Daniel BRÎNDESCU – OLARIU
West University of Timisoara

LABOR PRODUCTIVITY AS A FACTOR FOR BANKRUPTCY PREDICTION

Empirical study

Abstract

The current study evaluates the potential of the labor productivity in predicting corporate bankruptcy. The population subjected to the analysis included all companies form Timis County with yearly sales of over 2200 Euros.

The interest for the labor productivity was based on the recommendations of the scientific literature, as well as on the availability of information concerning its values to all stakeholders.

The event on which the research was focused was represented by the manifestation of bankruptcy 2 years after the date of the financial statements of reference. All tests were performed over a paired sample of 1424 companies.

The methodology employed in evaluating the potential of the labor productivity was based on the general accuracy ensured by the ratio (63.2%) and the Area Under the ROC Curve (0.665). The results confirm the practical utility of the labor productivity in the prediction of bankruptcy.

1. Introduction

In the context of the economic crisis, as well as that of the changes generated by the entrance of Romania in the European Union, the annual frequency of bankruptcy cases has increased at national level, reaching almost 3% by the end of 2013 (Brîndescu-Olariu, 2014a).

The increased frequency of the annual bankruptcy cases was accompanied by an increase in the loan default ratio, Romania topping in this regard at the end of 2012 the 4th place within the European Union.

Before 2007, the importance of the bankruptcy phenomenon from a macroeconomic perspective was limited in Romania, as there was little culture for bankruptcy filing at microeconomic level.

With the bankruptcy not representing a concerning phenomenon in the past, limited efforts were made at national level for the development of specific bankruptcy risk assessment tools. Instead, the scientific interest for the assessment of the bankruptcy risk was purely theoretical, with most researchers settling for testing foreign models for bankruptcy prediction over small isolated samples of Romanian companies. Several national models were elaborated over time, but most of the development methodologies were relatively superficial, as the public interest for the subject was low. The general goals of companies are usually related to maximizing profits and shareholders' wealth (tefea and Circa, 2006). In order to reach such goals, capital must be invested. The investment decisions must be fundamented not only on predicted return ratios, but also on risk analyses. The increase of the annual bankruptcy frequency has made the public significantly more aware of the phenomenon. As the state of bankruptcy affects all the stakeholders of the company, the existence of instruments for bankruptcy prediction becomes important.

Under these circumstances, there is a need for the development of methodologies specific to the current characteristics of the Romanian companies. Recent studies (Brîndescu – Olariu, 2014b, Dima et al., 2011) have reconfirmed the potential of financial ratios in the prediction of the bankruptcy risk, financial risk, financial performance or stock prices. The present paper is focused on testing the potential of labor productivity indicators for corporate bankruptcy prediction, 2 years prior to the possible event. Previous studies (Moldovan, Lobonț și Nicolescu, 2013) have shown that the managers from Romanian companies see the human capital as having only a low to average influence on the corporate competitiveness.

The hypothesis of the research is that labor productivity indicators are negatively correlated to the bankruptcy risk and thus can represent useful tools for the assessment of the bankruptcy risk.

Only publically available data was used. If the research would prove the usefulness of the productivity indicators in the prediction of bankruptcy, it could be continued with the development of a methodology of analysis for the assessment of the bankruptcy risk based on public data and thus accessible to all stakeholders.

2. Population and methodology

The population initially subjected to the analysis included all the companies from the Timis County that submitted financial statements to the fiscal authorities in the period 2001 – 2011 (247,037 yearly financial statements).

Financial ratio analysis was not considered applicable for companies with no yearly income, as the continuity of the operating activity represents a fundamental hypothesis of the financial ratio analysis.

Three phenomenons with national impact were also considered for their potential of changing the profile of the companies that declare bankruptcy:

- o The changes brought to the laws concerning bankruptcy through the adoption of law 85/2006;
- o The entrance within the European Union in 2007;
- o The manifestation of the economic crisis starting with the last quarter of 2008.

Under these circumstances, it was concluded that the initial population shows important problems of homogeneity, which do not recommend a unitary treatment:

- o The companies with no activity cannot be evaluated based on the same methodology as the companies with a financial history;
- o The companies that became bankrupt after the issue of law 2006/2006 show different characteristics compared to the companies that went bankrupt before 2007, under different laws;
- o The cases of bankruptcy registered after 2009 have different causes compared to the cases appeared before the beginning of the economic crisis.

Taking all the aforementioned differences into account, the initial population was adjusted:

- o all the yearly financial statements that reported sales under 10000 lei were excluded;
- o only financial statements from the period 2007 – 2010 were retained.

The research targeted the risk of bankruptcy after 2 years from the date of the financial statements taken as reference in the analysis. As the interest was focused on the phenomenon of bankruptcy during the crisis period, the first financial statements included in the study were from 2007.

The last year for which data concerning the status of the companies was available was 2012. Under these circumstances, the last financial statements included in the study were those from 2010.

Holding all the above into account, the target population included all companies from Timis County that submitted yearly financial statements to the fiscal authorities during the period 2007-2010 and that registered yearly sales of at least 10000 lei (aprox. 2200 Euros).

In accordance, 53,252 financial statements from the period 2007-2010 were included in the analysis. The companies of which financial statements were included for one year were not necessarily included for the following periods. As the study did not target a dynamics analysis, the yearly financial statements can be regarded as individual subjects.

The source of the data was represented by the online publications of the Ministry of Public Finances of Romania. The current study employed methods for calculating the financial ratios that would make the proposed methodology of analysis accessible to all stakeholders.

Of the entire target population, 712 companies went bankrupt in the period 2009 – 2012, two years from the date of the financial statements of reference:

- o of the 12,570 companies included with financial statements for 2007 in the research, 30 went bankrupt in 2009 (0.24%); the rest of the companies continued their activity under normal conditions at least until the end of 2012.

- o of the 13,037 companies included with financial statements for 2008 in the research, 94 went bankrupt in 2010 (0.72%); the rest of the companies continued their activity under normal conditions at least until the end of 2012.

- o of the 12,574 companies included with financial statements for 2009 in the research, 159 went bankrupt in 2011 (1.26%); the rest of the companies continued their activity under normal conditions at least until the end of 2012.

- o of the 15,071 companies included with financial statements for 2010 in the research, 429 went bankrupt in 2012 (2.85%); the rest of the companies continued their activity under normal conditions at least until the end of 2012.

Two productivity ratios were tested for their potential in the assessment of the bankruptcy risk. Commonly, productivity ratios are based on a volume measure of output and a measure of input (number of hours worked or total employment).

As public data does not include information concerning the production volume of companies, yearly turnover (as an expression of the goods and services sold) was used as an output indicator instead.

Thus, the first ratio had the following form:

$$\text{Labor productivity 1} = \frac{\text{Sales}}{\text{Total employment}}$$

Another popular approach in labor productivity analysis uses the gross added value as an output indicator. The only component of the yearly value added that is publically available is the gross profit. Although the gross profit does not generally remunerate the employees (it goes to the state, stakeholders or remains as part of the equity), it is directly connected to the gross added value and thus, indirectly connected to the total employment.

$$\text{Labor productivity 2} = \frac{\text{Gross profit}}{\text{Total employment}}$$

In accordance with many of the approaches from the international literature, the ratios were tested over a paired sample. In order to build a paired-sample, each of the 712 companies that went bankrupt in the period 2009 – 2012 was associated with a company from the same economic field that had the closest turnover in the year of reference for the financial statements included in the analysis.

The data was processed by using the SPSS software. The state of the company two years from the date of the financial statements of reference was defined as the dependent variable, a binary variable that can take the following values:

- o 1, for the companies that went bankrupt 2 years after the date of the financial statements of reference;

- o 0, for the companies that continued their activity under normal conditions at least until the end of 2012.

In order to simplify the explanations, the companies that went bankrupt 2 years after the date of the financial statements of reference will simply be referred to as „bankrupt", while the companies that continued their activity under normal conditions at least until the end of 2012 will be referred to as „non-bankrupt".

When defining the target population, the companies that close their activity for other reasons than bankruptcy during the period of analysis were excluded.

As an example, the value of the variable „State" was „1" for all the companies that went bankrupt in 2011 and it was associated with the financial ratios of the respective companies from 2009. These companies were not included in the analysis for the following years (for 2010 with the financial statements and for 2012 with the state variable), even if they still existed.

Initially, the performance of each ratio as predictor of bankruptcy was tested through the Area Under the ROC Curve over the entire paired sample of 1424 companies.

The ROC Curve reflects graphically the relationship between the sensitivity and the specificity for all possible cut-off values (van Erkel, Pattynama, 1998). The area under the ROC Curve thus isolates the classification performance of a classifier with no connection to a specific cut-off value, which makes it one of the most viable solutions for measuring the classification performance and for comparing classifiers (Hanely, McNeil, 1982, Faragi i Reiser, 2002).

The area under the ROC Curve (AUC), can take values between 0 and 1 (Skalska i Freylich, 2006). An AUC of 0.5 corresponds to a "by chance" classification accuracy, while an AUC of 1 corresponds to a perfect accuracy.

The evaluation of predictors by their AUCs is usually based on the following grid (Tazhibi, Bashardoost i Ahmadi, 2011):

- o 0.5 – 0.6: fail;
- o 0.6 – 0.7: poor;
- o 0.7 – 0.8: fair;
- o 0.8 – 0.9: good;
- o 0.9 – 1: excellent.

In a second step, for the ratios confirmed as possible predictors by their AUCs (over 0.6), the general classification accuracy was determined.

The general accuracy of the classification represents the percentage of companies correctly classified, a weighted average of the sensitivity and the specificity.

The sensitivity represents the accuracy of the classification of bankrupt companies.

The specificity represents the accuracy of the classification of non-bankrupt companies.

The optimal cut-off value for the 2010 sample was used for out-of sample tests (over the 2007-2009 samples). The optimal cut-off value for the 2010 sample was determined through the inspection of the coordinating points of the ROC Curve.

As the samples used were paired, the weight of the bankrupt companies was equal to the weight of the non-bankrupt companies (50%). For such a sample, the "by chance" accuracy is 50% (by classifying all 1424 companies as bankrupt, the analyst would be correct in 50% of the cases). A ratio is considered a useful classifier if it allows for a general accuracy at least 25% higher than the "by chance" accuracy (Chung, K., Tan, S., Holdsworth, D., 2008).

Based on this benchmark, the ratios would be considered as potentially useful if they would offer an accuracy of at least 62.5% (a = 50% x 125%).

4. Results

The Area Under the ROC Curve over the 2007-2010 paired sample specific to the labor productivity 1 (based on sales) was of 0.539, which excludes the ratio as a possible bankruptcy predictor. The area under the ROC Curve over the 2007-2010 paired sample specific to the labor productivity 2 (based on gross profits) was of

0.665, which can be evaluated as relatively poor, but valid classification accuracy (Tazhibi, Bashardoost and Ahmadi, 2011).

Under these circumstances, the ratio based on gross profits was submitted to additional tests. The AUC was determined for each of the 4 yearly paired samples. The AUC remains over 0.6 for each yearly sample (figure 1), which confirms the classification capability of the ratio.

Based on the coordinating points of the ROC Curve for 2010, an optimal cut-off value was determined (labor productivity = -6055 lei). By classifying all the companies from the 2010 paired sample that registered labor productivities lower than -6055 as bankrupt and all the companies from the 2010 paired sample that registered labor productivities higher than -6055 as non-bankrupt, the general classification accuracy would be of 64.1%. Thus, the in-sample general accuracy overlaps the 62.5% benchmark. Out of sample accuracy tests were performed over the 2007-2009 paired samples. The optimal cut-value for 2010 was used. The general accuracy maintained its level for the 2009 sample (64.2%), but decreased to 59.0% for 2008 and to 58.3% for 2007. The out-of-sample general accuracy for the entire 2007-2009 sample was of 61.8%. The variations of the general accuracy registered in 2008 and 2007 are mostly generated by variations of the cut-off value (and less by the reduction of intrinsic classification capabilities of the labor productivity). The general accuracy levels correspondent to the optimal cut-off values for the 4 yearly paired samples are reflected in figure 2.

The general accuracy for the entire sample of 1424 companies was of 63.2%.

5. Conclusions

The Area Under the ROC Curve for the entire paired sample shows that the labor productivity based on sales is not a useful classifier. Instead, the value of the AUC suggests that the labor productivity based on gross profits can be used a tool for the assessment of the bankruptcy risk. This conclusion is sustained by a general classification accuracy of 63.2% over the entire paired sample of 1424 companies. Commonly used in this field, the paired sample was useful in evaluating the potential of the ratios. Nevertheless, as the structure of both the base-sample and the test-sample are significantly different from the structure of the target population, an optimal cut-off value for the entire population cannot be determined. The research proves the potential of the labor productivity ratio in the prediction of bankruptcy and underlines the need for determining an optimal cut-off value through research over the entire population (or a sample with the same structure).

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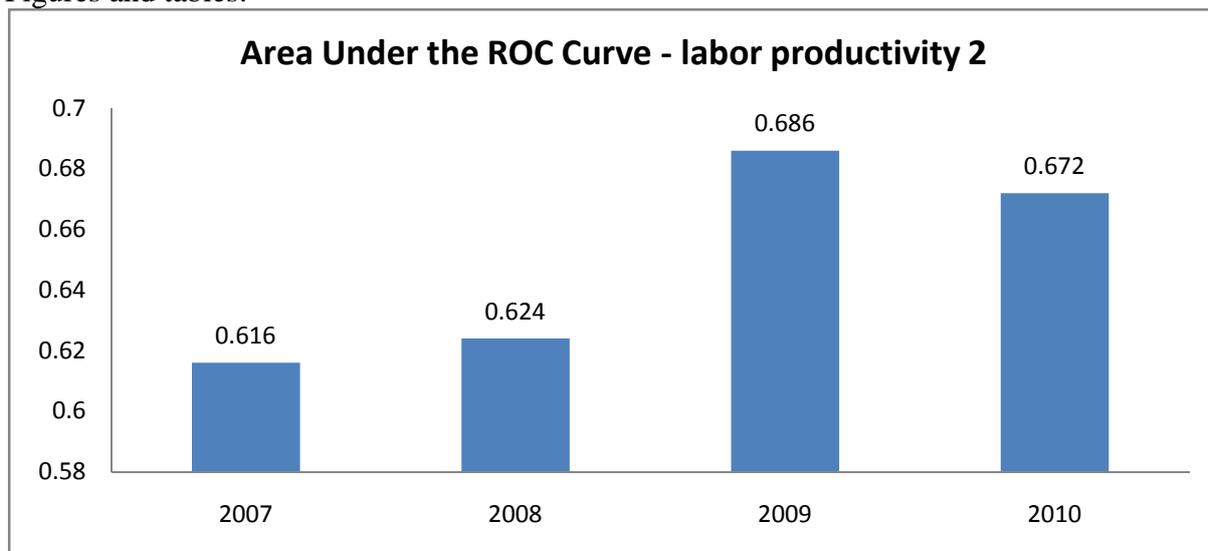
Figures and tables:

Area Under the ROC Curve - labor productivity 2

Year	Value
2007	0.616
2008	0.624
2009	0.686
2010	0.672

Figure 1. Area Under the ROC Curve over a paired sample - labor productivity 2

General accuracy with optimal cut-off values for each year

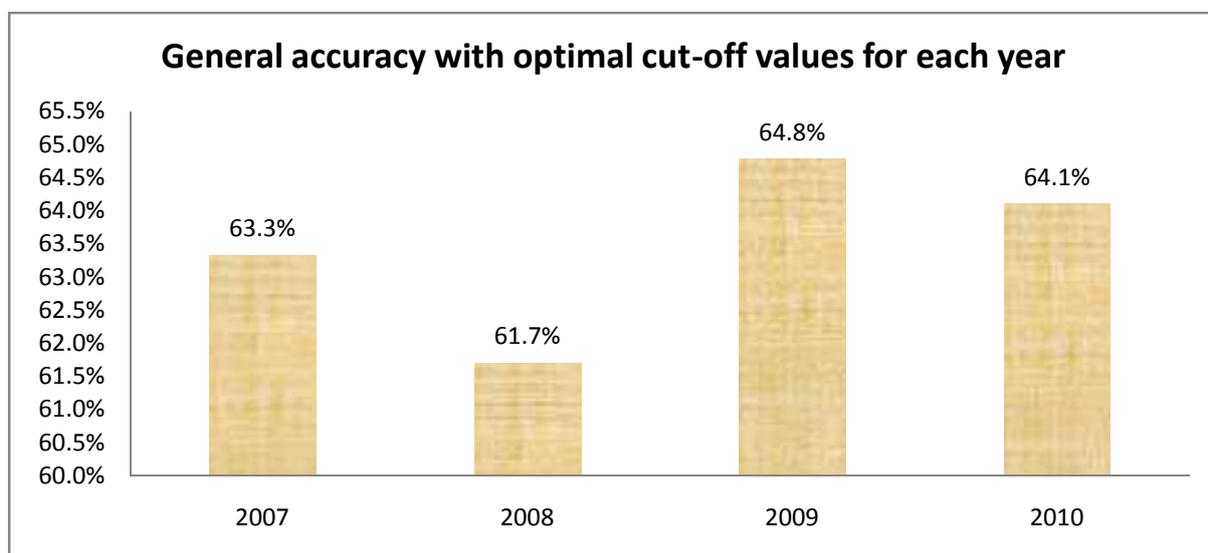| Year	Value
2007	63.3%
2008	61.7%
2009	64.8%
2010	64.1%

Figure 2. General accuracy with optimal cut-off values for each year