%** | **100,00%** |

*Figure 85 – Own elaboration*

This situation turns out to be confirmed by the second model under analysis. In fact, the application of the O-Score model shows that in those years the probability of bankruptcy is equal to 100%.

In this case, both models have a similar result, and both predicted, in previous years, the liquidation in 2017.

**Chapter 4 – Conclusions**

The following tables show the results of the analysis conducted in the previous chapter in a macroscopic view of the entire sample, first in relation to the Altman Z-Score model and then to the Ohlson O-Score model. They are divided according to the year in which the analysis is performed. Specifically, year T corresponds to the year closest to bankruptcy and, consequently, years T-1 and T-2 are the previous ones.

*4.1 Altman Z-Score – Year T*

| | ALTMAN Z-SCORE - Year T | | | | | |
|---|---|---|---|---|---|---|
| | **Private Manufacturing** | | | **Non - manufacturing** | | |
| | z' >2.90 | 1.23 < z'< 2.90 | z' < 1.23 | z'' >2.60 | 1.1 < z''< 2.60 | z'' <1.1 |
| **Name** | "Safe" zone | "Grey" zone | "Distress" zone | "Safe" zone | "Grey" zone | "Distress" zone |
| 3 L WIND SRL | | | X | | | |
| 8WM1LUC S.R.L. | | | X | | | |
| ABENGOA SOLAR ITALIA S.R.L. | | | X | | | |
| ACQUALEO S.R.L. | | | X | | | |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | | | | | | X |
| ALGAE FACTOR S.R.L. | | | X | | | |
| A.P.I.C.E. S.R.L. | | | X | | | |
| A.S.A.D. S.R.L. | | | X | | | |
| ENERGIE RINNOVABILI ITALIA S.R.L. | | | X | | | |
| SIAMO ENERGIA & PARTNERS S.R.L. | | | X | | | |
| EIFFEL S.R.L. | | | | | | X |
| MOBILSERVICE S.R.L. | | | X | | | |
| FRI-EL POWER TRADING S.R.L. | | | | | X | |
| VELGA S.R.L. | | | | | | X |
| BELLATRIX S.R.L. | | | X | | | |
| GREEN POWER ENERGY S.R.L. | | | | | X | |
| SACH S.R.L. | | | X | | | |
| ITALIAN JOB S.R.L. | | | | | X | |
| NUOVA IRIDE S.R.L. | | X | | | | |
| COGENER S.R.L. | | | X | | | |
| **TOTAL** | **0** | **1** | **13** | **0** | **3** | **3** |

*Figure 86 – Own elaboration*
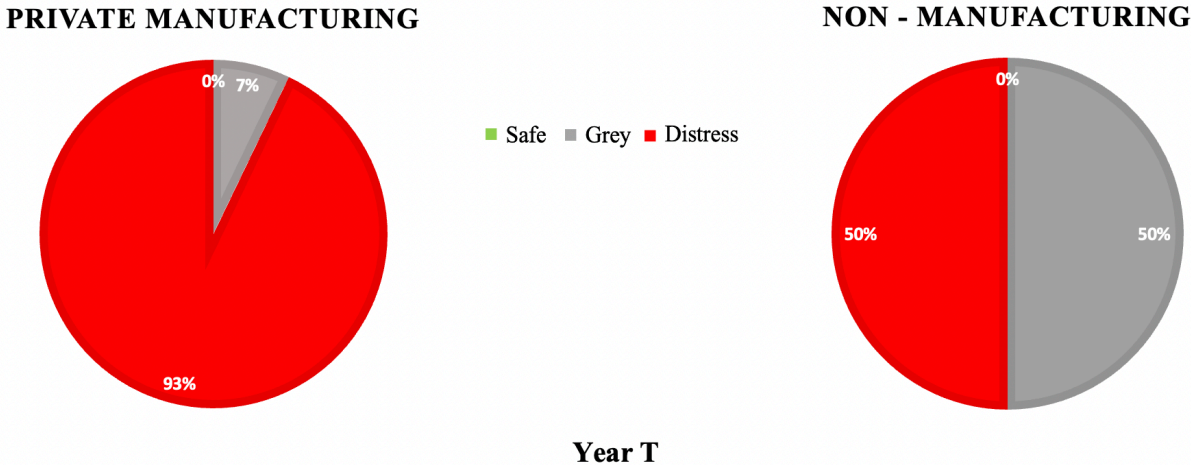


*Figure 87 – Own elaboration*

In the first case, whose data used are those for the year closest to bankruptcy (T), of the 14 enterprises classified as manufacturing, 93% are found to belong to the distress zone, while 7%

belongs to the grey zone. As for the 6 enterprises classified as non-manufacturing, the situation is more balanced, with 50% belonging to the distress zone and 50% in the grey zone.

Overall, in this first analysis, the model has a good predictive ability, considering in both cases 0% of the firms belonging to the safe zone.

*4.2 Altman Z-Score – Year T-1*

| | ALTMAN Z-SCORE - Year T-1 | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Private Manufacturing | | | Non - manufacturing | | |
| | z' > 2.90 | 1.23 < z' < 2.90 | z' < 1.23 | z'' > 2.60 | 1.1 < z'' < 2.60 | z'' < 1.1 |
| Name | "Safe" zone | "Grey" zone | "Distress" zone | "Safe" zone | "Grey" zone | "Distress" zone |
| 3 L WIND SRL | | | X | | | |
| 8WM1LUC S.R.L. | | | X | | | |
| ABENGOA SOLAR ITALIA S.R.L. | X | | | | | |
| ACQUALEO S.R.L. | | | X | | | |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | | | | | | X |
| ALGAE FACTOR S.R.L. | | | X | | | |
| A.P.I.C.E. S.R.L. | | | X | | | |
| A.S.A.D. S.R.L. | | | X | | | |
| ENERGIE RINNOVABILI ITALIA S.R.L. | | | X | | | |
| SIAMO ENERGIA & PARTNERS S.R.L. | | | X | | | |
| EIFFEL S.R.L. | | | | X | | |
| MOBILSERVICE S.R.L. | | | X | | | |
| FRI-EL POWER TRADING S.R.L. | | | | | X | |
| VELGA S.R.L. | | | | | X | |
| BELLATRIX S.R.L. | | | X | | | |
| GREEN POWER ENERGY S.R.L. | | | | | X | |
| SACH S.R.L. | | | X | | | |
| ITALIAN JOB S.R.L. | | | | | | X |
| NUOVA IRIDE S.R.L. | X | | | | | |
| COGENER S.R.L. | | | X | | | |
| TOTAL | 2 | 0 | 12 | 1 | 3 | 2 |

*Figure 88 – Own elaboration*



**PRIVATE MANUFACTURING**

**NON - MANUFACTURING**
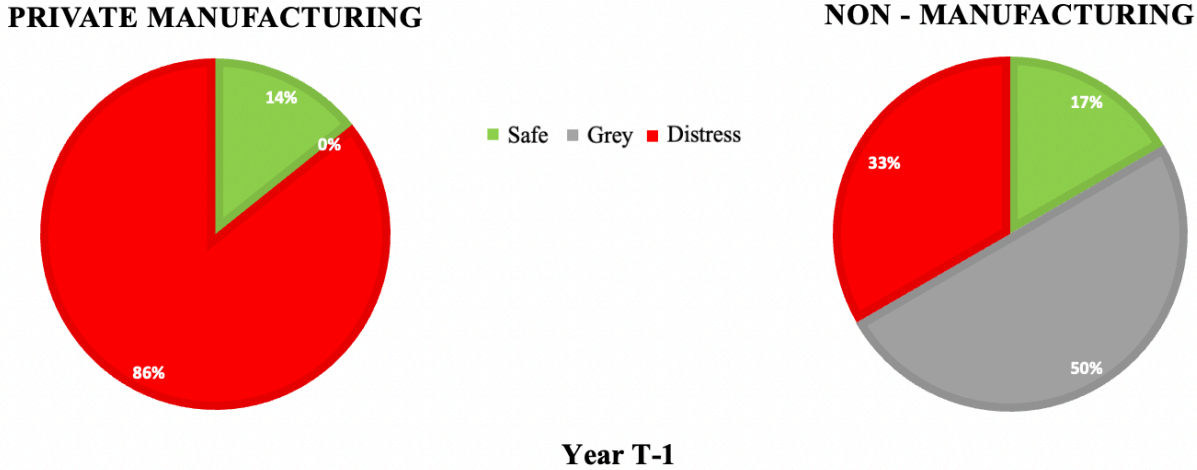
Safe ■ Grey ■ Distress

**Year T-1**

*Figure 89 – Own elaboration*

In the second case, whose data used are those for the year T-1, of the 14 enterprises classified as manufacturing, 86% are found to belong to the distress zone, 14% are in the safe zone, and 0% belongs to the grey zone. As for the 6 enterprises classified as non-manufacturing, the situation is more varied, with 33% belonging to the distress zone, 50% to the grey zone and 17% to the safe one.

So, the predictive ability of the model again turns out to be better in the case of firms classified as manufacturing, although overall it has a lower reliability considering that cases of firms belonging to the safe zone occur in both classifications.

*4.3 Altman Z-Score – Year T-2*

| | ALTMAN Z-SCORE - Year T-2 | | | | | |
|---|---|---|---|---|---|---|
| | **Private Manufacturing** | | | **Non - manufacturing** | | |
| | z' > 2.90 | 1.23 < z' < 2.90 | z' < 1.23 | z'' > 2.60 | 1.1 < z'' < 2.60 | z'' < 1.1 |
| **Name** | "Safe" zone | "Grey" zone | "Distress" zone | "Safe" zone | "Grey" zone | "Distress" zone |
| 3 L WIND SRL | | | X | | | |
| 8WM1LUC S.R.L. | | | X | | | |
| ABENGOA SOLAR ITALIA S.R.L. | | | X | | | |
| ACQUALEO S.R.L. | | | X | | | |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | | | | X | | |
| ALGAE FACTOR S.R.L. | | | X | | | |
| A.P.I.C.E. S.R.L. | | | X | | | |
| A.S.A.D. S.R.L. | | | X | | | |
| ENERGIE RINNOVABILI ITALIA S.R.L. | | | X | | | |
| SIAMO ENERGIA & PARTNERS S.R.L. | | | X | | | |
| EIFFEL S.R.L. | | | | | | X |
| MOBILSERVICE S.R.L. | | | X | | | |
| FRI-EL POWER TRADING S.R.L. | | | | | | X |
| VELGA S.R.L. | | | | | X | |
| BELLATRIX S.R.L. | | | X | | | |
| GREEN POWER ENERGY S.R.L. | | | | X | | |
| SACH S.R.L. | | | X | | | |
| ITALIAN JOB S.R.L. | | | | | X | |
| NUOVA IRIDE S.R.L. | X | | | | | |
| COGENER S.R.L. | | | X | | | |
| **TOTAL** | **1** | **0** | **13** | **2** | **2** | **2** |

*Figure 90 – Own elaboration*



PRIVATE MANUFACTURING — 7%, 0%, 93%

NON - MANUFACTURING — 33%, 34%, 33%
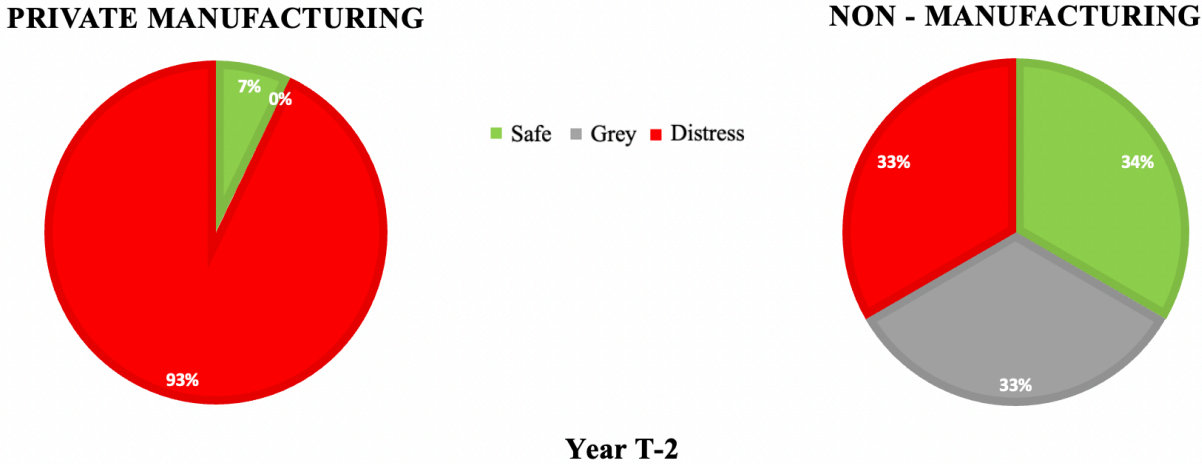
■ Safe  ■ Grey  ■ Distress
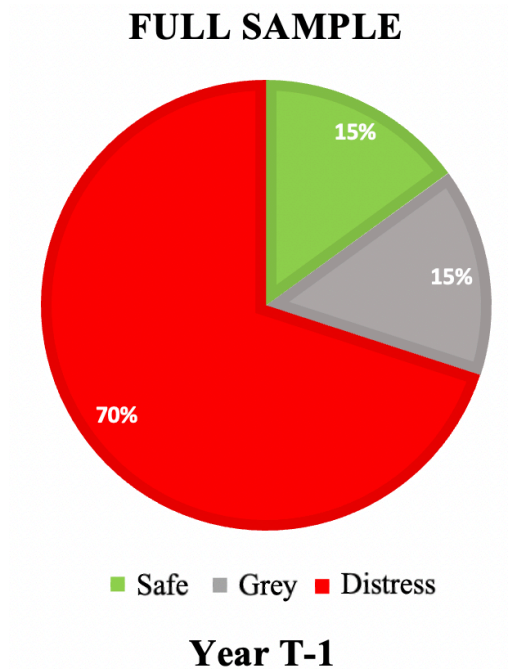
**Year T-2**

*Figure 91 – Own elaboration*

In the third case, whose data used are those for the year T-2, of the 14 enterprises classified as manufacturing, 93% were found to belong to the distress zone, 7% to the safe zone and 0% to the grey zone. As for the 6 enterprises classified as non-manufacturing, the situation changes again, with 33% belonging to the distress zone, 33% to the grey zone and 34% to the safe zone. So, once again, the predictive ability of the model turns out to be better in the case of enterprises classified as manufacturing. Overall, it has a higher reliability than the year T-1, even if in both classifications there are cases of enterprises belonging to the safe zone.

The following graphs show the results obtained from the analysis conducted in a more macroscopic view, considering the entire sample and without the distinction between manufacturing and non-manufacturing.

**FULL SAMPLE**
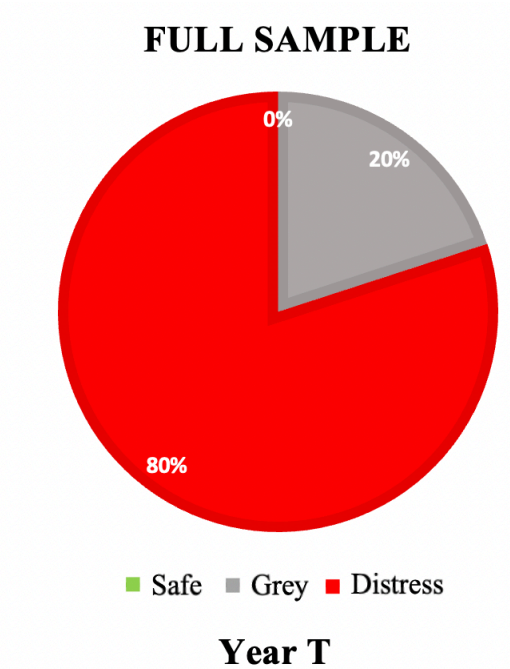


**Year T**

*Figure 92 – Own elaboration*

As can be seen from the graph, in this first case, where the available balance sheet data closest to bankruptcy (Year T) is used, 80% of the enterprises are found to be in the distress zone, while 20% belong to the grey zone. No enterprise is located in the safe zone.

**FULL SAMPLE**



**Year T-1**

*Figure 93 – Own elaboration*

In the second case, whose data used are those of Year T-1, 70% of the enterprises are in the distress zone, while the remaining 30% split equally into the grey zone and safe one.

By merging the first two zones, there are 85% of firms showing clear signs of crisis, confirming the good predictive ability of the model.
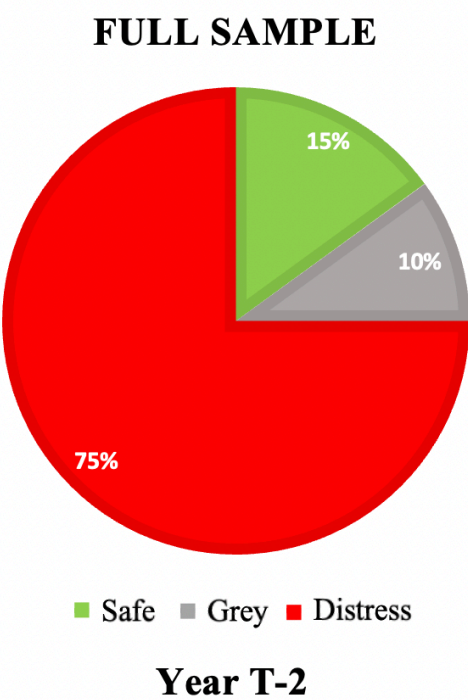
**FULL SAMPLE**



*Figure 94 – Own elaboration*

Finally, in the third case, whose data used are those of year T-2, 75% of the firms belong to the distress zone, 10% to the grey zone and 15% to the safe one. As in the previous case, also in this circumstance, merging the first two zones results in 85% of enterprises showing clear signs of crisis, confirming the good predictive ability of the model.

Overall, Altman model exhibits a good predictive ability, with an average predictive accuracy rate of 75%. Consistent with other studies on the subject, it has the highest predictive ability (80%) when applied at times close to failure, while it appears to be slightly less accurate when applied to more remote years.

However, an anomalous finding is present, since the predictive accuracy rate appears to be marginally higher in year T-2 (75%) than in the previous year T-1 (70%).

In addition, in all the three periods considered, it is possible to observe a better predictive ability in the case of manufacturing firms than for non-manufacturing ones. On the basis of the analysis just concluded, it is possible to make some assumptions. One of the reasons for this finding

may be related to the fact that compared to the model for manufacturing firms constructed by Altman (*Z' score*), *Z'' Score*, applicable to non-manufacturing companies, has the same variables (except for $x_5$, which turns out to be 0) but different and significantly higher coefficients. Thus, the overall model results to be less sensitive to the values of the variables, except when they assume negative figures.

In sum, from this analysis it can be concluded that the Altman Z-Score model can be applied to unlisted Italian companies belonging to the energy sector and has satisfactory results.

Going back to the initial research question, it can be stated that the accuracy and reliability of the Z-score model applied to unlisted Italian companies operating in the energy sector is comparable to that obtained by other researchers in tests conducted in other countries and different sectors.

In fact, as can be seen from the updated table, the predictive accuracy rate measured by this analysis is slightly greater than the overall average of other research (73%).

| Research | Country | Business Sector | Predictive accuracy rate Z-Score |
|---|---|---|---|
| Putri Renalita Sutra Tanjung (2020) | Indonesia | Pharmaceutical | 90,00% |
| Alareeni & Branson (2013) | Jordania | Pharmaceutical | 90,00% |
| Alkhatib & Al Bzour (2011) | US | Pharmaceutical | 80,00% |
| Altman, Danovi, and Falini (2013) | Italy | Manufacturing | 77,80% |
| Massimiliano Celli (2015) | Italy | Not specified | 77,13% |
|  | Italy | Energy | 75,00% |
| Pongsatat, Ramage and Lawrence (2004) | Asia | Not specified | 64,24% |
| Mani Shehni Karamzadeh (2012) | Iran | Not specified | 62,93% |
| Imelda and Alodia (2016) | Indonesia | Manufacturing | 61,00% |
| Gerantonis, Vergos & Christopoulos (2009) | Greece | Manufacturing | 52,33% |

*Figure 95 – Own elaboration*

*4.4 Application Ohlson O-Score method*

**OHLSON O-SCORE - Probability of default**

| Company | Year T | | Year T-1 | | Year T-2 | |
|---|---|---|---|---|---|---|
| | % > 95% | % < 95% | % > 95% | % < 95% | % > 95% | % < 95% |
| 3 L WIND SRL | X | | X | | X | |
| 8WM1LUC S.R.L. | X | | X | | X | |
| ABENGOA SOLAR ITALIA S.R.L. | X | | X | | X | |
| ACQUALEO S.R.L. | X | | X | | X | |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | X | | X | | X | |
| ALGAE FACTOR S.R.L. | X | | X | | X | |
| A.P.I.C.E. S.R.L. | X | | X | | X | |
| A.S.A.D. S.R.L. | X | | X | | X | |
| ENERGIE RINNOVABILI ITALIA S.R.L. | X | | X | | X | |
| SIAMO ENERGIA & PARTNERS S.R.L. | X | | X | | X | |
| EIFFEL S.R.L. | X | | | X | X | |
| MOBILSERVICE S.R.L. | X | | X | | X | |
| FRI-EL POWER TRADING S.R.L. | X | | X | | X | |
| VELGA S.R.L. | X | | X | | X | |
| BELLATRIX S.R.L. | X | | X | | X | |
| GREEN POWER ENERGY S.R.L. | X | | X | | X | |
| SACH S.R.L. | X | | X | | X | |
| ITALIAN JOB S.R.L. | X | | X | | X | |
| NUOVA IRIDE S.R.L. | X | | X | | X | |
| COGENER S.R.L. | X | | X | | X | |
| **TOTAL** | **20** | **0** | **19** | **1** | **20** | **0** |

*Figure 96 – Own elaboration*
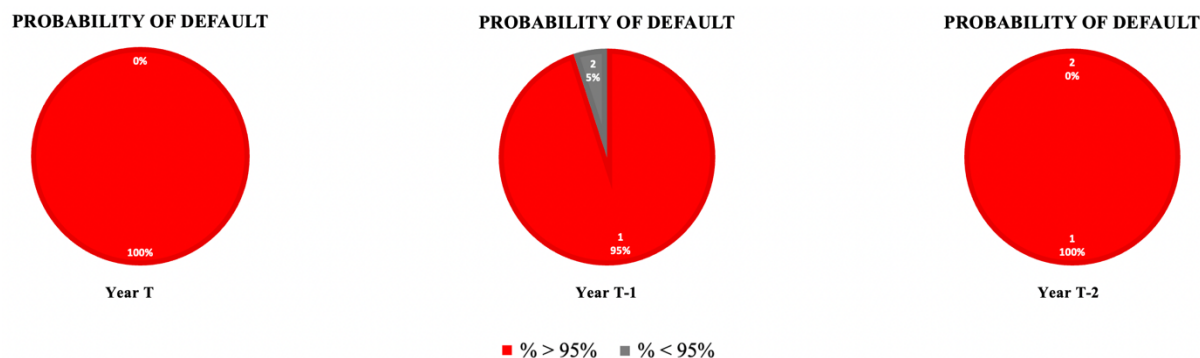


*Figure 97 – Own elaboration*

Regarding the results related to the application of the Ohlson O-Score model, in the first case, whose data used are those for the year closest to bankruptcy (Year T), 100% of the enterprises have a probability of default greater than 95%.

In the second case, whose data used are those for Year T-1, 95% of the enterprises have a probability of default greater than 95%, while 5% (only one enterprise) less than 95%.

Finally, in the third case, whose data used are those for the year T-2, 100% of the firms have a probability of default greater than 95%.

As in the application of Altman's model, an anomalous result is present, since the percentage of firms with a probability of default greater than 95% turns out to be higher in year T-2 than in the previous year.

However, it is possible to state that Ohlson model has an excellent predictive ability when applied to unlisted Italian firms belonging to the energy sector not only in a time horizon close to bankruptcy, but also in previous years.

Going back to the initial research question, it is important to note that the predictive ability of Ohlson model is better than the one of Altman. After the concluded analysis it is possible to state this because unlike the Z-Score, which has been unable to predict failure in some cases, the O-Score has been always accurate for all the enterprises of the sample.

Based on the analysis just conducted, it is possible to make some assumptions to explain this finding. In more detail, it can be supposed that Ohlson's model is always so accurate mainly due to the behavior of the variables $o_1$ and $o_2$, since they show the same pattern in all the cases analyzed. The former, although it presents a coefficient equal to - *0.407*, is crucial because the corresponding values reach very high negative quantities, due to the high figures of the Gross National Product price index level, that consequently give a considerable positive weight to the whole model. The latter presents the highest coefficient, equal to *6.03* and the corresponding values turn out to be positive for all the firms and periods considered. For these reasons, the sum of these two variables is always positive and represents an important basis of the final value of the O-score.

*4.5 Limitations and Further research*

This study has several limitations. One of these, common to other studies done on the same topic, may be the inability to generalize the results obtained with other countries because of structural and environmental differences.

Another limitation concerns the sample used in the analysis, since it includes only unlisted enterprises.

Regarding future possible research, it is possible to expand this study by using as sample listed Italian companies belonging to the energy sector. Moreover, a comparative analysis with listed or private companies belonging to Europe or other countries and operating in the same sector can be conducted.

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# SUMMARY

The purpose of this thesis is to verify the predictive ability of Altman's Z-score model applied to Italian unlisted companies belonging to the energy sector. Specifically, through an ex-post analysis on a sample of companies that failed in previous years, the study aims to understand whether Z-Score is more reliable in this sector of application compared to other industries in different countries. In addition, Ohlson's model is also applied to the same sample to check if the result obtained from the implementation of the first method is confirmed.

In order to get to the research question, it is appropriate to start from the final considerations of the paper *Can Z-Score Model Predict Listed Companies' Failures in Italy? An Empirical Test* written by Massimiliano Celli in 2015. He studied a sample of Italian listed companies belonging to different sectors and came to the conclusion that *"the predictive ability of the Z-score in the Italian context tends to be lower than that measured by Altman. In our opinion, this difference is "physiological," as the model was built and tuned with reference to companies and markets qualitatively different from the Italian ones."*

So, this thesis aims to extend the study conducted by Celli. In particular, the present work intends to demonstrate if, using as a sample unlisted companies belonging to a single industry (that of the energy sector), the predictive ability of the Z-Score turns out to be better than in the case analyzed by other authors in different countries and whether this ability turns out to be confirmed by the O-Score model as well.

Therefore, the research question is the following:
*"Is the degree of accuracy and reliability of the Z-score applied to unlisted Italian companies operating in the energy sector comparable to that obtained by other researchers in tests conducted in other countries in different sectors? Does Ohlson's model, for the same conditions, turn out to confirm this thesis?"*

**The financial distress**

The bankruptcy is a condition in which a company can no longer continue to operate properly due to the experiencing of financial difficulties. In particular, financial distress or bankruptcy usually occurs when current liabilities exceed current assets or when the amount of liabilities is greater than the fair value of assets.

The causes of financial distress can derive from internal or external sources. The former can be summarized as inexperience of managers and incompetence regarding the effective management of assets and liabilities. The latter can be summarized as factors like depreciation of foreign currencies, inflation, legal system, and taxes.

The state of corporate crisis cannot be determined according to a "static" mode but must be identified and analyzed by taking into consideration a particular time frame of the company's life.

Following this logic, four different stages of corporate crisis can be identified:

1. *Incubation*: the first effects of the crisis can be identified, such as a decline in the value of production or surplus inventory.

2. *Maturation*: the effects of the crisis present negative impacts that can be seen from the operating accounting results. This means that they have a duration of more than 12 months.

3. *Insolvency*: the company is no longer able to meet its obligations to creditors normally. This situation creates difficulties in the management of working capital, the procurement process of raw materials and the supply of products to end customers.

4. *Bankruptcy*: at this final stage, the company has disclosed its state of insolvency in the market and the only way forward is to initiate bankruptcy proceedings of a judicial or extrajudicial nature.

The evaluation of enterprises in crisis cannot be equated with the one of companies that are not in such a state. In fact, the use of an unsuitable method may lead to results that are far from reality. So, because the firm is in a distressed phase, normal valuation methods must be filtered and adapted to the real context of crisis in which the company is located. To explain why companies in decline create greater difficulties for analysts in evaluating them, it is appropriate to refer to the characteristics they may present in this condition.

Obviously, not all of them present the same set of situations, but it is possible to make a generalization:

- *Declining or stagnant revenues*
- *Negative or declining margins*
- *Asset divestitures*
- *Large payments-dividends and share repurchases*
- *Financial leverage – the downside*

For the identification of crisis situations, it is appropriate to construct certain parameters and indexes functional to an immediate detection of the economic and financial risks that the business could run in the immediate future. In order to make a final judgment on the business condition, it is useful to take into analysis not only balance sheet ratios derived from internal information, but also indicators built on extra-accounting quantities. Finally, analysts used to apply predictive models of failure in order to assess the health of a particular company. They can be divided into two different categories depending on whether they are based on accounting ratios or market values.

*Altman Z-score*

The Altman Z-score belongs to the category of predictive models based on accounting ratios. Since a number of variables are combined simultaneously to examine a company for its failure potential, the analysis can be considered multivariate.

The formulation of the so-called Zeta Score model led to the definition of an index designed to define the probability of failure of a given company through statistical techniques.

It was developed in 1968, with reference to industrial companies listed on the U.S. stock market and modified by the same author subsequently. With the help of this model, Altman could predict financial efficiency or bankruptcy up to 2-3 years in advance. It had been constructed using as a sample 66 manufacturing companies from two different health situations: 33 bankrupt (Group one) and 33 non-bankrupt firms (Group two). The information taken in consideration for the firms of the two groups were from the same years.

The next step was the selection of the ratios that could be considered important for studying the financial situation of the companies. Altman drew up a list of 22 potential ratios that were selected because of their potential relevance in studies and their popularity in the literature.

They were classified into five different categories that were the following:

- Liquidity
- Profitability
- Leverage
- Solvency
- Activity

Subsequently, it was necessary to perform a selection process to arrive at the final profile of the variables that was based on the following procedures:

1. Observation of the statistical significance of various alternative functions including determination of the relative contributions of each independent variable.

2. Valuation of the intercorrelations that had been created among the relevant variables.
3. Observation of the predictive accuracy of the various profiles.
4. Analyst's judgment.

The Altman Z-score model for *public manufacturing* firms is:

$$z = 1.2x_1 + 1.4x_2 + 3.3x_3 + 0.6x_4 + 0.999x_5$$

where the variables are defined as:

- *z = overall index*
- *$x_1$ = working capital / total assets*

  It represents a measure of the net liquid assets of the company relative to the total capitalization.

- *$x_2$ = retained earnings / total assets*

  It represents a measure of cumulative profitability over time and reflects the firm's age and its earning power.

- *$x_3$ = earnings before interest and income taxes / total assets*

  It represents the actual profitability or productivity of the company's assets, since this version of return on assets is independent of any tax leverage.

  According to Altman, this ratio is a better representation of the profitability of a company than cash flow. In fact, it measures the amount of cash supply available for allocation to creditors, government, and shareholders.

- *$x_4$ = market value of common equity / book value of total liabilities*

  This is a measure of how much a company's assets can decrease in value before liabilities exceed assets and the company becomes insolvent.

- *$x_5$ = sales / total assets*

  It represents a capital-turnover that indicates the ability of the company's assets in generating sales and it is a measure of the competitive ability of the management relating to sales. It also measures management's competitive ability, relating to sales.

Finally, Altman divided the Z-values into three different categories that determine the zones of discrimination as follows:

- $z > 2.99$ = safe zone
- $1.80 < z < 2.99$ = grey zone
- $z < 1.80$ = distress zone

The most probable range of false prediction was between 1.81 and 2.99, considered as the zone of ignorance or grey area. A Z-value less than 1.80 indicates a strong likelihood of bankruptcy, and greater than 2.99 indicate a low likelihood of bankruptcy *(Altman, 1968)*.

| Type of Company | Public manufacturing |
|---|---|
| Altman Z-Score Model | $z = 1.2x_1 + 1.4x_2 + 3.3x_3 + 0.6x_4 + 0.999x_5$ |

| Zone of discrimination | |
|---|---|
| Safe zone | $z > 2.99$ |
| Grey zone | $1.80 < z < 2.99$ |
| Distress zone | $z < 1.80$ |

*Own elaboration*

However, according to Altman "*credit analysis, private placement dealers, accounting auditors, and firms themselves are concerned that the original model is only applicable to publicly traded entities (since x₄ requires stock price data)*". So, in 1983 he developed a new model specifically for privately firms.

The Altman Z-score model for *private manufacturing* firms is:

$$z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$$

where the variables are defined as:

- $z'$ = overall index
- $x_1$ = working capital / total assets
- $x_2$ = retained earnings / total assets
- $x_3$ = earnings before interest and income taxes / total assets
- $x_4$ = book value of common equity / book value of total liabilities
- $x_5$ = sales / total assets

The new estimation of the model substitutes market value of equity with the book value of equity in $x_4$. As the coefficients changed for the revised model, so did the Z-score results and the zones of discrimination (Altman, 1983). They are:

- $z' > 2.90$ = safe zone
- $1.23 < z' < 2.90$ = grey zone
- $z' < 1.23$ = distress zone

| Type of Company | Private manufacturing |
|---|---|
| Altman Z-Score Model | $z' = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5$ |

| Zone of discrimination | |
|---|---|
| Safe zone | $z' > 2.90$ |
| Grey zone | $1.23 < z' < 2.90$ |
| Distress zone | $z' < 1.23$ |

*Own elaboration*

In 1993 Altman decided to adapt the model also to non-manufacturing firms. So, it was important to delete the industry effect that was represented by $x_5$ index.

The Altman Z-score model for *non - manufacturing* firms is:

$$z'' = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05x_4$$

where the variables are defined as:

- $z''$ = *overall index*
- $x_1$ = *working capital / total assets*
- $x_2$ = *retained earnings / total assets*
- $x_3$ = *earnings before interest and income taxes / total assets*
- $x_4$ = *book value of common equity / book value of total liabilities*

The new zones of discrimination are the following:

- $z'' > 2.60$ = safe zone
- $1.1 < z'' < 2.60$ = grey zone
- $z'' < 1.1$ = distress zone

| Type of Company | Non - manufacturing |
|---|---|
| Altman Z-Score Model | $z'' = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05x_4$ |

| Zone of discrimination | |
|---|---|
| Safe zone | $z'' > 2.60$ |
| Grey zone | $1.1 < z'' < 2.60$ |
| Distress zone | $z'' < 1.1$ |

*Own elaboration*

*Ohlson O-Score*

In 1980, another important predictive model of corporate bankruptcy was constructed by Ohlson. It differs from the previous one analyzed by Altman because this new model used logit statistical method in order to overcome the weakness of the Multi Discriminant Analysis used by his predecessor. In particular, the main problems when using the MDA methodology were:

- The variance-covariance predictors and other statistical requirements imposed on the nature of the distribution of the forecasters must be the same for bankrupt and non-bankrupt firms considered in the analysis.
- Since it is an ordinal ranking, the result of the application of the MDA is a score with a little percentage of intuitive interpretation.

- Problems regarding the "matching" procedure between the bankrupt and non-bankrupt companies. One example of this kind of criteria is the industry size.

The period on which Ohlson's analysis is based goes from 1970 to 1976. His study was conducted on 105 manufacturing companies that went bankrupt and 2058 companies that were not bankrupt during the period. The difference with Altman's model lay not only in the number of firms considered, but also in the source of data. In fact, the latter took data from Moody's manual, while Ohlson used as source the financial statement issued for taxes (10K-Financial Statement).

This procedure has one important advantage: the report shows at which moment they are released to the public, and therefore it is possible to check whether the company goes bankrupt before or after the release date.

The model is composed of nine variables consisting of several financial ratios and it is as follows:

$O\text{-}score = -1.32 - 0.407o_1 + 6.03o_2 - 1.43o_3 + 0.08o_4 - 2.37o_5 - 1.83o_6 + 0.285o_7 - 1.72o_8 - 0.52o_9$

where the variables are defined as:

- $o_1$ = total assets, inflation adjusted (ln (total assets/GNP price index level))
- $o_2$ = total liabilities / total assets
- $o_3$ = net working capital / total assets
- $o_4$ = current liabilities / current assets
- $o_5$ = net income / total assets
- $o_6$ = earnings before interest, income taxes, depreciation, amortization / total liabilities
- $o_7$ = 1 if net income was negative for the last two years, zero otherwise
- $o_8$ = 1 if book value of shareholders' equity is negative, zero otherwise
- $o_9$ = change in net income (net income – net income$_{-1}$) / absolute value of net income (net income + net income$_{-1}$)

The probability of default is given by the formula:

*Probability of default = Exp [O-score] / (1+ Exp [O-score])*

There are also the following zones of discrimination:

- O-score < 0.38 = safe zone
- O-score > 0.38 = distress zone

**Literature review**

This section aims to analyze existing literature related to the study and application of the two predictive models mentioned above. It is useful to focus on a good number of studies that have

tested the reliability of the Z-Score and O-Score in various countries and with respect to different business sectors, in order to better understand their predictive ability in relation to different application contexts. In particular, to have a background on which to base this study, it is appropriate to focus on the Italian panorama, analyzing the research that has been done on this topic. In this context, the two most relevant studies are the following.

*Altman, Danovi, and Falini*, in 2013, in the paper *Z-Score Models' Application to Italian Companies Subject to Extraordinary Administration*, apply Altman's model to Italian firms reported to be under extraordinary administration between 2000 and 2010. This research turns out to be fundamental in verifying the applicability of the model to the manufacturing industry in Italy. The companies considered by Danovi and Falini were manufacturing firms subjected to extraordinary administration procedures pursuant to Legislative Decree 270/1999 and d.l. 347/2003 during the period 2000-2010. The sample used is composed of a total of 52 companies subject to the Extraordinary Administration procedures.

The two scholars decided to apply the *Z' Score and Z'' Score* models due to the small number of listed companies in the Italian system and, in particular, in the sample considered: in fact, listed companies correspond to only 5% of the selected firms.

For what concerns the result, during the course of the five-year pre-bankruptcy period, the classifications of the indicator are accurate in 72.3% of the cases (which climbs to 77.8% if data from year x-5 are ignored).

Another relevant research always related to the Italian scenario was conducted by *Massimiliano Celli*, in 2015, titled *Can Z-Score Model Predict Listed Companies' Failures in Italy? An Empirical Test*. Using an ex-post approach, it verifies whether the model would have been able to forecast the development of the financial difficulties of the companies taken as a sample. Through a subsequent comparison of the results obtained by the application of the statistical model and what actually happened, it is possible to measure the reliability rate of Altman's model for listed companies in Italy. The test was run on a group of 51 businesses whose shares were permanently delisted or suspended in the years 1995 to 2013 as a result of irreversible crises. To determine whether the Z-score would have accurately forecast the future of those businesses, the model has been implemented to the balance sheet values in the three years preceding the delisting (or prior to suspension from listing).

For what concerns the results, the Z-score effectiveness of estimates provided in the first (T-1), second (T-2), and third (T-3) years previous to the year of delisting or permanent suspension (T) was, respectively, 87.3%, 77.5%, and 66.6%. Consequently, the Z-score demonstrates a fair capability to predict corporate failures, at least one year before the company is delisted. However, as the prediction time horizon rises, its reliability declines.

It should be highlighted that the model's prediction accuracy is marginally inferior to that derived from industrial companies listed on Anglo-Saxon markets. This discrepancy results from the fact that the Z-Score has been created using enterprises and markets that are fundamentally different from those in Italy. Nevertheless, the model used to classify Italian listed companies has acceptable error rates and accurate classification.

In the table below it is possible to observe, in a summarized manner, the results obtained from past research regarding different countries and various industries of application. The Z-Score predictive accuracy rate shown is the average of the percentages of the three years preceding the bankruptcy of the companies considered.

| Research | Country | Business Sector | Predictive accuracy rate Z-Score |
|---|---|---|---|
| Putri Renalita Sutra Tanjung (2020) | Indonesia | Pharmaceutical | 90,00% |
| Alareeni & Branson (2013) | Jordania | Pharmaceutical | 90,00% |
| Alkhatib & Al Bzour (2011) | US | Pharmaceutical | 80,00% |
| Altman, Danovi, and Falini (2013) | Italy | Manufacturing | 77,80% |
| Massimiliano Celli (2015) | Italy | Not specified | 77,13% |
| Pongsatat, Ramage and Lawrence (2004) | Asia | Not specified | 64,24% |
| Mani Shehni Karamzadeh (2012) | Iran | Not specified | 62,93% |
| Imelda and Alodia (2016) | Indonesia | Manufacturing | 61,00% |
| Gerantonis, Vergos & Christopoulos (2009) | Greece | Manufacturing | 52,33% |

*Own elaboration*

**The analysis**

To conduct the analysis in support of this thesis, there has been employed as a sample 20 unlisted Italian companies belonging to the energy sector that failed between the years *2007* and *2021*. So, the approach used to measure the reliability of the models is ex-post, since it verifies whether the model is able to forecast the future bankruptcy of the companies taken as a sample. Through a subsequent comparison of the results obtained by the statistical model and what actually happened, it is possible to measure the reliability rate of Altman's model for the companies considered. Data on the financial statements of these firms are extracted from the AIDA database. The application of the two models is performed in the last three years preceding the last available financial statements. Thus, not only it is possible to understand the predictive ability of the two methods even several years before the dissolution of the enterprise, but it is also a way to be sure that there have been used data that is as reliable as possible. In fact, data from the last available balance sheet before bankruptcy may not be entirely correct for such an analysis because it is too compromised by the crisis situation in which the enterprise is located. However, for the analysis of some firms it was necessary to use the last available balance sheet as the starting year (Year T). This was necessary because, for an appropriate application of the

Ohlson's model in a given year, data from the financial statements of the previous two years are needed, but such statements were not always available in the AIDA database.

The sample of the 20 enterprises analyzed is as follows:

| Name | ATECO Code | Activity | Type | Date of failure | Last accounting closing date |
|---|---|---|---|---|---|
| 3 L WIND SRL | 351100 | Production of electricity | Manufacturing | 06/08/14 | 31/12/13 |
| 8WM1LUC S.R.L. | 351100 | Production of electricity | Manufacturing | 28/09/16 | 31/12/15 |
| ABENGOA SOLAR ITALIA S.R.L. | 351100 | Production of electricity | Manufacturing | 29/01/18 | 31/12/16 |
| ACQUALEO S.R.L. | 351100 | Production of electricity | Manufacturing | 01/08/18 | 31/12/19 |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | 351400 | Transmission and distribution of electricity | Non-manufacturing | 31/12/18 | 31/12/18 |
| ALGAE FACTOR S.R.L. | 351100 | Production of electricity | Manufacturing | 21/12/18 | 31/12/17 |
| A.P.I.C.E. S.R.L. | 351100 | Production of electricity | Manufacturing | 20/12/13 | 31/12/12 |
| A.S.A.D. S.R.L. | 351100 | Production of electricity | Manufacturing | 23/11/15 | 31/12/14 |
| ENERGIE RINNOVABILI ITALIA S.R.L. | 271100 | Manufacture of electric motors | Manufacturing | 21/12/15 | 31/12/14 |
| SIAMO ENERGIA & PARTNERS S.R.L. | 351100 | Production of electricity | Manufacturing | 09/09/20 | 31/12/16 |
| EIFFEL S.R.L. | 351400 | Trade of electricity | Non-manufacturing | 20/10/17 | 31/12/16 |
| MOBILSERVICE S.R.L. | 351100 | Production of electricity | Manufacturing | 08/13/07 | 31/12/06 |
| FRI-EL POWER TRADING S.R.L. | 351400 | Trade of electricity | Non-manufacturing | 07/12/16 | 31/12/15 |
| VELGA S.R.L. | 351300 | Distribution of electricity | Non-manufacturing | 26/05/21 | 31/12/19 |
| BELLATRIX S.R.L. | 351100 | Production of electricity | Manufacturing | 17/06/20 | 31/12/18 |
| GREEN POWER ENERGY S.R.L. | 351400 | Trade of electricity | Non-manufacturing | 29/01/21 | 31/12/19 |
| SACH S.R.L. | 351100 | Production of electricity | Manufacturing | 17/12/19 | 31/12/17 |
| ITALIAN JOB S.R.L. | 351400 | Trade of electricity | Non-manufacturing | 22/01/20 | 31/12/18 |
| NUOVA IRIDE S.R.L. | 351100 | Production of electricity | Manufacturing | 03/10/19 | 31/12/17 |
| COGENER S.R.L. | 351100 | Production of electricity | Manufacturing | 10/05/17 | 31/12/15 |

*Own elaboration*

## Conclusions

The following tables show the results of the analysis conducted, first in relation to the Altman Z-Score model and then to the Ohlson O-Score model. They are divided according to the year in which the analysis is performed. Specifically, year T corresponds to the year closest to bankruptcy and, consequently, years T-1 and T-2 are the previous ones.

*Altman Z-Score – Year T*

| | ALTMAN Z-SCORE - Year T | | | | | |
|---|---|---|---|---|---|---|
| | Private Manufacturing | | | Non - manufacturing | | |
| | z' > 2.90 | 1.23 < z' < 2.90 | z' < 1.23 | z'' > 2.60 | 1.1 < z'' < 2.60 | z'' < 1.1 |
| Name | "Safe" zone | "Grey" zone | "Distress" zone | "Safe" zone | "Grey" zone | "Distress" zone |
| 3 L WIND SRL | | | X | | | |
| 8WM1LUC S.R.L. | | | X | | | |
| ABENGOA SOLAR ITALIA S.R.L. | | | X | | | |
| ACQUALEO S.R.L. | | | X | | | |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | | | | | | X |
| ALGAE FACTOR S.R.L. | | | X | | | |
| A.P.I.C.E. S.R.L. | | | X | | | |
| A.S.A.D. S.R.L. | | | X | | | |
| ENERGIE RINNOVABILI ITALIA S.R.L. | | | X | | | |
| SIAMO ENERGIA & PARTNERS S.R.L. | | | X | | | |
| EIFFEL S.R.L. | | | | | | X |
| MOBILSERVICE S.R.L. | | | X | | | |
| FRI-EL POWER TRADING S.R.L. | | | | | X | |
| VELGA S.R.L. | | | | | | X |
| BELLATRIX S.R.L. | | | X | | | |
| GREEN POWER ENERGY S.R.L. | | | | | X | |
| SACH S.R.L. | | | X | | | |
| ITALIAN JOB S.R.L. | | | | | X | |
| NUOVA IRIDE S.R.L. | | X | | | | |
| COGENER S.R.L. | | | X | | | |
| TOTAL | 0 | 1 | 13 | 0 | 3 | 3 |

*Own elaboration*

**PRIVATE MANUFACTURING**
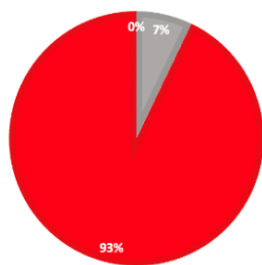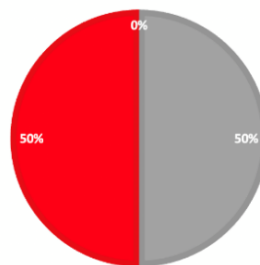
**NON - MANUFACTURING**

■ Safe ■ Grey ■ Distress

**Year T**

*Own elaboration*

In the first case, whose data used are those for the year closest to bankruptcy (T), of the 14 enterprises classified as manufacturing, 93% are found to belong to the distress zone, while 7% belongs to the grey zone. As for the 6 enterprises classified as non-manufacturing, the situation is more balanced, with 50% belonging to the distress zone and 50% in the grey zone.

Overall, in this first analysis, the model has a good predictive ability, considering in both cases 0% of the firms belonging to the safe zone.

*Altman Z-Score – Year T-1*

| | ALTMAN Z-SCORE - Year T-1 | | | | | |
|---|---|---|---|---|---|---|
| | **Private Manufacturing** | | | **Non - manufacturing** | | |
| | z' >2.90 | 1.23 < z' <2.90 | z' <1.23 | z'' >2.60 | 1.1 < z'' <2.60 | z'' <1.1 |
| **Name** | **"Safe" zone** | **"Grey" zone** | **"Distress" zone** | **"Safe" zone** | **"Grey" zone** | **"Distress" zone** |
| 3 L WIND SRL | | | X | | | |
| 8WM1LUC S.R.L. | | | X | | | |
| ABENGOA SOLAR ITALIA S.R.L. | X | | | | | |
| ACQUALEO S.R.L. | | | X | | | |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | | | | | | X |
| ALGAE FACTOR S.R.L. | | | X | | | |
| A.P.I.C.E. S.R.L. | | | X | | | |
| A.S.A.D. S.R.L. | | | X | | | |
| ENERGIE RINNOVABILI ITALIA S.R.L. | | | X | | | |
| SIAMO ENERGIA & PARTNERS S.R.L. | | | X | | | |
| EIFFEL S.R.L. | | | | X | | |
| MOBILSERVICE S.R.L. | | | X | | | |
| FRI-EL POWER TRADING S.R.L. | | | | | X | |
| VELGA S.R.L. | | | | | X | |
| BELLATRIX S.R.L. | | | X | | | |
| GREEN POWER ENERGY S.R.L. | | | | | X | |
| SACH S.R.L. | | | X | | | |
| ITALIAN JOB S.R.L. | | | | | | X |
| NUOVA IRIDE S.R.L. | X | | | | | |
| COGENER S.R.L. | | | X | | | |
| **TOTAL** | **2** | **0** | **12** | **1** | **3** | **2** |

*Own elaboration*



**PRIVATE MANUFACTURING**
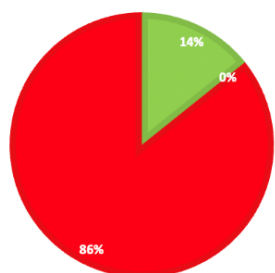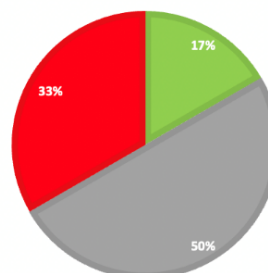
**NON - MANUFACTURING**

■ Safe ■ Grey ■ Distress
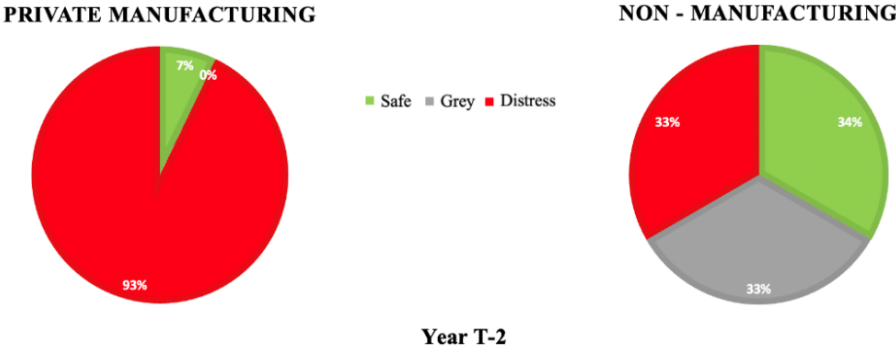
**Year T-1**

*Own elaboration*

In the second case, whose data used are those for the year T-1, of the 14 enterprises classified as manufacturing, 86% are found to belong to the distress zone, 14% are in the safe zone, and 0% belongs to the grey zone. As for the 6 enterprises classified as non-manufacturing, the situation is more varied, with 33% belonging to the distress zone, 50% to the grey zone and 17% to the safe one. So, the predictive ability of the model again turns out to be better in the case of firms classified as manufacturing, although overall it has a lower reliability considering that cases of firms belonging to the safe zone occur in both classifications.

*Altman Z-Score – Year T-2*

| | ALTMAN Z-SCORE - Year T-2 | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Private Manufacturing | | | Non - manufacturing | | |
| | z' >2.90 | 1.23 < z' <2.90 | z' < 1.23 | z'' >2.60 | 1.1 < z'' <2.60 | z'' < 1.1 |
| Name | "Safe" zone | "Grey" zone | "Distress" zone | "Safe" zone | "Grey" zone | "Distress" zone |
| 3 L WIND SRL | | | X | | | |
| 8WM1LUC S.R.L. | | | X | | | |
| ABENGOA SOLAR ITALIA S.R.L. | | | X | | | |
| ACQUALEO S.R.L. | | | X | | | |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | | | | X | | |
| ALGAE FACTOR S.R.L. | | | X | | | |
| A.P.I.C.E. S.R.L. | | | X | | | |
| A.S.A.D. S.R.L. | | | X | | | |
| ENERGIE RINNOVABILI ITALIA S.R.L. | | | X | | | |
| SIAMO ENERGIA & PARTNERS S.R.L. | | | X | | | |
| EIFFEL S.R.L. | | | | | | X |
| MOBILSERVICE S.R.L. | | | X | | | |
| FRI-EL POWER TRADING S.R.L. | | | | | | X |
| VELGA S.R.L. | | | | | X | |
| BELLATRIX S.R.L. | | | X | | | |
| GREEN POWER ENERGY S.R.L. | | | | X | | |
| SACH S.R.L. | | | X | | | |
| ITALIAN JOB S.R.L. | | | | | X | |
| NUOVA IRIDE S.R.L. | X | | | | | |
| COGENER S.R.L. | | | X | | | |
| TOTAL | 1 | 0 | 13 | 2 | 2 | 2 |

*Own elaboration*



Year T-2

*Own elaboration*

In the third case, whose data used are those for the year T-2, of the 14 enterprises classified as manufacturing, 93% were found to belong to the distress zone, 7% to the safe zone and 0% to the grey zone. As for the 6 enterprises classified as non-manufacturing, the situation changes again, with 33% belonging to the distress zone, 33% to the grey zone and 34% to the safe zone. Overall, it has a higher reliability than the year T-1, even if in both classifications there are cases of enterprises belonging to the safe zone.

The following graphs show the results obtained from the analysis conducted in a more macroscopic view, considering the entire sample and without the distinction between manufacturing and non-manufacturing.
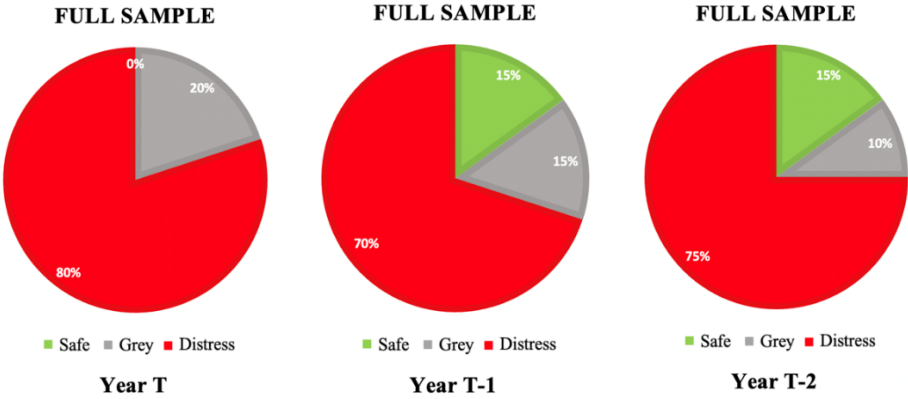


In the first case, where the available balance sheet data closest to bankruptcy (Year T) is used, 80% of the enterprises are found to be in the distress zone, while 20% belong to the grey zone. No enterprise is located in the safe zone.

In the second case, whose data used are those of Year T-1, 70% of the enterprises are in the distress zone, while the remaining 30% split equally into the grey zone and safe one. By merging the first two zones, there are 85% of firms showing clear signs of crisis, confirming the good predictive ability of the model.

Finally, in the third case, whose data used are those of year T-2, 75% of the firms belong to the distress zone, 10% to the grey zone and 15% to the safe one. As in the previous case, also in this circumstance merging the first two zones results in 85% of enterprises showing clear signs of crisis, confirming the good predictive ability of the model.

Overall, Altman model exhibits a good predictive ability, with an average predictive accuracy rate of 75%. Consistent with other studies on the subject, it has the highest predictive ability (80%) when applied at times close to failure, while it appears to be slightly less accurate when applied to more remote years. However, an anomalous finding is present, since the predictive accuracy rate appears to be marginally higher in year T-2 (75%) than in the previous year T-1 (70%). In addition, in all the three periods considered, it is possible to observe a better predictive ability in the case of manufacturing firms than for non-manufacturing ones. On the basis of the analysis just concluded, it is possible to make some assumptions. One of the reasons for this finding may be related to the fact that, compared to the model for manufacturing firms constructed by Altman (*Z' score*), *Z'' Score*, applicable to non-manufacturing companies, has the same variables (except for $x_5$, which turns out to be 0) but different and significantly higher

coefficients. Thus, the overall model results to be less sensitive to the values of the variables, except when they assume negative figures.

In sum, from this analysis it can be concluded that the Altman Z-Score model can be applied to unlisted Italian companies belonging to the energy sector and has satisfactory results.

Going back to the initial research question, it can be stated that the accuracy and reliability of the Z-score model applied to unlisted Italian companies operating in the energy sector is comparable to that obtained by other researchers in tests conducted in other countries and different sectors. In fact, as can be seen from the updated table, the predictive accuracy rate measured by this analysis is slightly greater than the overall average of other research (73%).

| Research | Country | Business Sector | Predictive accuracy rate Z-Score |
|---|---|---|---|
| Putri Renalita Sutra Tanjung (2020) | Indonesia | Pharmaceutical | 90,00% |
| Alareeni & Branson (2013) | Jordania | Pharmaceutical | 90,00% |
| Alkhatib & Al Bzour (2011) | US | Pharmaceutical | 80,00% |
| Altman, Danovi, and Falini (2013) | Italy | Manufacturing | 77,80% |
| Massimiliano Celli (2015) | Italy | Not specified | 77,13% |
| | Italy | Energy | 75,00% |
| Pongsatat, Ramage and Lawrence (2004) | Asia | Not specified | 64,24% |
| Mani Shehni Karamzadeh (2012) | Iran | Not specified | 62,93% |
| Imelda and Alodia (2016) | Indonesia | Manufacturing | 61,00% |
| Gerantonis, Vergos & Christopoulos (2009) | Greece | Manufacturing | 52,33% |

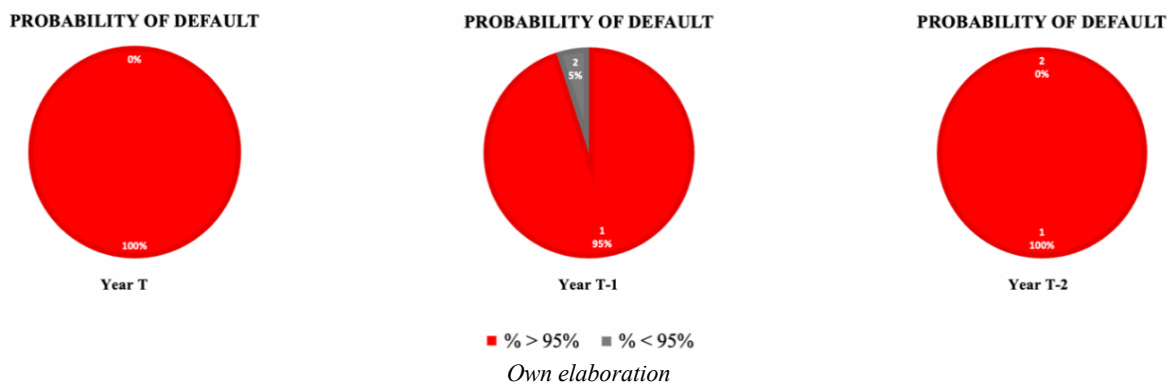*Own elaboration*

*Application Ohlson O-Score method*

**OHLSON O-SCORE - Probability of default**

| Company | Year T | | Year T-1 | | Year T-2 | |
|---|---|---|---|---|---|---|
| | % > 95% | % < 95% | % > 95% | % < 95% | % > 95% | % < 95% |
| 3 L WIND SRL | X | | X | | X | |
| 8WM1LUC S.R.L. | X | | X | | X | |
| ABENGOA SOLAR ITALIA S.R.L. | X | | X | | X | |
| ACQUALEO S.R.L. | X | | X | | X | |
| ADVISE BROKERAGE PLAN ENERGY S.R.L. | X | | X | | X | |
| ALGAE FACTOR S.R.L. | X | | X | | X | |
| A.P.I.C.E. S.R.L. | X | | X | | X | |
| A.S.A.D. S.R.L. | X | | X | | X | |
| ENERGIE RINNOVABILI ITALIA S.R.L. | X | | X | | X | |
| SIAMO ENERGIA & PARTNERS S.R.L. | X | | X | | X | |
| EIFFEL S.R.L. | X | | | X | X | |
| MOBILSERVICE S.R.L. | X | | X | | X | |
| FRI-EL POWER TRADING S.R.L. | X | | X | | X | |
| VELGA S.R.L. | X | | X | | X | |
| BELLATRIX S.R.L. | X | | X | | X | |
| GREEN POWER ENERGY S.R.L. | X | | X | | X | |
| SACH S.R.L. | X | | X | | X | |
| ITALIAN JOB S.R.L. | X | | X | | X | |
| NUOVA IRIDE S.R.L. | X | | X | | X | |
| COGENER S.R.L. | X | | X | | X | |
| **TOTAL** | **20** | **0** | **19** | **1** | **20** | **0** |

*Own elaboration*

PROBABILITY OF DEFAULT — Year T
PROBABILITY OF DEFAULT — Year T-1
PROBABILITY OF DEFAULT — Year T-2

■ % > 95%   ■ % < 95%

*Own elaboration*

Regarding the results related to the application of the Ohlson O-Score model, in the first case, whose data used are those for the year closest to bankruptcy (Year T), 100% of the enterprises have a probability of default greater than 95%. In the second case, whose data used are those for Year T-1, 95% of the enterprises have a probability of default greater than 95%, while 5% (only one enterprise) less than 95%. Finally, in the third case, whose data used are those for the year T-2, 100% of the firms have a probability of default greater than 95%.

As in the application of Altman's model, an anomalous result is present, since the percentage of firms with a probability of default greater than 95% turns out to be higher in year T-2 than in the previous year. However, it is possible to state that Ohlson model has an excellent predictive ability when applied to unlisted Italian firms belonging to the energy sector not only in a time horizon close to bankruptcy, but also in previous years.

Going back to the initial research question, it is important to note that the predictive ability of Ohlson model is better than the one of Altman. After the concluded analysis, it is possible to state that because, unlike the Z-Score, which has been unable to predict failure in some cases, the O-Score has been always accurate for all the enterprises of the sample.

Based on the analysis just conducted, it is possible to make some assumptions to explain this result. In more detail, it can be supposed that Ohlson's model is always so accurate mainly due to the behavior of the variables $o_1$ and $o_2$, since they show the same pattern in all the cases analyzed. The former, although it presents a coefficient equal to - *0.407*, is crucial because the corresponding values reach very high negative quantities, due to the high figures of the Gross National Product price index level, that consequently give a considerable positive weight to the whole model. The latter presents the highest coefficient, equal to *6.03*. The corresponding values turn out to be always positive, adding again a positive weight to the model. For these reasons, the sum of these two variables is always positive and represents an important basis of the final value of the O-score.