SMEs Crises and Forecasting Tools.
An Application to Italian Environment

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Abstract

This paper aims to ascertain if two score-based warning tools (*Z'-Score* and *BCS*) can correctly predict the failure of industrial non listed SMEs in Italy. First, we have analyzed the theoretical and practical characteristics of the two models. Second, we have examined a sample of 200 industrial SMEs, of which 100 companies have been subjected in the period 2005-2015 in bankruptcy proceedings because of a default, whereas the remaining 100 companies, which have been selected based on same core business, year of data collection and a comparable size of total assets, did not go bankruptcy. The models were tested by verifying *ex-post* whether the future health status of the businesses in the sample, and the impending business failures specifically, could have been predicted up to four years earlier and with reasonable precision using the examined models.

Introduction and Objectives

Score-based warning tools are based on an array of financial ratios in a multivariate context and on a discriminated model, and play an important role for predicting the failure of non-listed industrial SMEs within a few years before bankruptcy,

The reason of their success is both in the fact that they use easily obtainable data from financial statements, are 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. Besides, the Anglo-Saxons originated models are highly reliable in measuring the default potential of industrial business in Anglo-Saxon contests.

This paper ascertains if two of such statistical failure-prediction models, one originally developed by Altman for U.S. small industrial firms non-listed on regulated markets (*Z'-Score* – 1993 and 2013), while the other one is an adaptation of the latter to the peculiarities of the socio-economic Italian enviroment (*BCS* - 2004), are effectively reliable in measuring the default potential of industrial non-listed Sme's in Italy.

Specifically, we have firstly analyzed the theoretical and practical characteristics of the two models, secondly, we have examined a sample of 200 non-listed industrial SMEs, of which 100 companies have been subjected in the period 2005-2015 in bankruptcy proceedings because of a default (which is revealed by one of the following legal procedures: business failure, admission to Italian extraordinary administration proceedings and winding up), whereas the remaining 100 companies (so called "control group"), which have been selected based on same core business, year of data collection and a comparable size of total assets, did not go bankruptcy. The models were tested by verifying *ex-post* ("yesterday for today") whether the future health status of the businesses in the sample, and the impending business failures specifically, could have been predicted up to four years earlier and with reasonable precision using the examined models.

The research is organized as follows. In the following section we analyze the characteristics of the models with special attention to the components of the statistically discriminating functions. In section 3 we illustrate the research methodology. In section 4 we report the results of the application of the models to Italian non-listed industrial Sme's. In section 5, we draw conclusions on the topic.

Characteristics of *Z'-Score* and *BCS*

Score models were developed in order to combine the traditional index analysis with rigorous statistical techniques. Similar to the majority of models used for early diagnosis of default risk of businesses, they are based on multivariate discriminant analysis. Such methods allows classification - with tendentially 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 (Danovi & Quagli, 2012). Each variable in the multivariate function is multiplied by different ponderable 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 (2013) of the *Z'-Score* model is the following:

$$Z' = 0{,}717\,X_1 + 0{,}847\,X_2 + 3{,}107\,X_3 + 0{,}420\,X_4 + 0{,}998\,X_5$$

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

- X_1 = Working Capital / Total Assets;
- X_2 = Net Income / Total Assets;
- X_3 = Earnings Before Interests and Taxes / Total Assets;
- X_4 = Equity Capital / Book Value of Total Liabilities;
- X_5 = Sales / Total Assets.

Also the *BCS* model (2004) uses as discriminating variables quantitative indices derived exclusively from the financial statements, and is for all intents and purposes an "indigenous" variant of the *Z'-Score* aimed at adapting it to the peculiarities of the Italian socio-economic environment (the differences with respect to the original model lie above all in the value of the "weights" assigned to each discriminating variable, and to a marginal extent in the different composition of the indices X_1, X_2 e X_4).

The last version (2004) of the *BCS* model is the following:

$$BCS = 1{,}981\,X_1 + 9{,}841\,X_2 + 1{,}951\,X_3 + 3{,}206\,X_4 + 4{,}037\,X_5$$

The independent variables are:

- X_1 = Net Working Capital / Total Assets;
- X_2 = (Legal Reserve + Extraordinary Reserve) **/** Total Assets;
- X_3 = Earnings Before Interests and Taxes / Total Assets;
- X_4 = Equity Capital / Book Value of Total Liabilities;
- X_5 = Sales / Total Assets.

In order to apply the aforementioned models 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.

The *cut-off* value of the *Z'-score* model is set 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 1,23 (below which companies are definitely exposed to default) and 2,9 (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 health and further information are needed in order to classify the company in any of the two groups aforementioned. With regard to the *BCS* model, the upper and lower boundaries of the area of uncertainty are, respectively, 8.105 and 4.846, while the *cut-off* point has not been determined by the Authors.

Research methodology

This study aims at ascertain if the score-based warning tools *Z'-Score* and *BCS* can correctly predict the failure of industrial non listed Sme's in Italy.

The validation test was performed on a set of 200 non-listed industrial SME's, of which 100 companies have been subjected in the period 2005-2015 in bankruptcy proceedings because of a default, whereas the remaining 100 companies (so called "control group"), which have been selected based on same core business, year of data collection and a comparable size of total assets, did not go bankruptcy.

The degree of reliability of each model was measured through an *ex-post* approach ("yesterday for today"), i.e. we verified if the models would have been able to foresee the trend of the operating difficulties of each company. Specifically, for each company in the sample, the discriminant function was applied to the balance sheet values (from the AIDA - *Bureau Van Dijk Electronic Publishing* database and/or the electronic archive of the chambers of commerce *Telemaco*) in the four years prior to bankruptcy, in order to ascertain if the models would have predicted the future of those businesses accurately. By comparing the data obtained through the statistical models and what actually happened to the companies under investigation it is possible to precisely ascertain the accuracy rate of the models.

In order to improve the comprehensibleness and helpfulness of our study we calculated some indicators, likewise other studies on the topic at stake (Gerantonis, Vergos & Christopoulos, 2009; Alareeni & Branson, 2013):

- *Type I correct classification rate* is defined as the number of failed firms correctly predicted as failed by the models, divided by the total number of failed companies in the study sample;
- *Type II correct classification rate* is defined as the number of non-failed companies correctly predicted as non-failed by the model divided by the total number of non-failed companies in the study sample;
- *Type I error rate* is the ratio of the number of failed companies incorrectly classified as non-failed by the model to the total number of companies failed in the sample;
- *Type II error rate* is the ratio of the number of non-failed companies incorrectly classified as failed by the model to the total number of non-failed companies in the sample.

Data results

With reference to the 100 SMEs subject to bankruptcy proceedings in the period 2005-2015, the application of the *Z'-Score* and the *BCS* gave the following score assignments (Tables 1 and 2):

In general, the reliability rates of both models are quite high over the entire analysis period (with a clear prevalence, in any case, of the *Z'-Score*), reaching the peak values in the years immediately preceding the opening of bankruptcy proceedings and progressively decreasing as the time horizon expands.

Table 1 - Z'-Score

Anno	Type I correct classification Z'<1,23	Type I error Z' >2,90	Grey Area 1,23< Z'< 2,90
T-1	82%	3%	15%
T-2	68%	4%	28%
T-3	55%	2%	43%
T-4	44%	4%	52%

Table 2 - BCS

Anno	Type I correct classification BCS <4,846	Type I error BCS >8,105	Grey Area 4,846 < BCS < 8,105
T-1	78%	5%	17%
T-2	63%	6%	31%
T-3	55%	9%	36%
T-4	43%	17%	40%

With reference to the 100 "healthy" SMEs in the control sample, which were therefore not subject to bankruptcy procedures in the period 2011-2015, the application of the models in question led to the following scoring assignments (Tables 3 e and 4):

Table 3 - Z'-Score

Anno	Type II correct classification Z' >2,90	Type II error Z' <1,23	Grey Area 1,23< Z'< 2,90
N-1	28%	9%	63%
N-2	25%	12%	63%
N-3	22%	11%	67%
N-4	21%	7%	72%

Table 4 - BCS

Anno	Type II correct classification BCS >8,105	Type II error BCS <4,846	Grey Area 4,846 < BCS < 8,105
T-1	32%	10%	58%
T-2	28%	10%	62%
T-3	23%	11%	66%
T-4	24%	9%	67%

In the light of the data reported in the above tables, it is clear that both *Z'-Score* and *BCS* classify the majority of the "healthy" companies under examination in their respective areas of uncertainty, thus proving much more imprecise compared to the results previously recorded with regard to companies subject to bankruptcy proceedings.

Conclusions

Overall, both the *Z'-Score* and the *BCS* have demonstrated good diagnostic reliability in measuring the "health status" of manufacturing SMEs located in Italy and, while showing clear difficulties in correctly classifying healthy companies, the results of the tests carried out in this study appear to be quite fulfilling. In particular, in our opinion, the models under examination are particularly suitable for correctly discriminating against companies at risk of default, for the purpose of recording values of the correct Type I classification indices that are rather high (and also of the reasonably low error rates) up to the fourth year prior to the year of opening of bankruptcy proceedings (although a preference should be given, in the light of the tabular evidence, to the *Z'-Score*).

In this regard, it is interesting to note that the BCS, although it was developed according to the specific socio-economic characteristics of small and medium-sized Italian companies, has finally recorded a degree of reliability (therefore with regard to both companies at risk of default and those in "health") substantially mirroring that achieved by Z'-score, in our opinion consistently with its being a partial reworking of the latter rather than a model developed ad hoc.

The reliability rate of both models, which was quite high in the year prior to the opening of bankruptcy proceedings, gradually decreased as the analysis period extended, while the rate of misclassifications increased proportionally. The explanation of the non-uniform temporal distribution of the classifying errors must be considered, once again, completely intuitive: the forecasts are all the more accurate if made in a period as close as possible to the moment of the onset of the state of crisis, while the risk of error (both false positives and false negatives) increases with the extension of the temporal interval over which the observations are unraveled.

In any case, the potential shown by *Z'-score* and *BCS* in correctly classifying SMEs in current and/or prospective failure since the fourth year prior to the declaration of bankruptcy is evident, and therefore the models in question can be considered, even against some theoretical-applicative limits (with particular regard to the congenital limits of analysis elements obtained exclusively from the financial statements, whose possible "pollution" inevitably affects the assessments provided by any diagnostic tool based on these elements), effective early warning tools, qualified not only by the maximum ease of use and absolute objectivity of application (in addition to non-existent management costs), but also by high predictive reliability even if used in different spatio-temporal areas.

References

Alareeni B., Branson J. (2013), "Predicting listed companies' failure in Jordan using Altman models: a case study", International Journal of Business and Management, Vol. 8, Issue 1, pp. 113-126.

Altman E.I. (1993), Corporate financial distress and bankruptcy, Second Edition, Wiley & Sons, New York.

Altman E.I., Sabato G. (2007), Modelling credit risk for SMEs: evidence from the U.S. market, Abacus, 43, 7, pp. 332-357. Doi:10.1111/j.1467-6281.2007.00234.x

Altman E.I., Danovi A., Falini A. (2013), "Z-score models' application to Italian companies subject to extraordinary administration", Bancaria, Issue 4, pp. 24-37.

Begley J., Ming J., Watts S. (1996), Bankruptcy classifications errors in the 1980s: an empirical analysis of Altman's and Ohlson's models, Review of Accounting Studies, 1, 4, pp. 267-284. Doi: 10.1007/bf00570833

Bellovary J.L., Giacomino D.E., Akers M.D. (2007), A review of bankruptcy prediction studies: 1930 to present, Journal of Financial Education, 33, 4, pp. 1-43. Doi: 10.19030/jber.v5i5.2541

Celli M. (2015), Can Z-Score model predict listed companies' failures in Italy? An empirical test, International Journal of Business and Management, 10, 3, pp. 57-69. Doi: 10.5539/ijbm.v10n3p57

Danovi A., Quagli A., Crisi aziendali e processi di risanamento, Ipsoa, Milano, 2012, pp.154-167.

Edmister R.O., (1972), "An empirical test of financial ratio analysis for small business failure prediction", Journal of Financial and Quantitative Analysis, Vol. 7, Issue 2, pp. 1477-1493.

Gerantonis N., Vergos K., Christopoulos A.G. (2009), "Can Altman Z-score models predict business failures in Greece?", Research Journal of International Studies, Vol. 12, Issue 10, pp. 21-28.

Grice J., Ingram R. (2001), "Tests of generalizability of Altman's bankruptcy prediction model", Journal of Business Research, Vol. 54, pp. 53-61.

Hamza T., Lahiani A., Mselmi N. (2017), Financial distress prediction: the case of French Sme, International Review of Financial Analysis, 50, 3, pp. 67-80. Doi: 10.1016/j.irfa.2017.02.004

Madonna S., Cestari G. (2015), The accuracy of bankruptcy prediction models: a comparative analysis of multivariate discriminant models in the Italian context, European Scientific Journal, 11, 34, pp. 106-133. Doi: 10.19044/esj.2015.v11n34p417

Platt H., Platt M. (1990), "Development of a class of stable predictive variables: the case of bankruptcy predictions", Journal of Business Finance & Accounting, Vol. 17, Issue 1, pp 31-51.

Tian S., Yu Y. (2017), Financial ratios and bankruptcy predictions: an international evidence, International Review of Economics and Finance, 51, 9, pp. 510-526. Doi: 10.1016/j.iref.2017.07.025