Can Altman *Z-Score* Model Predict Business Failures in non Anglo-Saxon Countries?

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Abstract

The Altman's*Z-score* model was developed in 1968 for assessingthe distress of industrial corporations listed on the US stock market. This paper analyses whether *Z-score* can correctly predict business failures in non US stock markets (and, more in general, Anglo-Saxon) in today's context. To this aim, weanalyse the theoretical and practical characteristics of the original *Z-score* model and highlight some of its potential shortcomings, specifically focusing on its critical aspects.

Introduction and Objectives

The Altman's *Z-score* is a statistical failure-prediction model developed in 1968 for assessing the distress of industrial corporations listed on the US stock market, and it still plays an important role for practitioners throughout the world.

The reason of its success is in the fact that the Altman's model is easy to understand and can be used by any subjects even in the absence of adequate knowledge and skills in the field of business insolvency risk analysis. As we will see further on, the model uses easily obtainable data, both from balance sheets and statements and from the mean market share value relative to the reference period. Besides, the *Z-score* model is highly reliable in measuring the default potential of industrial business listed on the US market (and, more in general, Anglo-Saxon).

This article aims to analyze the characteristics and the critical aspects of*Z-score* model in its original version (elaborated by Altman in 1968 and modified by the same author in 1993), in order to verify if it can be used to assess bankruptcy potential for businesses listed on regulated markets different from US and Anglo-Saxon, with asimilar degree of accuracy.

The article is organized as follows. The following section provides a literature review of the topic in object. In section 3 we analyse the characteristics of the *Z-score* model with special attention to the components of the statistically discriminating function and to the definition of the *cut-off* points needed to apply the model. In section 4 we point out the critical aspects of the *Z-score*, that may compromise (or limit) the ability of the model in detecting bankruptcy potentials in specific environments and under specific circumstances.

Literature overview

Financial insolvency of big businesses, a typical and dramatic phenomenon that affects the economic and social structure of a country, has been the object of numerous

studies that aimed to detect the causes and predict its future happening with reasonable accuracy.

Between the 60s and the 70s of last century a branch of studies was developed to try to predict insolvency by means of statistical methodologies based on the use of economic and financial indicators (Beaver, 1966; Altman, 1968, 1970, 2002; Elam, 1975; Libby, 1975; Altman, Hartzell and Peck, 1995; Alberici, 1975; Tamari, 1966).

In the 1990s, the discriminant analysis (the dominant method in the previous decade and whose most appreciated author was Altman) was complemented by studies characterised by Probit analysis, by the use of neural networks and other innovative methodologies (Platt and Platt, 1990). As for the *Z-score*, despite its success over the years many authors have criticized its generalizability. Specifically, some research has indicated that the model is weak in classifying the companies' positions in countries other than the US and similar developed countries. The model is not always effective in classifying companies into failed or non-failed groups in different economic and political environments (Grice and Ingram, 2001; Flagg, Giroux and Wiggins, 1991). Other studies have revealed that *Z*-model is sensitive to industry type, and its accuracy is much higher for industrial businesses than for the service industry - particularly financial and insurance businesses - (Grice, 2000).

Characteristics of *Z-Score*

The *Z-score* model was developed in order to combine the traditional index analysis with rigorous statistical techniques. Similar to the majority of the models used for early diagnosis of businesses' default risk, it is a set of financial ratios in a multivariate context and based on a multiple discriminated model.

The discriminant methodology used follows the assumption that the entities under investigation can be divided into groups that have the same homogeneous characteristics for the elements included in each group, and heterogeneous characteristics for the elements belonging to different groups. The possibility of clearly describing distinct sets is the fundamental prerequisite for the classification of an element in one of the two groups with no margin of error. If an element is identified by the model as having similar characteristics as a specific group, it will be classified through a comparative and associative process (Danovi and Quagli, 2012).

Such method allows classification - with very low error probability - of a set of statistical units into two or more groups identified beforehand (in this particular case, financially healthy businesses and default risk businesses) on the basis of some known variables (discriminant variables) that are observed in the same units. Such variables are: balance sheets indicators selected according to their frequency of use in the literature, their quantitative relevance and their mean value on the equity market. Each variable in the multivariate function is multiplied by different ponderal factors: the final result of the function is called *score* and assigns the statistical unit examined to one group rather than to another.

The last version (1993) of the *Z-score* model is the following:

$$\boldsymbol{Z} = 1{,}2\ X_1 + 1{,}4\ X_2 + 3{,}3\ X_3 + 0{,}6\ X_4 + 1{,}0\ X_5$$

The independent variables (ratios), symbolized by X_n, are:

- X_1= Working Capital / Total Assets (WC/TA). This liquidity index value tends to decrease under crisis conditions, provided that the increasingly negative results involve a downturn in the value of current activities;

- X_2 = Retained Earnings / Total Assets (RE/TA). It measures the ability of a firm of self-financing, that is of investing the income gained periodically – totally or in part - in new business projects;
- X_3 = Earnings Before Interests and Taxes / Total Assets (EBIT/TA). This index measures returns on any type of invested capital (risk or financial investment) in the business;
- X_4 = Market Value of Equity / Book Value of Total Liabilities (MVE/TL). This particular index introduces the discriminant function (otherwise based on balance sheet indicators only). This parameter takes into account the market value of own capital, i.e. common stock representing the business' total assets, and is calculated on the day of each closure of accounts. The value of total liabilities, instead, is calculated based on management data and includes both long and short term financing;
- X_5 = Sales / Total Assets (S/TA). This index calculates the total assets ability to generate earnings (i.e. how often invested capital produces cash returns collected on sales).

In order to apply *Z-score* to measure the default risk of a specific company, one needs to solve the linear equation above by simply replacing each independent variable with the corresponding balance sheet indicators and the market value of own capital. The score obtained is then compared to a threshold value (*cut-off* value) set beforehand, on condition that the companies under examination will be classified as financially healthy or at default risk only after this comparison.

Altman set the *cut-off* value of the *Z-score* model at 2,675. A score above this value means that the company is potentially healthy, whereas a score below this value means that the company is probably headed for bankruptcy. The author also introduces the concept of a *grey area* ('uncertainty area') with a *Z-score* between 1,81 (below which companies are definitely exposed to default) and 2,99 (above this the risk of default is equal to zero). In this case, it is impossible to make a clear assessment as to the company's operating difficulties, (which may be inherent in the company or likely to lead to default) and further data and information are needed in order to classify the company in any of the two groups aforementioned.

Critical Aspects of *Z-Score*

As for the theoretical limitations of this model, we believe that, in *primis*, they lie in the fact that the *Z-score* has been constructed for and tested by Altman on US industrial businesses quoted on regulamentated markets in a specific period. Its high default-predictability rate is therefore applicable to the American (and broadly speaking Anglo-Saxon) context, but it could be possible that this model is not effective in classifying firms into failed and non-failed categories in different industries, different economic and political environments and/or in different time periods.

For companies quoted on different markets it might be advisable to proceed to a preliminary validation of the model and, if necessary, carry out some modification (with respect to ponderal factors in particular) in order to tailor the model to the characteristics of the companies that are being investigated and to the economic systems in which they operate (Begley, Ming and Watts, 1996). In 1993 Altman himself constructed the *Z'-score*, in which the original model is modified in order to assess the distress of companies not listed on regulated markets (such as Small-Medium Entities). In 1995, the model *Z''-score* (Altman, Hartzell and Peck), was introduced in order to predict potential financial distress in companies that do not belong to the industrial sector.

It is worth pointing out that the *Z-score* effectiveness in classifying US industrial quoted companies has been tested many times (Zavgren, 1985) at 95% one year prior to

default (year -1), at 83% two years prior to default (year -2) and at 62% three years prior to default (year -3).As for time distribution of errors, the accuracy of the model improves as the year of delisting approaches: logically, predictions are more accurate when they concern a span of time that is closest to the time when financial distress occurs, whereas the error risk is higher when the reference time horizon increases.However, for companies quoted on the Greek market, for example, the accuracy rate of the model is very different (Gerantonis, Vergos and Christopoulos, 2009): the degree of correct classification is of 66% in the year before default (year -1), and goes gradually down to 52% and to 39% in year two (year -2) and three (year -3) before default. For companies quoted on the Jordanian market, instead, the accuracy rate of the model is still different (Alareeni and Branson, 2013): the *Z-score* effectiveness has been tested at 87% one year prior to default (year -1), at 94% two years prior to default (year -2) and at 89% three years prior to default (year -3).

Besides, as already mentioned above, all independent variables in the discriminant function are based on balance sheet data. On the one hand, this makes the *Z-score* of easy and immediate use; on the other hand, the data available might not be completely objective (or even worse, be totally false), since the investigated companies' managers may have adopted budget policies aimed at hiding the ongoing or forthcoming crisis. This is likely to affect the reliability of the model to a greater or lesser degree – it is understood that similar behaviours should be immediately made known and sanctions applied by public and private control bodies. The use of rigorous statistical methodologies to assess the businesses' degree of solvency does not allow overcoming the intrinsic limitations of balance sheet values; if they are altered, the accuracy of the assessment of the statistical models – which are based on these data – is inevitably compromised.

Finally, the discriminant function of the *Z-score* is significantly unbalanced with regard to business profitability (ponderal factor equal to 3,3) the variable that may potentially predict the company's crisis. On the one hand, this approach may be justified, if we posit that the continuation of a firm over time depends *also* on its ability to obtain returns on the invested capital. On the other hand, it should be pointed out that a firm with poor profitability is not necessarily at default risk, provided that its financial position and cash flows appear to be safe at present and in the future.

Conclusions

The *Z-score* supplies *ex-ante* classification, with a relatively low level of error, of a set of statistical units into two groups (both healthy businesses and at default risk) on the basis of known characteristics and compares the score obtained from the business under investigation with the scores of sample businesses. The role of the *Z-score* is to identify a trend that combines the values of the analyzed variables in the years prior to the crisis, for both healthy businesses and the defaulted ones; consequently, it appears to be a descriptive and comparative approach rather than a probabilistic one, as Altman himself pointed out (Altman, Danovi and Falini, 2013). In this regard, the usefulness of the *Z-score* as a way of "warning"– with the limitations we have highlighted in this article – rather than predicting should not be questioned, even when applied to different spatial-temporal environments.

Further research

Additional studies will be required to investigate empirically whether the *Z-score* model could predict the default of industrial firms listed in non Anglo-Saxon markets, with a degree of accuracy and reliability comparable to the one obtained by Altman (and by many other authors) in the tests performed in the US and Anglo-Saxon contexts.

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