EXPECTED DEFAULT FREQUENCIES FOR THE COMPANIES LISTED AT THE BUCHAREST STOCK EXCHANGE

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This paper uses the structural models methodology to estimate the credit risk for the Romanian companies that are listed at the Bucharest Stock Exchange. Under the new Basel Capital Accord that is also spreading to the capital markets, financial institutions are allowed to report using internal ratings. We present a methodology for computing the probabilities of default on the Romanian capital, which constitutes the first part of the development of a rating system based on market values.

Cuvinte cheie: Expected Default Frequencies, Structured Credit Risk Model, Romanian Capital Market,Credit Rating

Introduction and Objective

This paper uses the structural models methodology to estimate the credit risk for the Romanian companies that are listed at the Bucharest Stock Exchange. Under the new Basel Capital Accord that is also spreading to the capital markets, financial institutions are allowed to report using internal ratings. We present a methodology for computing the probabilities of default on the Romanian capital, which constitutes the first part of the development of a rating system based on market values.

Generally the defaults occur when the firm is unable to meet its financial obligations. Here, the models are based on the timing of the event that causes the default. Most of the time, these models depend on the balance sheet interpretations. In other words the default occurs when the assets are too small compared to the liabilities.

The first developers of models in this area were Black and Scholes (1973) and Merton (1974). In these models default occurs at the maturity date of the debt, and when the condition of assets of the issuer is less than the face value of the debt is satisfied. In practice KMV corporation has developed estimated default frequency, which is based on this model and used for empirical estimator of default probabilities. Moody's also developed an estimator which depends on the balance sheet information for the same purpose.

The main idea of the structural models originating from Black-Scholes(1973) and Merton(1974) is to consider corporate liabilities as contingent claims on the assets of the firm. In other words the market value of the firm is the fundamental state variable (Giesecke 2002). Here, there is also the paper by Longstaff and Schwartz (1995) that we need to mention which is considered to be the second general methodology to price debt instruments subject to credit risk and also correlated interest rates and the credit risk.

In the classic papers Black-Scholes(1973) and Merton (1974), the contingent claims-based approach to valuing the corporate debt assumes that the interest rates constant and the default risk was modeled by means of option pricing theory.

The unrealistic part of the approach was that the default only occurs when the firm exhausts its assets. This point was taken into account by Black and Cox (1976) and they allowed default to happen when the assets of the firm reaches a specified level of threshold. This new addition of default condition enabled Black and Cox to construct a model where credit spreads would be consistent with the ones existed in the corporate debt markets. However, they carried the same assumption as before and, took the interest rates constant. This would make the calculation of the risky fixed income securities very difficult.

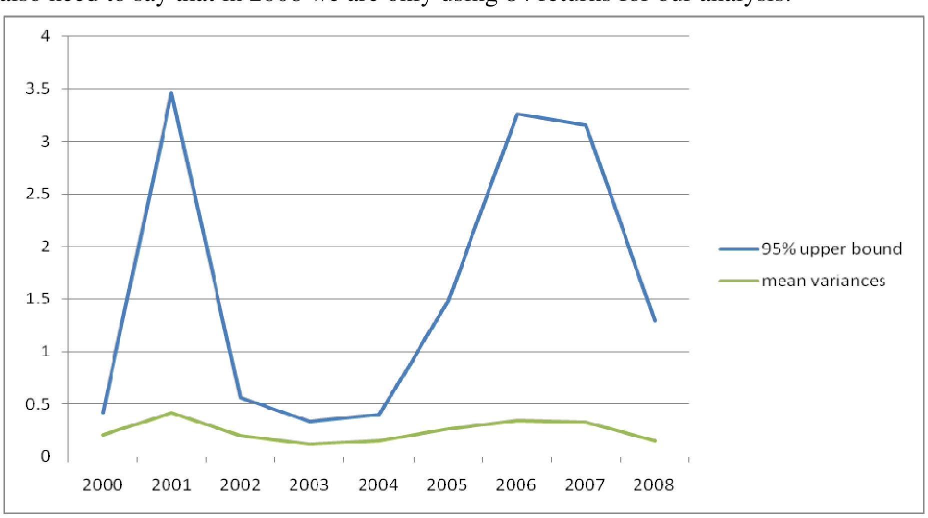
The importance of the Longstaff and Schwartz (1995) is to extend the Black and Cox (1976) Model in order to generate a new basic model for valuing risky debt where they combined default risk and interest rate risk and added the possibility of deviation from strict absolute priority. One of the most important results of the study was that; if there is different correlation between the assets of the firm and changes in the interest rates, there can be significant variations in the credit spreads of the firms whose default risks are similar. By the same token, they answered the existence of the different credit spreads of the bonds with similar credit ratings in different sectors.

Data and Methodology

We used data from the Bucharest Stock Exchange website and the first task was to organize it so that we can compute daily variances for each year. The variances were multiplied with square root of the number of observations that we had for each year for each stock in order to have annual variances. The Matlab software was used for all the computations. We obtained 77269 data for closing prices of all the stocks listed at the exchange from the 5th of January 2000 until the 29th of April 2008. For the days in which we lacked prices (due to holidays or days when the respective stock was not traded) we considered returns to be equal to zero. In this case we are aware that we reduce the variance for the respective days, by using introducing higher constancy into the data, but, on the other hand, the possible jumps, which would eventually happen at the next trading day, will sometimes compensate this fact. On the other hand, the usual interpolation techniques do not seem reasonable for the movement of the returns, as they showed to have low autocorrelation in previous studies. One way to extend the analysis would consist in fitting a GARCH process to the movement of the returns for each stock, but, we also had in mind the fact that we are only concerned with finding one statistic that proxies the volatility of the logarithmic returns for the entire year, so in the end we would have also had to average the volatilities out.

The variances that we obtained for each stock were computed as the variance of the daily logarithmic returns multiplied by the number of observations in each year. One part of the work we developed was to build a vector with all the working days in the respective time interval and fill in returns for each day, so the number of observations was considered to be the same for all the stocks in our sample.

The variances were computed for 62 stocks for each year from 2000 until 2008. As we can see in the following graph, the variances at the beginning of our period were relatively high, with respect to the rest of the period. The blue line shows that the average returns were not so important but their dispersion among the stocks taken into account was quite impressive. The same thing can be observed in 2006 and 2007 and we can observe that the dispersion of the stocks around the mean variance is reducing towards 2007. We also need to say that in 2008 we are only using 84 returns for our analysis.



Average variances and the 95% upper bound for all the stocks in each year

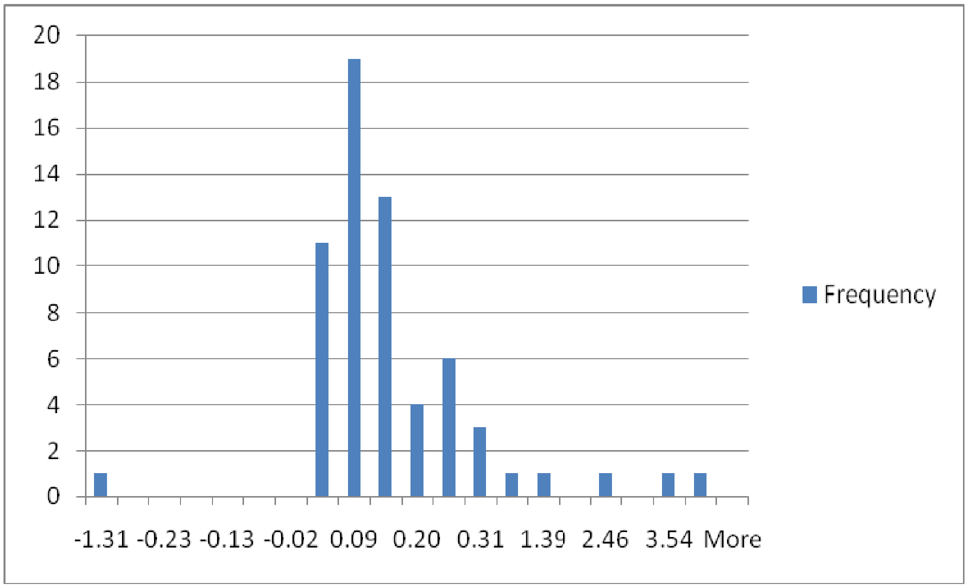
As shown in the following table, the number of companies is increasing from 2000 until 2008, mainly due to the fact that we focused on characterizing the credit risk for the companies that are now listed at the Bucharest Stock Exchange, many of which were not traded such a long time ago.

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Mean variance	0.209	0.418	0.205	0.121	0.154	0.263	0.348	0.328	0.155
Standard deviation of variances	0.105	1.519	0.180	0.110	0.123	0.609	1.453	1.413	0.570
95% upper bound	0.420	3.456	0.566	0.341	0.401	1.481	3.254	3.154	1.296
Number of stocks	42	45	46	46	49	54	56	59	62

Dynamics of the yearly variances from 2000 until 2008 for the Romanian listed securities

The reduction of the variances, followed by the reduction of the dispersion of the variances among the Romanian stocks, might be interpreted as a period of reduced risk. An interesting analysis might consist in checking for the relation between the dispersion of the variances among stocks and the market efficiency or the application of the standardized models of analysis. We can observe that the change in the mean variance is not linearly connected to the dispersion of the variances – in 2002 until 2004 the mean variance was the smallest from our analysis, and a very small movement in this mean created an impressive dispersion in 2005 until 2007 as well as in 2000 until 2002. We can conclude that a small change of the mean variance determines an important change in the dispersion of the variances among stocks. Also, one might look at the similar movements of the mean variance and its upper bound in the other countries in the region.

We also computed the values for linear trends for all the stocks taking as input the movement in variances in all the 9 years.



Histogram of the linear trends in the variances for all the listed stocks

As can be seen in the histogram, the trends of the variances are dispersed very much around 0, so we could not say much about the average trend in the variance – the largest part of the trends are focused in the interval from 0.04 to 0.2, which means a very slight increase in the variance in the year to come.

All this information about the variance will provide important perspective as far as risk of the companies is concerned. As previously mentioned, our focus here is not to analyze the variance but to compute the risk-neutral default probabilities for our listed stocks. Consequently, the next step was to collect information about the market capitalization of our stocks as well as the book value of assets and total debt. We obtained information about these financial indicators by consulting the website www.ktd.ro, which contains electronic versions of financial reports for the stocks under analysis. We obtained annual reports for years 2000 until 2003 and quarterly reports for the years 2004 until 2007. Despite the information provided in the public sources we were not able to compute reliable figures for total assets, which made us, in the end, to reduce our analysis to the years 2005 until 2007 (we did not include any reports for 2008 being mainly preliminary computations of the indicators).

Our main focus was to match the variances computed in the first part of the study with the information provided by these reports. We needed the total assets and the market capitalization at the moment of the reports as well as the variances and the risk free rates for each year. As proxy for the risk free rates we computed the average of the ROBID and ROBOR for the annual rates from 2000 until 2008 using the quotes supplied by the Romanian National Bank. The average rates are to be used in the Black Scholes Merton equation in order to find the market value of assets and the variance of these values.

In order the find the two factors we had to solve the system of two nonlinear equations containing two unknowns[99]. As in Delianedis and Geske (1999) the equations are the following:

$$S = VN(k + \sigma_v\sqrt{T-t} - Me^{-rf(T-t)}N(k) \qquad (1)$$

where

$$k = \frac{\ln\left(\frac{V}{M}\right) + \left(r_f - \frac{1}{2\sigma_v^2}\right)(T-t)}{\sigma_v\sqrt{T-t}}$$

and

S = current market value of the stock (in our case the market capitalization of the company);

V = current market value of the firm (the market value of the assets – variable we need to find);

M = face value of debt (total debt considered to mature in one year);

rf = the theoretical risk-free rate of interest (average of the ROBID and ROBOR rates in each year);

σv = the instantaneous variance of the return on the firm's assets (the variance of the market value of assets, the other variable we need to find);

t = current time;

T = maturity date of the debt (one year into to future);

N(.) = univariate cumulative normal distribution function

The second equation relies on the relation between the variance of the market value of assets and the variance of the stock returns, as follows:

$$\sigma_s = \frac{\partial S}{\partial V}\frac{V}{S}\,\sigma_v \qquad (2)$$

From equation (1) and (2) we need to find the values for σ_v and V, considering that we know all the other data (σ_v is computed as the mean variance of the daily log-returns multiplied by the number of observations in each year). We computed the first part of equation (2) as the changes in the values of the market capitalization divided by the changes in the values of the market values of assets from one year to another. Sometimes, in cases where we did not have information about one of the variables, we had to consider these changes to spread over many years. As previously said, equation (1) provides a setting in which the shareholders have the option to pay the debt (assumed to mature in one year[100]).

The two variables will help us to find the risk-neutral probability of default, expressed as the probability that the company will not have enough resources to cover for the debt they have to pay until the end of the year, in a world where all the investors are risk-neutral. As shown by standard theoretical developments, initiated by Black, Scholes and Merton, the risk-neutral world is a theoretical setting under which all investors are satisfied with the risk-free rate as a compensation for their investments (no risk-premiums),

[99] The Matlab setting consisted in building a function that contains the two equations and then use the "fsolve" function to find the solution in an optimization manner – the values for our unknowns were found at the level where the value of the function was closed to 0

[100] The assumption is not so strong as we know that Romanian companies usually use short term debt.

which means that the utility functions are linear (not concave, as in the case of risk-aversion, neither convex as in the case of risk-lovers). If we decide to assume risk-aversion, which is usually the case in most of the markets (risk premiums are positive) it can be shown that the risk-neutral probabilities of default are larger than the real probabilities of default, which means that, in all the cases, this methodology provides a rather conservative and not at all flawed measure of the credit risk. We estimated this as the probability that the market value of assets to be lower than the face value of debt in the following year.

Results

Our estimates of the risk neutral default probabilities were computed for the available information concerning the value of assets and the face value of debts for years 2005, 2006 and 2007. Due to the lack of space, the data for each stock in each year is not going to be shown here but it can be presented upon request.

As shown in the following table, the probabilities of default seem to be relatively low, but we need to notice that about half of the companies in our sample have default probabilities in the extremes – around 20% very close to 0% probability of default and about 20% close to 50% probability of default. In between these extremes the values for the risk of default seems to be relatively constantly dispersed.

Intervals	**2005**	**2006**	**2007**
0.00	9.52%	21.43%	19.05%
0.05	14.29%	16.67%	11.90%
0.10	7.14%	4.76%	4.76%
0.15	9.52%	0.00%	4.76%
0.20	0.00%	0.00%	7.14%
0.25	4.76%	4.76%	0.00%
0.30	7.14%	16.67%	0.00%
0.35	11.90%	4.76%	7.14%
0.40	7.14%	9.52%	2.38%
0.45	9.52%	7.14%	19.05%
0.50	19.05%	14.29%	23.81%

The frequency of the risk-neutral probabilities of default

We can also notice that the trend shows n increase in the risk of default as the percentage of companies with low values for the default probabilities is decreasing close to the 0 probability tail while on the other tail the probabilities are increasing – a higher percentage of companies with higher risk neutral probabilities on the 50% extreme.

Concluding remarks

Our paper aims at providing a framework for a methodology to use market date of the listed companies to find estimates of the probabilities of default. The setting is interesting if we have to take into account the fact that it could provide a methodology to establish a rating system for the Romanian companies listed at the Bucharest Stock Exchange.

Using the methodology of Merton and Delianedis and Geske (1999) we estimated risk-neutral probabilities of default considering a one year horizon for the total payment of the actual debt. We found that the market estimates for the probabilities of default are very much concentrated on the extremes of very close to 0% and close to 50%, for 42 Romanian companies.

The next step that we can envisage consists in finding proper thresholds for possible ratings. We aim at developing a matrix for the probabilities of transition of the companies from one rating to another, in a setting similar to Moody's KMV methodology. The challenge resides in finding the proper method to obtain steady ratings using the structural models.

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