Ratings of the Long–Term Projects: New Approach

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Abstract: The paper continues create a new approach to rating methodology: in addition to two papers, which have considered the creditworthiness of the non–finance issuers (Brusov *et al*., 2018c,d), we develop here a new approach to project rating. We work within investment models, created by authors. One of them describes the effectiveness of investment project from perspective of equity capital owners, while other model describes the effectiveness of investment project from perspective of equity capital and debt capital owners.

The important features of current consideration as well as in previous studies are: 1) The adequate use of discounting of financial flows virtually not used in existing rating methodologies, 2) The incorporation of rating parameters (financial "ratios"), used in project rating, into considered modern investment models.

Analyzing within these investment models with incorporated rating parameters the dependence of *NPV* on rating parameters (financial "ratios") at different values of equity cost k_0, at different values of credit rates k_d as well as at different values of leverage level *L* we come to very important conclusion, that *NPV* in units of *NOI* $(\frac{NPV}{NOI})$ (as well as *NPV* in units of *D* ($(\frac{NPV}{D})$) depends only on equity cost k_0, on credit rates k_d, on leverage level L as well as on one of the leverage ratios l_j (on one of the coverage ratios i_j) and does not depend on equity value *S*, debt value *D* and *NOI*. This means that obtained results on the dependence of NPV (in units of *NOI*) $(\frac{NPV}{NOI})$ on leverage ratios l_j (as well as on the dependence of *NPV* (in units of *D*) $(\frac{NPV}{NOI})$ on coverage ratios i_j) at different equity costs k_0, at different credit rates k_d, at different leverage levels L carry the universal character: these dependencies remain valid for investment projects with any equity value *S*, any debt value *D* and any *NOI*.

Keywords: Long-term projects, rating, rating methodology, discounting of financial flows, Brusov-Filatova-Orekhova theory, coverage ratios, leverage ratios.

1. INTRODUCTION

Rating agencies play a very important role in economics. Their analysis of issuer's state, generated credit ratings of issuers help investors make reasonable investment decision, as well as help issuers with good enough ratings get credits on lower rates etc.

The paper continues create a new approach to rating methodology: in addition to two papers, which have considered the creditworthiness of the non–finance issuers (Brusov *et al*., 2018c,d), we develop here a new approach to project rating. We work within investment models, created by authors. One of them describes the effectiveness of investment project from perspective of equity capital owners, while other model describes the effectiveness of investment project from perspective of equity capital and debt capital owners.

The important features of current consideration as well as in previous studies are: 1) The adequate use of discounting of financial flows virtually not used in existing rating methodologies, 2) The incorporation of rating parameters (financial "ratios"), used in project rating, into considered modern investment models.

Analyzing within these investment models with incorporated rating parameters the dependence of *NPV* on rating parameters (financial "ratios") at different values of equity cost k_0, at different values of credit rates k_d as well as at different values of leverage level *L* we come to very important conclusion, that *NPV* (in units of *NOI*) $(\frac{NPV}{NOI})$ (as well as *NPV* (in units of *D*)

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E-ISSN: 1929-7092/18

($(\frac{NPV}{D})$) depends only on equity cost k_0, on credit rates k_d, on leverage level L as well as on one of the leverage ratios l_j (on one of the coverage ratios i_j) and does not depend on equity value S, debt value D and NOI. This means that results on the dependence of NPV (in units of NOI) ($\frac{NPV}{NOI}$) on leverage ratios l_j (as well as on the dependence of NPV (in units of D) ($\frac{NPV}{D}$) on coverage ratios i_j) at different equity costs k_0, at different credit rates k_d, at different leverage levels L carry the universal character: these dependencies remain valid for investment projects with any equity value S, debt value D and NOI.

2. INVESTMENT MODELS

We work within investment models, created by authors. One of them describes the effectiveness of investment project from perspective of equity capital owners, while other model describes the effectiveness of investment project from perspective of equity capital and debt capital owners.

In the former case, investments at the initial time moment $T = 0$ are equal to $-S$ and the flow of capital for the period (in addition to the tax shields k_dDt it includes a payment of interest on a loan $-k_d D$):

$$CF=\left(\mathrm{NOI}-k_d D\right)\left(1-t\right). \tag{1}$$

Here, for simplicity, we suppose that interest on the loan will be paid in equal shares k_d D during all periods. Note that principal repayment is made at the end of the last period.

We will consider the case of discounting, when operating and financial flows are not separated and both are discounted, using the general rate (as which, obviously, the weighted average cost of capital (WACC) can be selected). In this case for long–term (perpetuity) projects, the Modigliani–Miller formula (Modigliani and Miller 1958, 1963, 1966) for WACC will be used and for projects of finite (arbitrary) duration Brusov–Filatova–Orekhova formula will be used (Brusov and Filatova 2011; Brusov *et al*. 2011a, b, c, 2012a, b, 2013a, b. 2014a, b; Filatova *et al*. 2008; Brusova 2011).

Note that debt capital is the least risky, because in case of bankruptcy, claims of creditors are satisfied immediately after the payment of taxes in the first place. Therefore, the cost of credit will always be less than the equity cost, whether of ordinary or of preference shares $k_e > k_d; k_p > k_d$. Here k_e, k_p is the equity cost of ordinary or of preference shares consequently.

2.1. The Effectiveness of the Investment Project from the Perspective of the Equity Holders Only (Without Flows Separation)

In this case operating and financial flows are not separated and are discounted. using the general rate (as which, obviously, WACC can be selected).

The credit reimbursable at the end of the project (at the end of the period (n)) can be discounted either at the same rate WACC or at the debt cost rate k_d. Now we choose a uniform rate and the first option.

$$\begin{aligned}\mathrm{NPV} &= -S+\sum_{i=1}^{n}\frac{\mathrm{NOI}\left(1-t\right)-k_d D\left(1-t\right)}{\left(1+\mathrm{WACC}\right)^i}-\frac{D}{\left(1+\mathrm{WACC}\right)^n}\\ &= -S+\frac{\mathrm{NOI}\left(1-t\right)-k_d D\left(1-t\right)}{\mathrm{WACC}}\\ &\quad\left(1-\frac{1}{\left(1+\mathrm{WACC}\right)^n}\right)-\frac{D}{\left(1+\mathrm{WACC}\right)^n}.\end{aligned} \tag{2}$$

At a Constant Value of Equity Capital (*S* = const)

Accounting that in the case S = const NOI is proportional to the invested capital, I, $\mathrm{NOI} = \beta I = \beta S\left(1+L\right)$ and substituting $D = LS$, we get

$$\begin{aligned}\mathrm{NPV} &= -S+\frac{\mathrm{NOI}\left(1-t\right)-k_d D\left(1-t\right)}{\mathrm{WACC}}\\ &\quad\left(1-\frac{1}{\left(1+\mathrm{WACC}\right)^n}\right)-\frac{D}{\left(1+\mathrm{WACC}\right)^n},\end{aligned} \tag{3}$$

$$\begin{aligned}\mathrm{NPV} &= -S\left[1+\frac{Lk_d\left(1-t\right)}{\mathrm{WACC}}\left(1-\frac{1}{\left(1+\mathrm{WACC}\right)^n}\right)+\frac{L}{\left(1+\mathrm{WACC}\right)^n}\right]\\ &\quad+\frac{\beta S\left(1+L\right)\left(1-t\right)}{\mathrm{WACC}}\left(1-\frac{1}{\left(1+\mathrm{WACC}\right)^n}\right).\end{aligned} \tag{4}$$

2.1.1. Modigliani–Miller Limit (Long–term (Perpetuity) Projects)

In perpetuity limit ($n \to \infty$) (Modigliani–Miller limit) (turning to the limit $n \to \infty$ in the relevant equations). we have

$$\mathrm{NPV} = -S+\frac{\mathrm{NOI}\left(1-t\right)-k_d D\left(1-t\right)}{\mathrm{WACC}}. \tag{5}$$

At a Constant Value of Equity Capital ($S = \text{const}$)

$$\text{NPV} = -S + \frac{\text{NOI}\left(1-t\right) - k_{\text{d}}D\left(1-t\right)}{\text{WACC}} \tag{6}$$

Substituting $D = LS$, we get

$$\begin{aligned}\text{NPV} &= -S\left[1 + \frac{Lk_{\text{d}}\left(1-t\right)}{\text{WACC}}\right] + \frac{\text{NOI}\left(1-t\right)}{\text{WACC}} \\ &= -S\left[1 + \frac{Lk_{\text{d}}\left(1-t\right)}{k_0\left(1 - Lt/\left(1+L\right)\right)}\right] + \frac{\beta S\left(1+L\right)\left(1-t\right)}{k_0\left(1 - Lt/\left(1+L\right)\right)}.\end{aligned} \tag{7}$$

In last equation we substituted the perpetuity (Modigliani–Miller) formula for WACC

$$WACC = k_0\left(1 - \frac{Lt}{1+L}\right) \tag{8}$$

So, below we consider the long–term (perpetuity) projects and will use the following formula for calculations

$$NPV = -S\left[1 + \frac{Lk_d\left(1-t\right)}{k_0\left(1 - \frac{Lt}{1+L}\right)}\right] + \frac{\beta S\left(1+L\right)\left(1-t\right)}{k_0\left(1 - \frac{Lt}{1+L}\right)} \tag{9}$$

3. INCORPORATION OF FINANCIAL COEFFICIENTS, USING IN PROJECT RATING, INTO MODERN INVESTMENT MODELS

Below we incorporate the financial coefficients, used in project rating, into modern investment models, created by authors. We will consider two kind of financial coefficients: coverage ratios as well as leverage coefficients. In each group of financial coefficients we incorporate three particular quantities.

For coverage ratios we incorporate: 1) coverage ratios of debt, $i_1 = \frac{NPV}{D}$; 2) coverage ratios of interest on the credit $i_2 = \frac{NPV}{k_d D}$; 3) coverage ratios of debt and interest on the credit $i_3 = \frac{NPV}{\left(1+k_d\right)D}$.

For leverage ratios we incorporate: 1) leverage ratios of debt, $l_1 = \frac{D}{NPV}$; 2) leverage ratios of interest on the credit $l_2 = \frac{k_d D}{NPV}$; 3) leverage ratios of debt and interest on the credit $l_3 = \frac{(1+k_d)D}{NPV}$.

3.1. Coverage Ratios

3.1.1. Coverage Ratios of Debt

Let us first incorporate the coverage ratios, using in project rating, into modern investment models, created by authors. Dividing both parts of equation (9) by *D* one gets

$$\frac{NPV}{D} = -\frac{1}{L} - \frac{\left(k_d - i_1\right)\left(1-t\right)}{k_0\left(1 - \frac{Lt}{1+L}\right)} \tag{10}$$

Here $i_1 = \frac{NPV}{D}$ (11)

3.1.2. Coverage Ratios of Interest on the Credit

Dividing both parts of equation (9) by $k_d D$ one gets

$$\frac{NPV}{k_d D} = -\frac{1}{Lk_d} - \frac{\left(1 - i_2\right)\left(1-t\right)}{k_0\left(1 - \frac{Lt}{1+L}\right)} \tag{12}$$

Here $i_2 = \frac{NPV}{k_d D}$ (13)

3.1.3. Coverage Ratios of Debt and Interest on the Credit

Dividing both parts of equation (9) by $(1+k_d)D$ one gets

$$\frac{NPV}{\left(1+k_d\right)D} = -\frac{1}{L\left(1+k_d\right)} - \frac{\left[k_d - i_3\left(1+k_d\right)\right]\left(1-t\right)}{k_0\left(1 - \frac{Lt}{1+L}\right)} \tag{14}$$

Here $i_3 = \frac{NPV}{(1+k_d)D}$ (15)

Analyzing the formulas (10), (12) and (14) we come to very important conclusion, that NPV (in units of D) ($\frac{NPV}{D}$) depends only on equity cost k_0, on credit rates k_d, on leverage level L as well as on one of the coverage ratios i_j and does not depend on equity value *S*, debt value *D* and *NOI*. This means that results on the dependence of NPV (in units of D) ($\frac{NPV}{D}$) on coverage ratios i_j at different equity costs k_0, at different credit rates k_d, at different leverage levels L are universal in nature: these dependencies remain valid for investment projects with any equity value *S*, any debt value *D* and any *NOI*.

3.2. Leverage Ratios

3.2.1. Leverage Ratios for Debt

Now let us incorporate the leverage ratios, using in project rating, into modern investment models, created by authors.

Dividing both parts of equation (9) by *NOI* one gets

$$\frac{NPV}{NOI}=\frac{-l_1}{L}+\frac{(1-k_d l_1)(1-t)}{k_0\left(1-\frac{Lt}{1+L}\right)} \tag{16}$$

Here $l_1=\frac{D}{NPV}$ (17)

3.2.2. Leverage Ratios for Interest on Credit

$$\frac{NPV}{NOI}=\frac{-l_2}{k_d L}+\frac{(1-l_2)(1-t)}{k_0\left(1-\frac{Lt}{1+L}\right)} \tag{18}$$

Here $l_2=\frac{k_d D}{NPV}$ (19)

3.2.3. Leverage Ratios for Debt and Interest on Credit

$$\frac{NPV}{NOI}=\frac{-l_3}{(1+k_d)L}+\frac{(1+k_d-l_3k_d)(1-t)}{(1+k_d)k_0\left(1-\frac{Lt}{1+L}\right)} \tag{20}$$

Here $l_3=\frac{(1+k_d)D}{NPV}$. (21)

Analyzing the formulas (16), (18) and (20) we come to very important conclusion, that *NPV* (in units of *NOI*) $(\frac{NPV}{NOI})$ depends only on equity cost k_0, on credit rates k_d, on leverage level L as well as on one of the leverage ratios l_j and does not depend on equity value *S*, debt value *D* and *NOI*. This means that results on the dependence of NPV (in units of *NOI*) $(\frac{NPV}{NOI})$ on leverage ratios l_j at different equity costs k_0, at different credit rates k_d, at different leverage levels L carry the universal character: these dependencies remain valid for investment projects with any equity value *S*, debt value *D* and *NOI*.

We investigate below the effectiveness of long–term investment projects studying the dependence of NPV on coverage ratios and on leverage ratios. We make calculations for coefficients i_1 and l_1. Calculations for the rest of coefficients (i_2 , i_3 and l_2 , l_3) could be made in a similar way.

We start from the calculations of the dependence of NPV on coverage ratios. We consider different values of equity costs k_0, of debt costs k_d and of leverage level *L=D/S*. Here t is tax on profit rate, which in our calculations is equal to 20%.

4. DEPENDENCE OF NPV ON COVERAGE RATIOS

4.1. Coverage Ratio on Debt

Below we calculate the dependence of NPV (in units of D) $(\frac{NPV}{D})$ on coverage ratio on debt i_1 at different equity costs k_0 (k_0 is equity cost at L=0). We will make calculations for two leverage levels L (L=1 and L=3) and for different credit rates k_d.

For calculation within MM approximation we use the formula (10)

$$\frac{NPV}{D}=-\frac{1}{L}-\frac{(k_d-i_1)(1-t)}{k_0\left(1-\frac{Lt}{1+L}\right)}$$

4.1.1. The Dependence of NPV on Coverage Ratio on Debt i_1 at Equity Cost k_0=24%

Below we investigate the dependence of NPV on coverage ratio on debt i_1 at different values of equity costs k_0, at different values of debt costs k_d at fixed value of equity cost, as well as at different values of leverage levels L.

Let us start our calculations from the case of equity cost k_0=24%.

The results of calculations of the dependence of NPV on coverage ratio on debt i_1 at equity cost k_0=24%, at different values of debt costs k_d and L=1 are shown in Table **1**.

The dependence of NPV(in units of D) on coverage ratio on debt i_1 at k_0=24%, k_d=6%, 10%,14% and 20% and L=1 is illustrated in Figure **1**.

Let us calculate the value of i_1 above which the investment project remains effective (NPV>0)

k_d	0.20	0.14	0.1	0.06
i_1	0.48	0.42	0.38	0.32

One can see from this Table that the value of i_1 above which the investment project remains effective (NPV>0) increases with credit rate k_d, that means that effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d.

Table 1: The Dependence of NPV on Coverage Ratio on Debt i_1 at Equity Cost k_0=24%, k_d=6%, 10%,14%, 20% and L=1

i_1	L	k_0	t	NPV/D (k_d=0.2)	NPV/D (k_d=0.14)	NPV/D (k_d=0.1)	NPV/D (k_d=0.06)
0	1	0.24	0.2	–1.741	–1.519	–1.37	–1.222
1	1	0.24	0.2	1.963	2.185	2.333	2.481
2	1	0.24	0.2	5.667	5.889	6.037	6.185
3	1	0.24	0.2	9.37	9.593	9.741	9.889
4	1	0.24	0.2	13.07	13.3	13.44	13.59
5	1	0.24	0.2	16.78	17	17.15	17.3
6	1	0.24	0.2	20.48	20.7	20.85	21
7	1	0.24	0.2	24.19	24.41	24.56	24.7
8	1	0.24	0.2	27.89	28.11	28.26	28.41
9	1	0.24	0.2	31.59	31.81	31.96	32.11
10	1	0.24	0.2	35.3	35.52	35.67	35.81

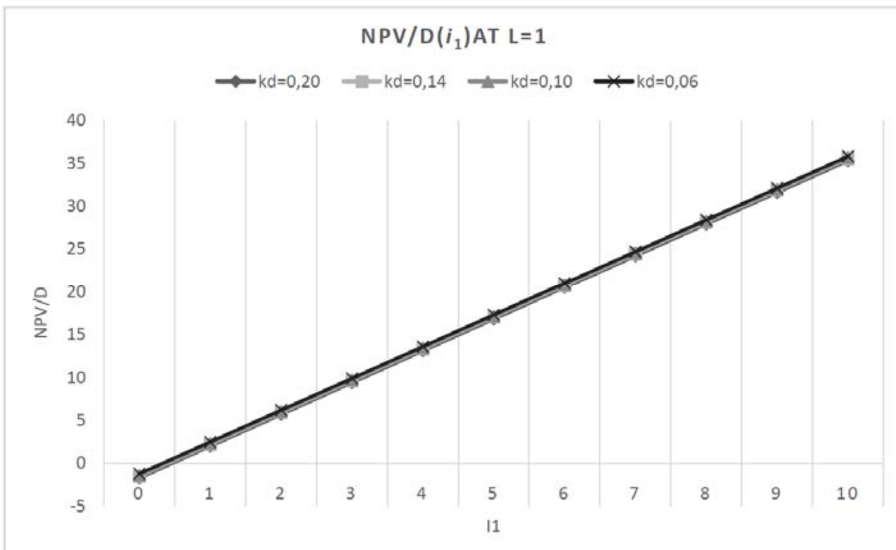

Figure 1: The dependence of NPV(in units of D) on coverage ratio on debt i_1 at k_0=24%, k_d=6%, 10%,14% and 20% and L=1.

Table 2: The Dependence of NPV on Coverage Ratio on Debt i_1 at Equity Cost k_0=24%, k_d=6%, 10%,14%, 20% and L=3

i_1	L	k_0	t	NPV/D (k_d=0.2)	NPV/D (k_d=0.14)	NPV/D (k_d=0.1)	NPV/D (k_d=0.06)
0	3	0.24	0.2	–1.118	–0.882	–0.725	–0.569
1	3	0.24	0.2	2.804	3.039	3.196	3.353
2	3	0.24	0.2	6.725	6.961	7.118	7.275
3	3	0.24	0.2	10.65	10.88	11.04	11.2
4	3	0.24	0.2	14.57	14.8	14.96	15.12
5	3	0.24	0.2	18.49	18.73	18.88	19.04
6	3	0.24	0.2	22.41	22.65	22.8	22.96
7	3	0.24	0.2	26.33	26.57	26.73	26.88
8	3	0.24	0.2	30.25	30.49	30.65	30.8
9	3	0.24	0.2	34.18	34.41	34.57	34.73
10	3	0.24	0.2	38.1	38.33	38.49	38.65

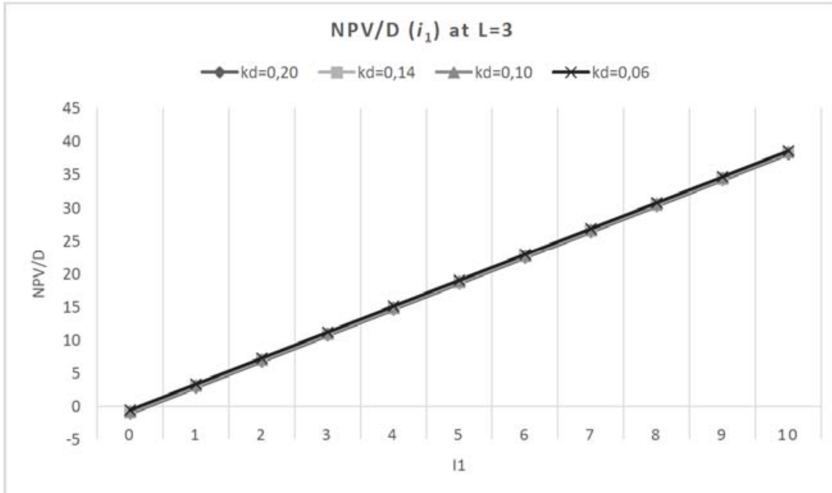

Figure 2: The dependence of NPV(in units of D) on coverage ratio on debt i_1 at k_0=24%, k_d=6%, 10%,14% and 20% and L=3.

Let us calculate the dependence of NPV (in units of D) on coverage ratio on debt i_1 at k_0=24%, k_d=6%, 10%, 14% and 20% and L=3.

The dependence of NPV(in units of D) on coverage ratio on debt i_1 at k_0=24%, k_d=6%, 10%,14% and 20% and L=3 is illustrated in Figure **2**.

Let us calculate the value of i_1 above which the investment project remains effective (NPV>0)

k_d	0.20	0.14	0.1	0.06
i_1	0.3	0.23	0.18	0.12

One can see from this Table that like the case of L=1 the value of i_1 above which the investment project remains effective (NPV>0) increases with credit rate k_d, that means that effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d. Comparing the case of L=1 one can see that at bigger leverage level (L=3) the investment project becomes effective (NPV>0) starting from smaller coverage ratio i_1, so bigger leverage level favors to the effectiveness of the investment project as well as its creditworthiness.

We see from the Tables **1** and **2** and Figures **1** and **2**, that $\frac{NPV}{D}$ increases with i_1 and that $\frac{NPV}{D}$ values turn out to be very closed each other at all i_1 values. It is seen as well that NPV increases with decreasing k_d. This means that effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d.

Below we investigate the dependence of $\frac{NPV}{D}$ on i_1 at different values of k_d in more details and will show the ordering of $\frac{NPV}{D}(i_1)$ curves at different values of k_d, as well as at different leverage levels L.

4.1.2. The Dependence of NPV on Coverage Ratio on Debt i_1 at Equity Cost k_0=12%

We study here the dependence of $\frac{NPV}{D}$ on i_1 at fixed equity cost k_0=12% and at different values of k_d in more details and will show the ordering of $\frac{NPV}{D}(i_1)$ curves at different values of k_d, as well as at different leverage levels L.

The results of calculations of the dependence of NPV on coverage ratio on debt i_1 at equity cost k_0=12%, at different values of debt costs k_d and L=1 are shown in Table **3**.

The results of calculations of the dependence of NPV on coverage ratio on debt i_1 at equity cost k_0=12%, at different values of debt costs k_d and L=3 are shown in Table **4**.

We see from the Tables **3** and **4** that NPV (in units of D) $(\frac{NPV}{D})$ increases with i_1 and that $\frac{NPV}{D}$ values turn out to be very closed each other at all i_1 values.

To show the difference in $\frac{NPV}{D}$ values in more details we show at the Figure **3** the dependence of $\frac{NPV}{D}$ on parameter i_1 for range i_1 from 1 to 2.

One can see, that all NPV (i_1) curves corresponding to L=3 lie above the curves corresponding to L=1. This means that NPV increases with L (with increasing of

Table 3: The Dependence of NPV(in Units of D) on Coverage Ratio on Debt i_1 at k_0=12%, k_d=2%, 4%,6%, 8% and 10% and L=1

i_1	t	k0	NPV/D k_d=0.1	NPV/D k_d=0.08	NPV/D k_d=0.06	NPV/D k_d=0.04	NPV/D k_d=0.02
0	0.2	0.12	–1.741	–1.593	–1.444	–1.296	–1.148
1	0.2	0.12	5.667	5.815	5.963	6.111	6.259
2	0.2	0.12	13.074	13.222	13.370	13.519	13.667
3	0.2	0.12	20.481	20.630	20.778	20.926	21.074
4	0.2	0.12	27.889	28.037	28.185	28.333	28.481
5	0.2	0.12	35.296	35.444	35.593	35.741	35.889
6	0.2	0.12	42.704	42.852	43.000	43.148	43.296
7	0.2	0.12	50.111	50.259	50.407	50.556	50.704
8	0.2	0.12	57.519	57.667	57.815	57.963	58.111
9	0.2	0.12	64.926	65.074	65.222	65.370	65.519
10	0.2	0.12	72.333	72.481	72.630	72.778	72.926

Table 4: The dependence of NPV(in units of D) on coverage ratio on debt i_1 at k_0=12%, k_d=2%, 4%,6%, 8% and 10% and L=3

i_1	t	k0	NPV/D k_d=0.1	NPV/D k_d=0.08	NPV/D k_d=0.06	NPV/D k_d=0.04	NPV/D k_d=0.02
0	0.2	0.12	–1.118	–0.961	–0.804	–0.647	–0.490
1	0.2	0.12	6.725	6.882	7.039	7.196	7.353
2	0.2	0.12	14.569	14.725	14.882	15.039	15.196
3	0.2	0.12	22.412	22.569	22.725	22.882	23.039
4	0.2	0.12	30.255	30.412	30.569	30.725	30.882
5	0.2	0.12	38.098	38.255	38.412	38.569	38.725
6	0.2	0.12	45.941	46.098	46.255	46.412	46.569
7	0.2	0.12	53.784	53.941	54.098	54.255	54.412
8	0.2	0.12	61.627	61.784	61.941	62.098	62.255
9	0.2	0.12	69.471	69.627	69.784	69.941	70.098
10	0.2	0.12	77.314	77.471	77.627	77.784	77.941

the debt financing). At fixed value L NPV increases with decreasing the credit rate k_d. This means that effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d.

Analyzing the obtained results one should remember, that NPV (in units of D) $(\frac{NPV}{D})$ depends only on equity cost k_0, on credit rates k_d, on leverage level L as well as on one of the coverage ratios i_j and does not depend on equity value *S*, debt value *D* and *NOI*. This means that obtained results on the dependence of NPV (in units of D) $(\frac{NPV}{D})$ on coverage ratios i_j at different equity costs k_0, at different credit rates k_d, at different leverage levels L are universal in nature: these dependencies remain valid for investment projects with any equity value *S*, any debt value *D* and any *NOI*.

5. DEPENDENCE OF NPV ON LEVERAGE RATIOS

5.1. Leverage Ratio of Debt

Below we calculate the dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at different equity costs k_0 (k_0 is equity cost at L=0). We make calculations for two leverage levels L (L=1 and L=3) and for different credit rates k_d.

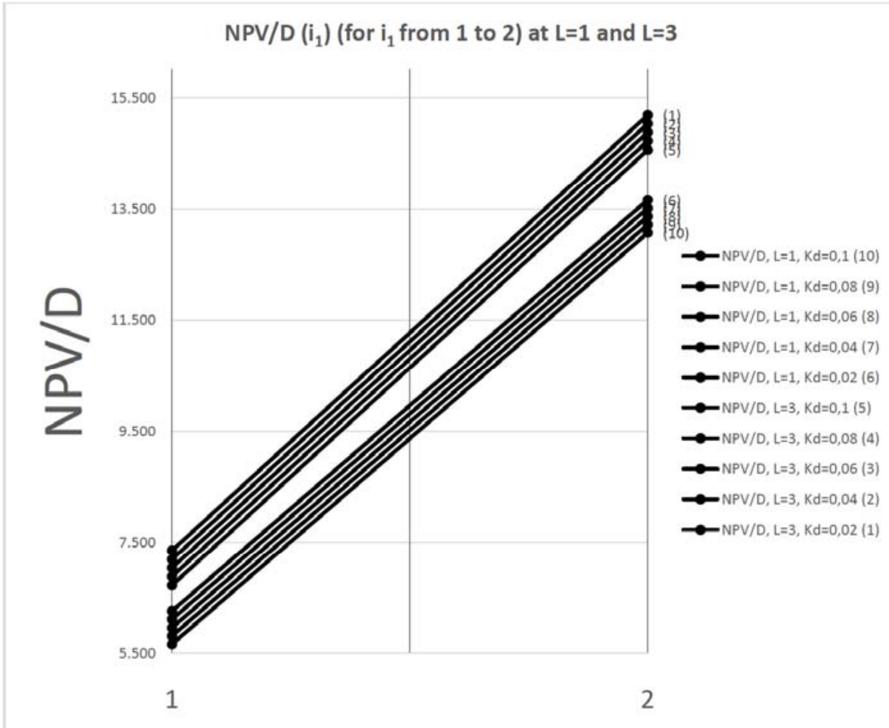

Figure 3: The dependence of NPV(in units of D) on coverage ratio on debt i_1 at k_0=12%, k_d=2%, 4%,6%, 8% and 10% and L=1 and L=3.

For calculation within MM approximation we use the formula (19)

$$\frac{NPV}{NOI} = \frac{-l_1}{L} + \frac{(1 - K_d * l_1)(1-t)}{k_0 * \left(1 - \frac{Lt}{1+L}\right)}.$$

5.1.1. The Dependence of NPV (in Units of NOI) ($\frac{NPV}{NOI}$) on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.12

Results are shown in Tables **5** and **6** and in Figures **4** and **5**

Based on the above calculations, we plot the dependences of NPV/NOI on leverage ratio on debt l_1 at different leverage levels L.

From Tables **5** and **6** and Figures **4** and **5** one can come to conclusion, that the NPV(in units of NOI) (NPV/NOI) decreases with increasing of the leverage ratio on debt l_1. With the increasing of the cost of debt capital k_d, curves of the dependence of NPV/NOI (l_1), outgoing from a single point at a zero value of l_1, lie below (i.e., the rate of decrease (or negative slope of curves) grows). Note, that while the dependences of NPV(in units of D) on coverage ratio on debt i_1 lie very close each other (see above), the dependences of NPV(in units of NOI) on leverage ratio on debt l_1 are separated significantly more.

Also, Figures **6-9** of the NPV/NOI dependence on l_1 can be plotted for fixed values of the debt cost k_d and two values of the leverage level L=1 and L=3.

Table 5: The Dependence of NPV (in Units of NOI) ($\frac{NPV}{NOI}$) on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.12, k_d=4%,6%, 8% and 10% and L=1

l_1	0	1	2	3	4	5	6	7	8	9	10
K_d=0.10	7.407	5.667	3.926	2.185	0.444	–1.296	–3.037	–4.778	–6.519	–8.259	–10
K_d=0.08	7.407	5.815	4.222	2.63	1.037	–0.556	–2.148	–3.741	–5.333	–6.926	–8.519
K_d=0.06	7.407	5.963	4.519	3.074	1.63	0.185	–1.259	–2.704	–4.148	–5.593	–7.037
K_d=0.04	7.407	6.111	4.815	3.519	2.222	0.926	–0.37	–1.667	–2.963	–4.259	–5.556

Table 6: The Dependence of NPV (in Units of NOI) $(\frac{NPV}{NOI})$ on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.12, k_d=4%,6%, 8% and 10% and L=3

l_1	0	1	2	3	4	5	6	7	8	9	10
K_d=0.10	7.843	6.725	5.608	4.49	3.373	2.255	1.137	0.02	–1.098	–2.216	–3.333
K_d=0.08	7.843	6.882	5.922	4.961	4	3.039	2.078	1.118	0.157	–0.804	–1.765
K_d=0.06	7.843	7.039	6.235	5.431	4.627	3.824	3.02	2.216	1.412	0.608	–0.196
K_d=0.04	7.843	7.196	6.549	5.902	5.255	4.608	3.961	3.314	2.667	2.02	1.373

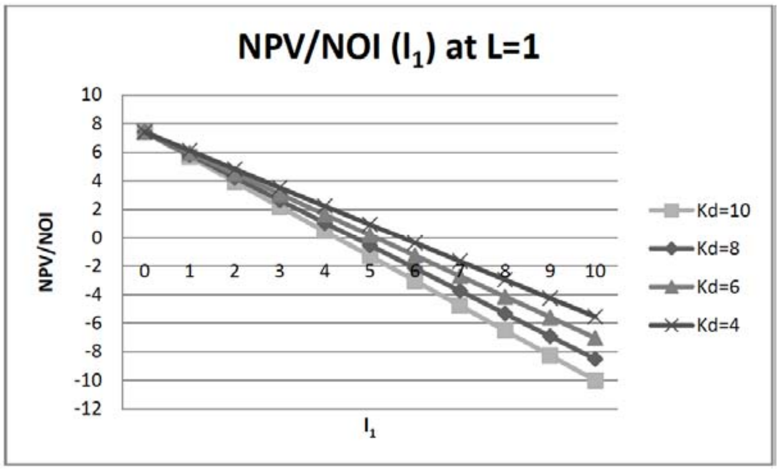

Figure 4: The dependence of NPV(in units of D) on leverage ratio on debt l_1 at k_0=12%, k_d=4%, 6%,8% and 10% and L=1.

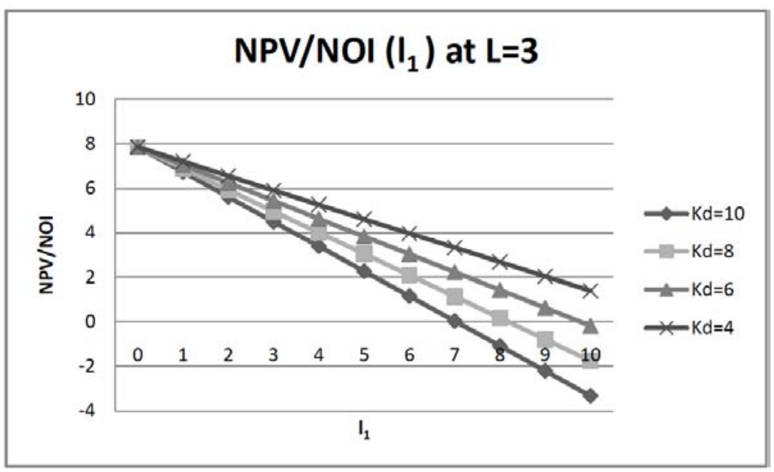

Figure 5: The dependence of NPV(in units of D) on leverage ratio on debt l_1 at k_0=12%, k_d=4%, 6%,8% and 10% and L=3.

One can see, that the rate of decrease of the ratio NPV/NOI decreases with increasing of the leverage level L.

5.1.2. The Dependence of NPV (in Units of NOI) $(\frac{NPV}{NOI})$ on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.14

Based on the obtained data, we plot the dependences of NPV/NOI on l_1 at k_0=14%, different values of debt cost k_d and at two different leverage levels L=1 and L=3 in Figures **10** and **11**.

From Tables **7** and **8** and Figures **10** and **11** one can come to conclusion, that the NPV(in units of NOI) (NPV/NOI) decreases with increasing of the leverage ratio on debt l_1. With the increasing of the cost of debt capital k_d, curves of the dependence of NPV/NOI (l_1), outgoing from a single point at a zero value of l_1, fall below (i.e., the rate of decrease grows).

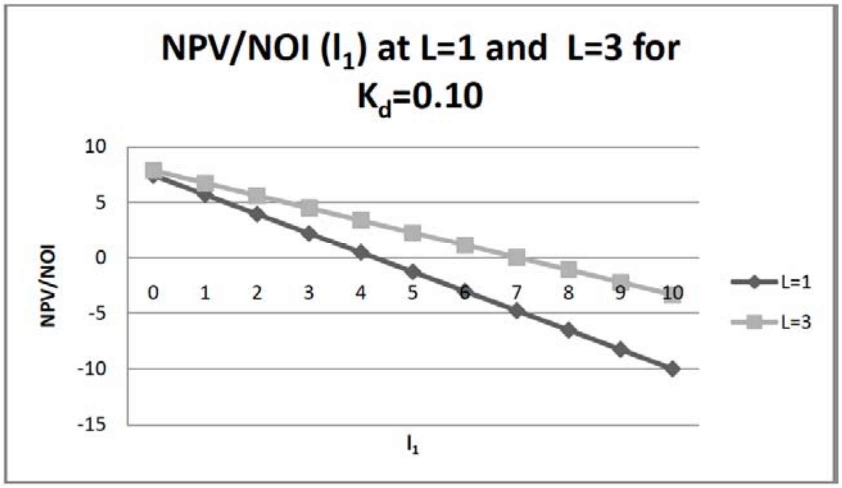

Figure 6: The dependence of NPV(in units of NOI) on leverage ratio on debt l_1 at k_0=12%, k_d=10% and L=1 and L=3.

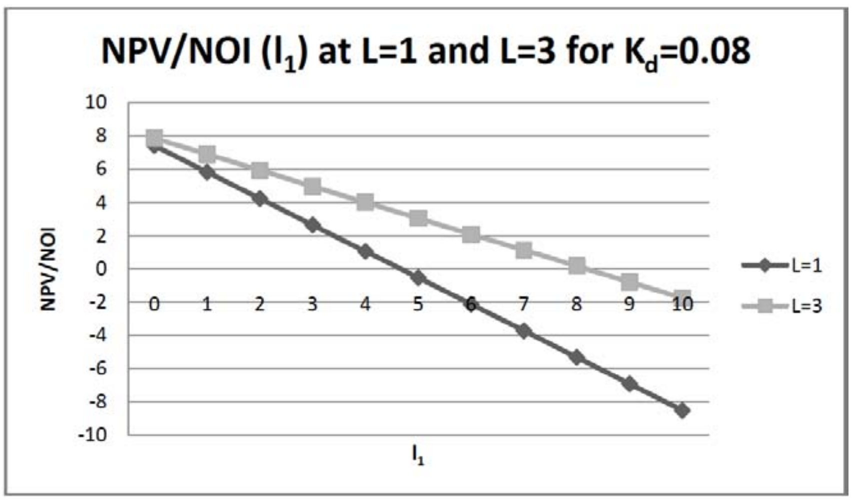

Figure 7: The dependence of NPV(in units of NOI) on leverage ratio on debt l_1 at k_0=12%, k_d=8% and L=1 and L=3.

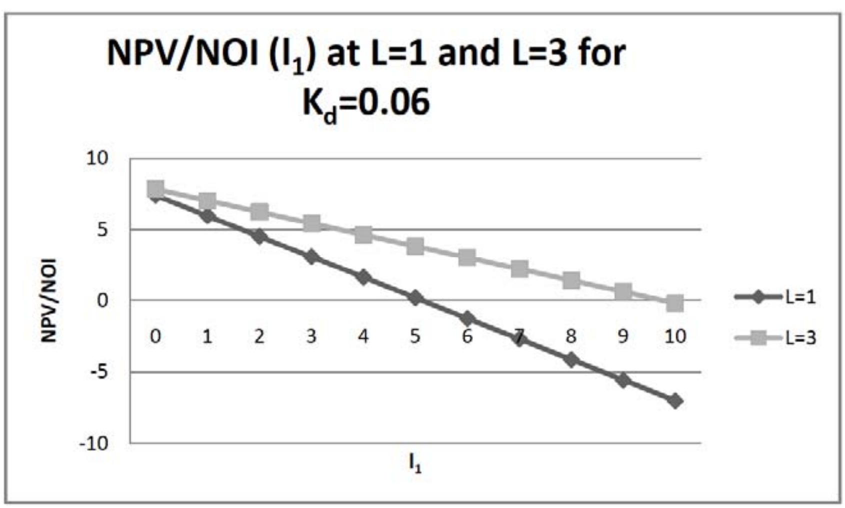

Figure 8: The dependence of NPV(in units of NOI) on leverage ratio on debt l_1 at k_0=12%, k_d=6% and L=1 and L=3.

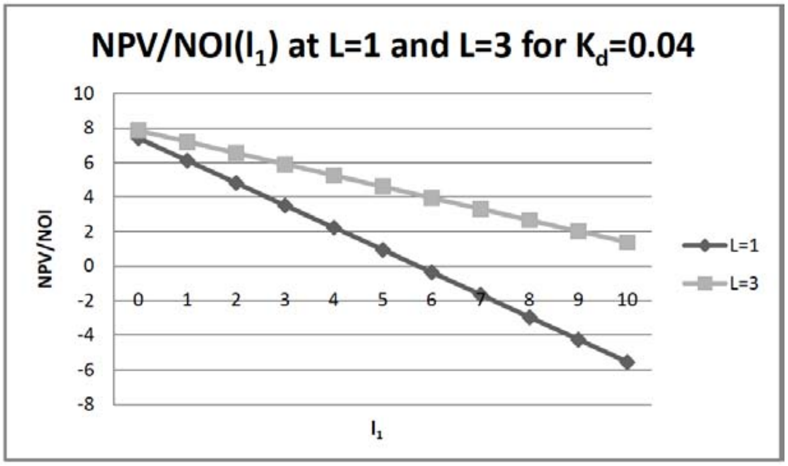

Figure 9: The dependence of NPV(in units of NOI) on leverage ratio on debt l_1 at k_0=12%, k_d=4% and L=1 and L=3.

L=1

Table 7: The Dependence of NPV (in Units of NOI) ($\frac{NPV}{NOI}$) on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.14, k_d=6%, 8%,10%,12% and L=1

l_1	L	k_0	t	NPV/NOI (k_d=0.12)	NPV/NOI(k_d=0.1)	NPV/NOI (k_d=0.08)	NPV/NOI (k_d=0.06)
0	1	0.14	0.2	6.349206349	6.349206349	6.349206349	6.349206349
1	1	0.14	0.2	4.587301587	4.714285714	4.841269841	4.968253968
2	1	0.14	0.2	2.825396825	3.079365079	3.333333333	3.587301587
3	1	0.14	0.2	1.063492063	1.444444444	1.825396825	2.206349206
4	1	0.14	0.2	–0.698412698	–0.19047619	0.317460317	0.825396825
5	1	0.14	0.2	–2.46031746	–1.825396825	–1.19047619	–0.555555556
6	1	0.14	0.2	–4.222222222	–3.46031746	–2.698412698	–1.936507937
7	1	0.14	0.2	–5.984126984	–5.095238095	–4.206349206	–3.317460317
8	1	0.14	0.2	–7.746031746	–6.73015873	–5.714285714	–4.698412698
9	1	0.14	0.2	–9.507936508	–8.365079365	–7.222222222	–6.079365079
10	1	0.14	0.2	–11.26984127	–10	–8.73015873	–7.46031746

L=3

Table 8: The Dependence of NPV (in Units of NOI) ($\frac{NPV}{NOI}$) on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.14, k_d=6%, 8%,10%,12% and L=3

l_1	L	k_0	t	NPV/NOI k_d=0.12	NPV/NOI k_d=0.1	NPV/NOI k_d=0.08	NPV/NOI k_d=0.06
0	3	0.14	0.2	6.722689	6.722689	6.722689	6.722689
1	3	0.14	0.2	5.582633	5.717087	5.851541	5.985994
2	3	0.14	0.2	4.442577	4.711485	4.980392	5.2493
3	3	0.14	0.2	3.302521	3.705882	4.109244	4.512605
4	3	0.14	0.2	2.162465	2.70028	3.238095	3.77591
5	3	0.14	0.2	1.022409	1.694678	2.366947	3.039216
6	3	0.14	0.2	–0.11765	0.689076	1.495798	2.302521
7	3	0.14	0.2	–1.2577	–0.31653	0.62465	1.565826
8	3	0.14	0.2	–2.39776	–1.32213	–0.2465	0.829132
9	3	0.14	0.2	–3.53782	–2.32773	–1.11765	0.092437
10	3	0.14	0.2	–4.67787	–3.33333	–1.9888	–0.64426

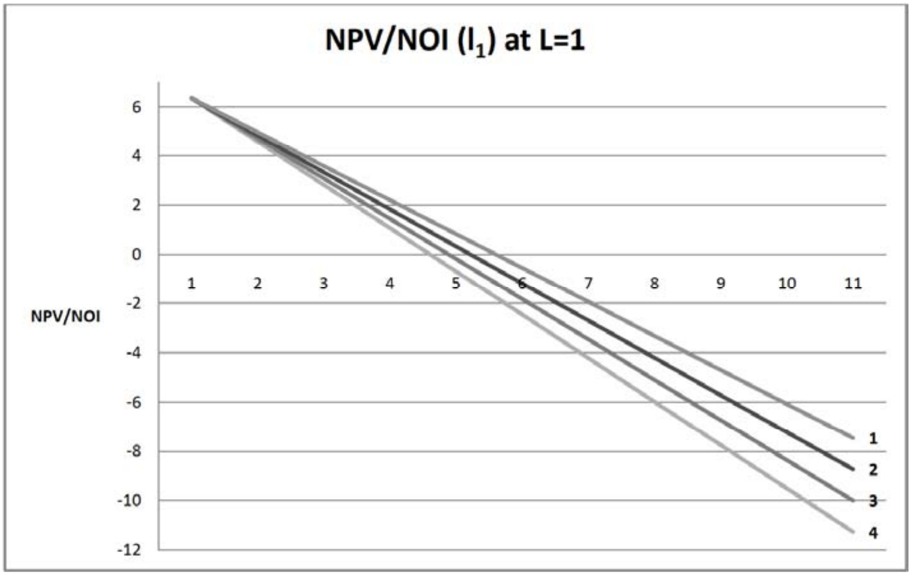

Figure 10: The dependence of NPV(in units of NOI) on leverage ratio on debt l_1 at k_0=14%, k_d=6%–(1),8%–(2),10%–(3),12%–(4) at L=1.

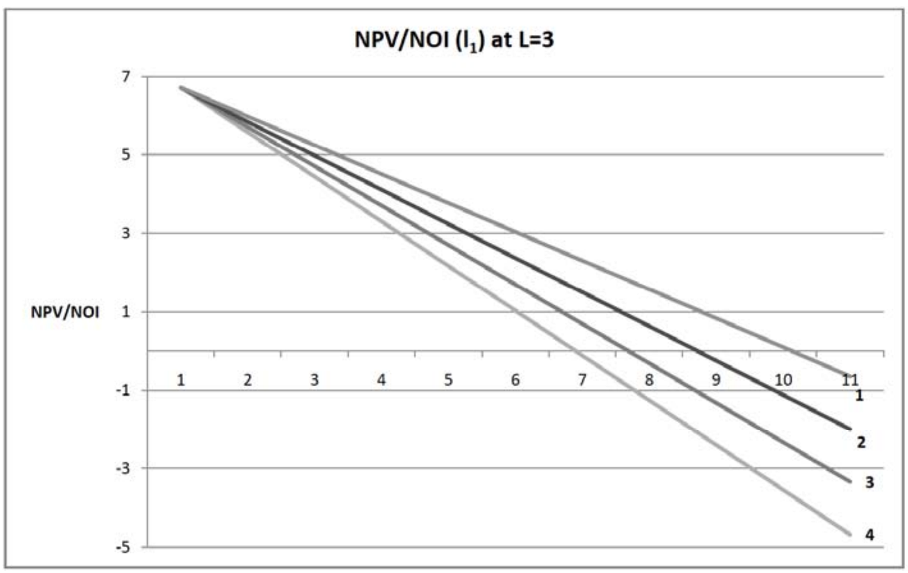

Figure 11: The dependence of NPV(in units of NOI) on leverage ratio on debt l_1 at k_0=14%, k_d=6%–(1),8%–(2),10%–(3),12%–(4) at L=3.

5.1.3. The Dependence of NPV (in Units of NOI) $(\frac{NPV}{NOI})$ on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.26

The formula of Modigliani and Miller in Excel will look like:

=(–A3/C3)+(((1–(E3*A3))*(1–B3))/(D3*(1–((C3*B3)/(1+C3)))))

Using this formula we calculate the dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost k_0=0.26, at different values of k_d =22%. 16%. 10%. 6% and at two values of leverage level L = 1 and L=3.

Let us start from the case L = 1.

Let us calculate the value of l_1 below which the investment project remains effective (NPV>0)

k_d	0.22	0.16	0.1	0.06
l_1	1.9	2.2	2.5	2.7

One can see from this Table that the value of l_1 below which the investment project remains effective (NPV>0) decreases with credit rate k_d, that means that

Table 9: The Dependence of NPV (in Units of NOI) $(\frac{NPV}{NOI})$ on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.26, k_d =22%. 16%. 10%. 6% and L = 1

l_1	NPV/NOI(l_1) K_d = 0.22	NPV/NOI(l_1) K_d = 0.16	NPV/NOI(l_1) K_d = 0.1	NPV/NOI(l_1) K_d = 0.06
0	3.418803419	3.4188034	3.41880342	3.4188034
1	1.666666667	1.8717949	2.07692308	2.2136752
2	–0.08547009	0.3247863	0.73504274	1.008547
3	–1.83760684	–1.2222222	–0.60683761	–0.196581
4	–3.58974359	–2.7692308	–1.94871795	–1.401709
5	–5.34188034	–4.3162393	–3.29059829	–2.606838
6	–7.09401709	–5.8632479	–4.63247863	–3.811966
7	–8.84615385	–7.4102564	–5.97435897	–5.017094
8	–10.5982906	–8.957265	–7.31623932	–6.222222
9	–12.3504274	–10.504274	–8.65811966	–7.42735
10	–14.1025641	–12.051282	–10	–8.632479

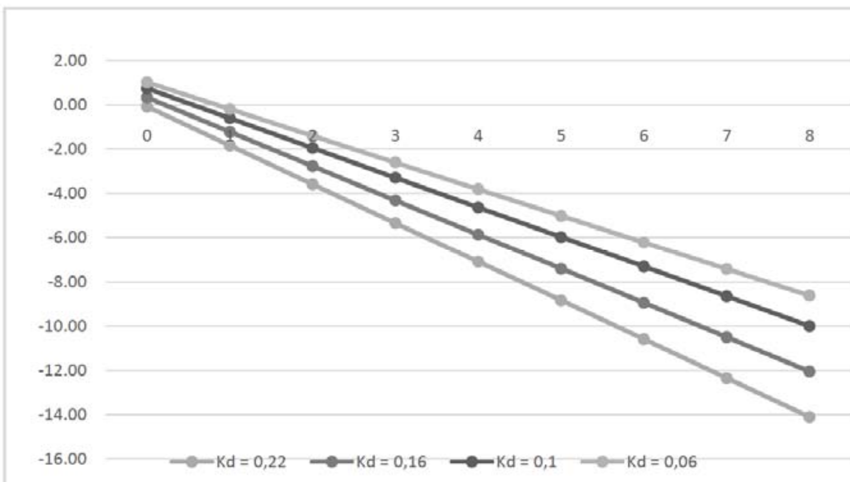

Figure 12: The dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost k_0=0.26, k_d =22%. 16%. 10%. 6% and L = 1.

effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d.

Let us calculate the value of l_1 below which the investment project remains effective (NPV>0)

k_d	0.22	0.16	0.1	0.06
l_1	3.85	4	5.6	6.6

One can see from this Table that like the case of L=1 the value of l_1 below which the investment project remains effective (NPV>0) decreases with credit rate k_d, that means that effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d. Comparing the case of L=1 one can see that at bigger leverage level (L=3) the investment project remains effective (NPV>0) until bigger leverage ratio l_1, so bigger leverage level favors to the effectiveness of the investment project as well as its creditworthiness.

Let us analyze also the dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost k_0=0.26 and each value of k_d at two leverage levels L = 1 and L = 3.

Studying the dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost

Table 10: The Dependence of NPV (in Units of NOI) $(\frac{NPV}{NOI})$ on Leverage Ratio on Debt l_1 at Equity Cost k_0=0.26, k_d =22%. 16%. 10%. 6% and L = 3

l_1	NPV/NOI(l_1) K_d = 0.22	NPV/NOI(l_1) K_d = 0.16	NPV/NOI(l_1) K_d = 0.1	NPV/NOI(l_1) K_d = 0.06
0	3.619909502	3.6199095	3.6199095	3.6199095
1	2.490196078	2.7073906	2.92458522	3.0693816
2	1.360482655	1.7948718	2.22926094	2.5188537
3	0.230769231	0.8823529	1.53393665	1.9683258
4	–0.89894419	–0.0301659	0.83861237	1.4177979
5	–2.02865762	–0.9426848	0.14328808	0.86727
6	–3.15837104	–1.8552036	–0.5520362	0.3167421
7	–4.28808446	–2.7677225	–1.24736048	–0.233786
8	–5.41779789	–3.6802413	–1.94268477	–0.784314
9	–6.54751131	–4.5927602	–2.63800905	–1.334842
10	–7.67722474	–5.505279	–3.33333333	–1.88537

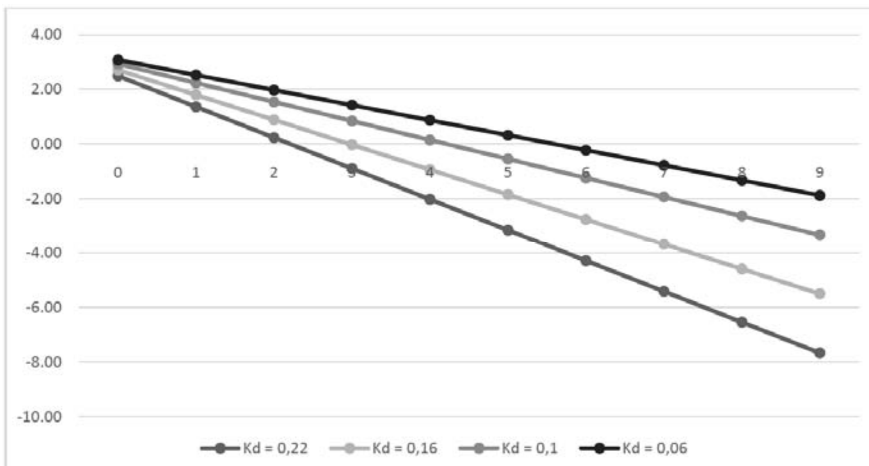

Figure 13: The dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost k_0=0.26, k_d =22%. 16%. 10%. 6% and L = 3.

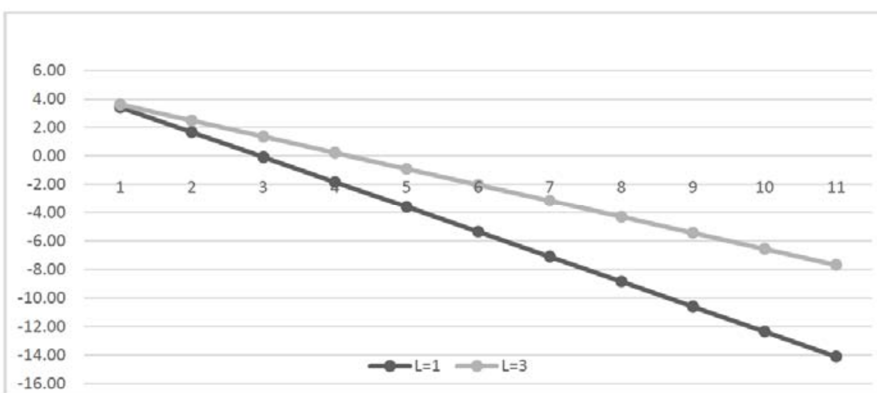

Figure 14: The dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost k_0=0.26, k_d =22 and L = 1 and L = 3.

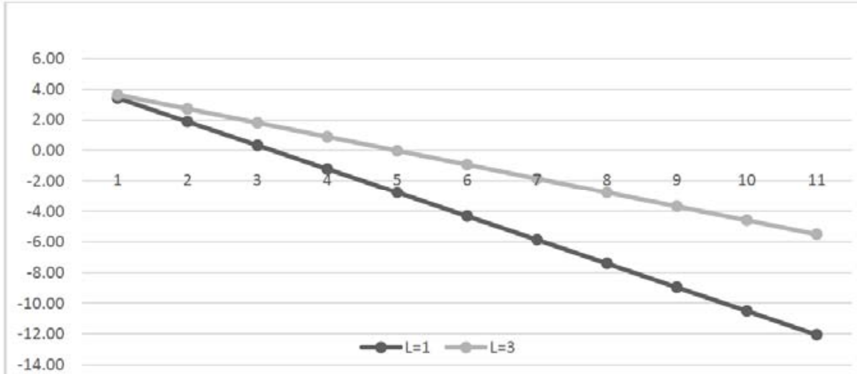

Figure 15: The dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost k_0=0.26, k_d =16% and L = 1 and L = 3.

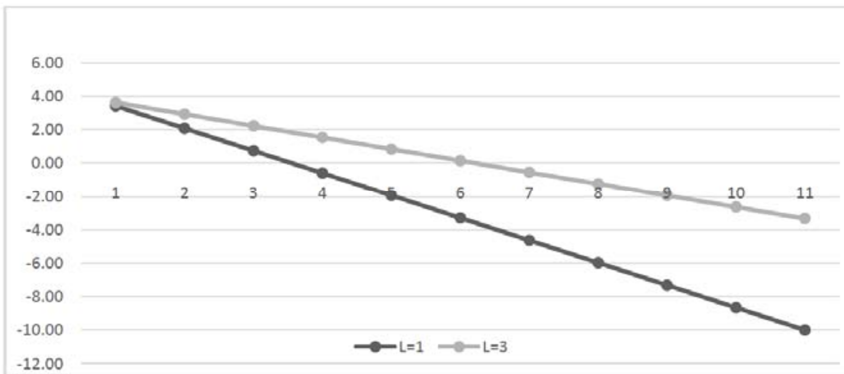

Figure 16: The dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost k_0=0.26, k_d =10% and L = 1 and L = 3.

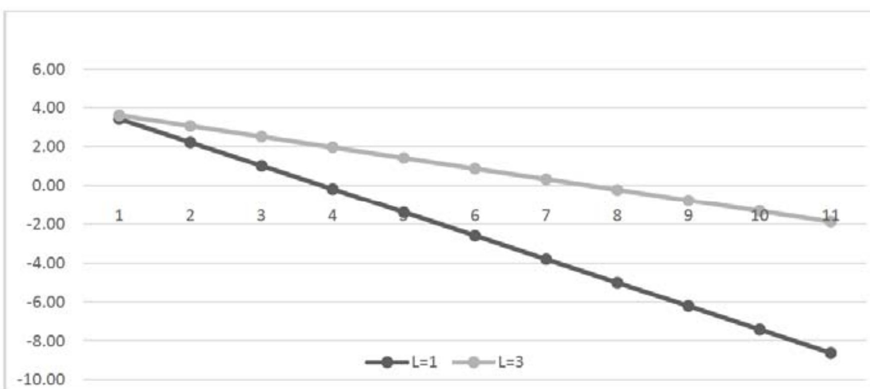

Figure 17: The dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at equity cost k_0=0.26, k_d =6% and L = 1 and L = 3.

k_0=0.26 and each value of k_d at two leverage levels L = 1 and L = 3 shows that the curve $\frac{NPV}{NOI}$ (l_1) corresponding to bigger leverage level (L=3) lies above the curve $\frac{NPV}{NOI}$ (l_1) corresponding to smaller leverage level (L=1). The curve $\frac{NPV}{NOI}$ (l_1) corresponding to bigger leverage level (L=3) has smaller (negative) slope. This means that debt financing of long–term projects favors effectiveness of the investment project as well as its creditworthiness.

Analyzing the obtained results one should remember, that *NPV* (in units of *NOI*) $(\frac{NPV}{NOI})$ depends only on equity cost k_0, on credit rates k_d, on leverage level L as well as on one of the leverage ratios l_j and does not depend on equity value *S*, debt value *D* and *NOI*. This means that obtained results on the dependence of NPV (in units of *NOI*) $(\frac{NPV}{NOI})$ on leverage ratios l_j at different equity costs k_0, at different credit rates k_d, at different leverage levels L are universal in nature: these dependencies remain valid for investment projects with any equity value *S*, debt value *D* and *NOI*.

CONCLUSIONS

The paper continues create a new approach to rating methodology: in addition to two papers, which have considered the creditworthiness of the non–finance issuers (Brusov *et al*., 2018c,d), we develop here a new approach to project rating. We work within investment models. created by authors. One of them describes the effectiveness of investment project from perspective of equity capital owners, while other model describes the effectiveness of investment project from perspective of equity capital and debt capital owners.

The important features of current consideration as well as in previous studies are: 1) The adequate use of discounting of financial flows virtually not used in existing rating methodologies, 2) The incorporation of rating parameters (financial "ratios"), used in project rating, into considered modern investment models.

Analyzing within these investment models with incorporated rating parameters the dependence of *NPV* on rating parameters (financial "ratios") at different values of equity cost k_0, at different values of credit rates k_d as well as at different values of on leverage level *L* we come to very important conclusion, that *NPV* in units of *NOI* $(\frac{NPV}{NOI})$ (as well as *NPV* in units of *D* $((\frac{NPV}{D}))$ depends only on equity cost k_0, on credit rates k_d, on leverage level L as well as on one of the leverage ratios l_j (on one of the coverage ratios i_j) and does not depend on equity value *S*, debt value *D* and *NOI*. This means that obtained results on the dependence of NPV (in units of *NOI*) $(\frac{NPV}{NOI})$ on leverage ratios l_j (as well as on the dependence of *NPV* (in units of *D*) $(\frac{NPV}{D})$ on coverage ratios i_j) at different equity costs k_0, at different credit rates k_d, at different leverage levels L are universal in nature: these dependencies remain valid for investment projects with any equity value *S*, debt value *D* and *NOI*.

Calculations on dependence of *NPV* in units of *D* (*NPV/D*) on the coverage ratio on debt i_1 show, that $\frac{NPV}{D}$ increases with i_1 and that $\frac{NPV}{D}$ values turn out to be very closed each other at all i_1 values. It is seen as well that NPV increases with decreasing k_d. This means that effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d. One can see, that all NPV (i_1) curves corresponding to L=3 lie above the curves corresponding to L=1. This means that NPV increases with leverage level L (with increasing of the debt financing). Thus, debt financing favors to effectiveness of the long–term project. At fixed value L NPV increases with decreasing the credit rate k_d.

It is shown the value of the coverage ratio on debt i_1 above which the investment project remains effective (NPV>0) increases with credit rate k_d, that means that effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d. Comparing the cases of L=1 and L=3 one can see that at bigger leverage level (L=3) the investment project becomes effective (NPV>0) starting from smaller coverage ratio i_1, so bigger leverage level favors to the effectiveness of the investment project as well as its creditworthiness.

Calculations on dependence of *NPV* in units of *NOI* *(NPV/NOI)* on the leverage ratio on debt l_1 show that *NPV* in units of *NOI* decreases with increasing of the leverage ratio on debt l_1. With the increasing of the cost of debt capital k_d, curves of the dependence of NPV/NOI (l_1), outgoing from a single point at a zero value of l_1, lie below (i.e., the rate of decrease (or negative slope of curves) grows). Note, that while the dependences of NPV(in units of D) on coverage ratio on debt i_1 lie very close each other, the dependences of NPV(in units of NOI) on leverage ratio on debt l_1 are separated significantly more.

One can see that the value of l_1 below which the investment project remains effective (NPV>0) decreases with credit rate k_d, that means that effectiveness of the investment project as well as its creditworthiness decreases with credit rate k_d.

Studying the dependence of NPV (in units of NOI) $(\frac{NPV}{NOI})$ on leverage ratio on debt l_1 at fixed equity cost k_0 and fixed credit rate k_d at two leverage levels L = 1 and L = 3 it was shown that the curve $\frac{NPV}{NOI}$ (l_1) corresponding to bigger leverage level (L=3) lies above the curve $\frac{NPV}{NOI}$ (l_1) corresponding to smaller leverage level (L=1). The curve $\frac{NPV}{NOI}$ (l_1) corresponding to bigger leverage level (L=3) has smaller (negative) slope. This means that debt financing of long–term projects favors effectiveness of the investment project as well as its creditworthiness.

Investigations, conducting in current paper, creates a new approach to rating methodology with respect to the long–term project rating. And this paper in combine with two our previous papers on this topic (Brusov *et al*., 2018 c,d) creates a new base for rating methodology in whole.

In our future papers we will consider rating methodology for investment projects of arbitrary duration.

ACKNOWLEDGEMENT

The reported study was funded by RFBR according to the research project №17–06–00251A.

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Received on 30-05-2018 Accepted on 19-08-2018 Published on 12-11-2018

DOI: https://doi.org/10.6000/1929-7092.2018.07.59