Modeling the Insolvency of Bond Issuer

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A mortgage lending crisis in USA has become a reason of liquidity lack in the Russian financial market. Today many Russian bond issuers have strong problems with implementing themselves obligations such as repayment of coupons and principal. As consequence several defaults have arisen in the Russian financial market during the last half year. In these conditions each investor must analyze a bond issuer more closely. But the main source of information about issuer is the financial report (annual, semi-annual, quarterly). It means that analyst analyzing firm's financial report meets with a problem of relevant information lack. The Russian corporate bond market has become developing widely only since a beginning of XXI century, it means that analyst can possess as maximum 31 quarterly data for each analyzing item. In this case imitation modeling is very useful instrument for analysis of bond issuer insolvency.

There are two key approaches for the bond issuer insolvency analysis: technical and fundamental analysis. The main objects of technical analysis are prices, courses for bonds, depth of a bond market. Unlike technical analysis a concept of fundamental analysis researches the key financial ratios such as liquidity ratios, solvency ratios, ratios of financial efficiency.

In this paper the modeling of the issuer insolvency will be made basing on the fundamental approach. There are too many criteria of determining bad financial status of a company, but the most distributed approach based on Biver's matrix. This matrix is shown below.

Table 1 "Bivera's matrix"

Ratio	Company with good financial status	Company with satisfied financial status	Company with bad financial status
$K_1 = \frac{Current\ assets}{Current\ liabilities}$	$2 < K_1 \le 3.2$	$1 \le K_1 \le 2$	$K_1 < 1$
$K_2 = \frac{Net\ income}{Total\ assets}\ (\%)$	$6 \le K_2 \le 8$	$0 \le K_2 \le 6$	$K_2 < 0$
$K_3 = \frac{Total\,debt}{Total\ liabilities}\ (\%)$	$K_3 \le 37$	$37 \le K_3 \le 50$	$K_3 < 80$
$K_4 = \frac{Current\ capital}{Current\ assets}$	$0.4 < K_4$	$0.3 \le K_4 \le 0.4$	$0.08 < K_4 < 0.3$

And so, a subject of our research is financial status of «Novosibirskiy Olovyannyi Kombinat» company. This company has issued bonds in 2006 year.

An aim of our research is to determine probability of a company bad financial status.

Having not diminish commonality of a research let we analyze only current liquidity ratio (K_1) as the most representative one.

Our mathematical model is $K_{1.} = \frac{Current\ assets}{Current\ liabilities} = \frac{A_1 + A_2 + A_3 + A_4}{L_1 + L_2}$ (1), where

A_1-inventories;

A_2-receivables;

A_3-short term investments;

A_4-cash;

K_1-loans;

K_2-payables.

Our model has statistical character.

In our work we'll analyze quarterly financial data in period from the 2Q03 to 2Q08 deflated to the 2Q03 level. (in all 20 time sets).

Current liquidity ratio in the end of the 2Q08 is 1.5; it means that company has satisfied financial status.

All our calculation will be made with «Data analysis» MS Excel 2003 and «Distribution fitting » Statistical 6.0.

Our work includes five stages:

1) An approximation of the exogenous parameters with theoretical l law of distribution.
2) An imitation experiment for exogenous parameters.
3) Checking the model on adequacy, stability and exactness.
4) An approximation of the endogenous parameter (current liquidity ratio) with theoretical law of distribution
5) Calculation the probability of the bad financial status of the analyzing company.

The first stage: an approximation of the exogenous parameters with theoretical law of distribution.

So as a number of our data series is 20 ($10 < N < 100$), let we use Kolmogorov-Smirnov test.

$$D = \max_n | F_n(x) - F(x) |$$

where

$F_n(x)$ - Empirical cumulative frequency;

$F(x)$ - Integral function of the theoretical distribution law.

In case $D\sqrt{n} < \lambda_\alpha$, where λ_α - α percentage quantile of the Kolmogorov distribution, hypothesis H_0 about coincidence between theoretical and empirical distribution can be accepted. Let $\alpha = 0.05$, then if $D < \frac{1.36}{\sqrt{20}}$ then we can accept hypothesis H_0.

Having calculated Kolmogorov's statistic we determined a suitable theoretical law of distribution for each analyzed endogenous variable.

Results of calculation are shown in the table #2.

Table 2 "Kolmogorov's statistic for empiric distributions"

	Normal	Exponential	Gamma	Lognormal	Chi-Square
Inventory	0.12067	0.34957	0.1292	0.135	0.5
Receivables	0.1273	0.185	0.1034		0.45
Short term investments	0.187	0.1896	0.12		0.6
Loans	0.108	0.37	0.156	0.186	0.4
Payables	0.134		0.111	0.129	0.5

Red figures in the Table 2 show what theoretical distribution is suitable for each analyzing item.

The second stage: an imitation experiment for exogenous parameters.

Upper we have determined suitable theoretical law for each exogenous parameter. In this stage we will imitate stochastic exogenous parameters. First of all let we calculate a minimum quantity of imitation experiments providing required exactness. According to the principal formulated by Neilor a minimum quantity of imitation can be calculated so:

$T = \frac{U_\alpha^2 \hat{D}}{\varepsilon^2}$, where

U_α - α percentage quantile of standard normal distribution

α - confidence level (0.05)

ε - required exactness (0.01)

$\hat{D}$ - statistical estimate of current liquidity variance. (0.16)

Then $T = \frac{1.64^2 * 0.16}{0.01^2} \approx 431$, let we give $T = 500$.

We'll modulate normal and gamma distributed population using method of the reverse function. Accomplish this we'll use function «RAND()», «GAMMAINV()»,«NIRMINV()»

The third stage: checking the model on adequacy, stability and exactness.

In the second stage we have imitated 500 sets of the endogenous variables using method of the reverse function. After that we have calculated population of the current liquidity ratio according to the formula 1. Mean of received population became 1.42, when the 2Q08 current liability ratio was 1.5, it means that imitation model is adequate (results of imitation are reliable). More than that model is stable because variance of the imitated current liability ratio values doesn't increase then N (quantity of imitations) increases. It's shown in the figure #2 below.

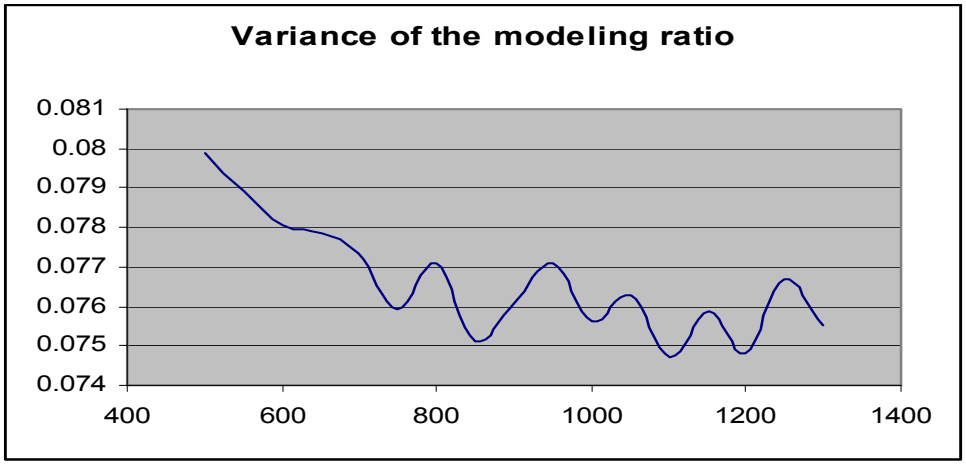

Figure 2 "Variance of the modeling ratio"

We see that variance is limited by value 0.077.

The fourth stage: an approximation of the endogenous parameter (current liquidity ratio) with theoretical l law of distribution. Having used Kolmogorov -Smirnov criterion described above we approximated imitated values of the current liquidity ratio with Gamma distribution law. ($\alpha = 25.5, \beta = 0.05$), $E(X) = \alpha\beta = 1.42$. It's shown on the figure #3 below.

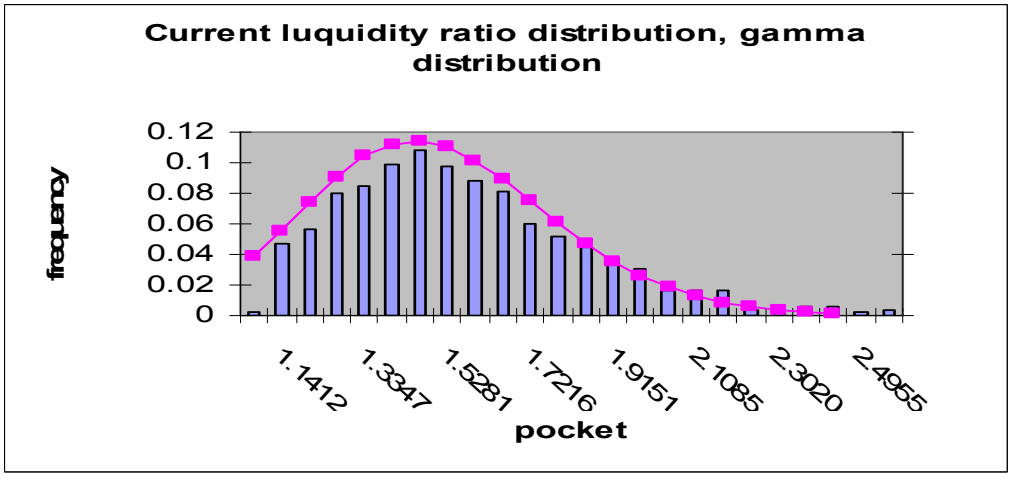

Figure 3 "Current ratio distribution, gamma distribution"

The fifth stage: calculation the probability of the bad financial status from the analyzed company.

In order to calculate the probability of the bad financial status of the analyzed company we should build an integrative function of gamma distribution with parameters $\alpha = 25.5,\ \beta = 0.05$. The chart of this function is shown in the figure #4.

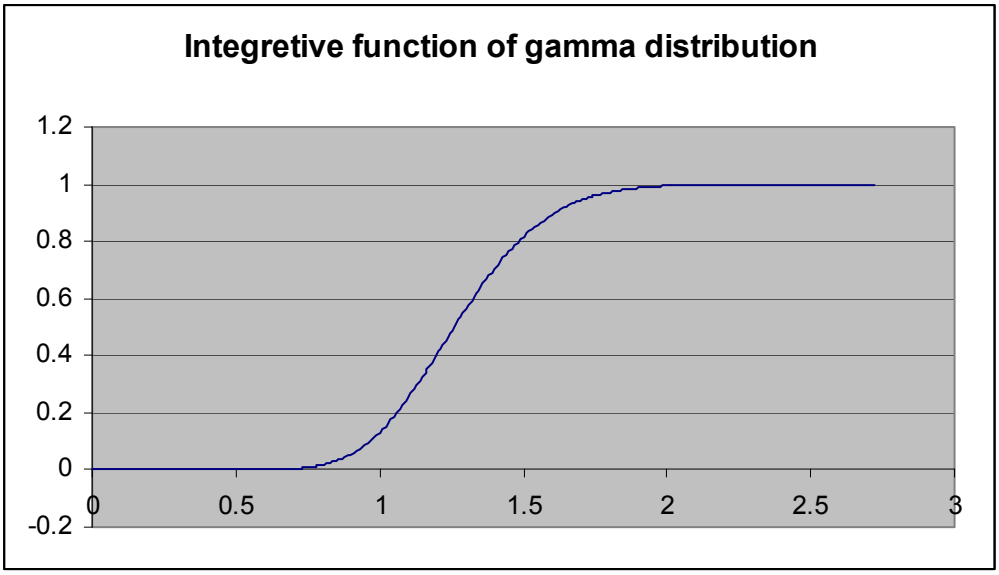

Figure #4 "Integrative function of gamma distribution with $\alpha = 25.5,\ \beta = 0.05$"

As we can see from the figure #4 probability of the bad financial status (current liquidity ratio is less than 1) is approximately 0.13 (13%). P(1< K_1 <2)=0.86, P(K_1 >2)=0.06.

So as P(K_1 <1)=0.13 is acceptable for as risk level we can recommend to buy bonds of the « Novosibirskiy Olovyannyi Kombinat» company for the current market price.