The Impact of the Central Bank Key Rate and Commercial Banks Credit Rates on Creating and Maintaining of a Favorable Investment Climate in the Country

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Abstract: Paper is devoted to study of the impact of the Central Bank key rate and commercial banks credit rates on creating and maintaining of a favorable investment climate in the country. Within the framework of modern investment models created by the authors, the dependence of the efficiency of investments on the level of debt financing within a wide range of values of equity costs and debt capital costs under different project terms (long –term projects as well as projects of arbitrary duration) and different investment profitability coefficients β is investigated. The effectiveness of investments is determined by Net Present Value, NPV. The study is conducted within the framework of investment models with debt repayment at the end of the project term. It is found that NPV depends practically linearly on leverage level L, increasing or decreasing depending on profitability coefficient β and credit rate values k_d. The cut off credit rate values k_d*, separating the range of increasing NPV(L) from range of decreasing NPV(L), are determined. The Central Bank should keep its key rate at the level which allow commercial banks keep their credit rates below the cut off credit rate k_d* values in order to create and maintain a favorable investment climate in the country.

Keywords: Central Bank, commercial banks, a favorable investment climate, credit rate, key rate, profitability coefficient.

1. INTRODUCTION

The investments play a very important role in an economy of each country. As a rule the debt financing is always used in the investments. In current paper we determine the role of the Central Bank and commercial banks in creating and maintaining of a favorable investment climate in the country. Within the framework of modern investment models created by the authors, the dependence of the efficiency of investments on the level of debt financing within a wide range of values of equity capital costs and debt capital costs under different project terms (long –term projects as well as projects of arbitrary duration) and different investment profitability coefficients β is investigated. The effectiveness of investments is determined by Net Present Value, NPV. The study is conducted within the framework of investment models with debt repayment at the end of the project term.

It is found that NPV depends practically linearly on leverage level L, increasing or decreasing depending on profitability coefficient β and credit rate values k_d. The cut off credit rate values k_d*, separating the range of increasing NPV(L) from range of decreasing NPV(L) are determined. The Central Bank should keep its key rate at the level which allow to commercial banks keep their credit rates below the cut off credit rate values k_d*in order to create and maintain a favorable investment climate in the country.

2. INVESTMENT MODELS WITH DEBT REPAYMENT AT THE END OF THE PROJECT

The effectiveness of the investment project could be considered from two perspectives: the owners of equity and debt and the equity holders only. For each of these cases, NPV could be calculated in two ways: with the division of credit and investment flows (and thus discounting of the payments using two different rates) and without such a division (in this case, both flows are discounted using the same rate, as which can be,

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obviously, chosen WACC). For each of the four situations, two cases could be considered: (1) a constant value of equity S and (2) a constant value of the total invested capital $I = S + D$ (D is value of debt funds).

As it was stated above, the effectiveness of the investment project is considered from two perspectives: the owners of equity and debt and the equity holders only. In the first case, the interest and duty paid by owners of equity (negative flows) returned to the project because they are exactly equal to the flow (positive), obtained by owners of debt capital. The only effect of leverage in this case is the effect of the tax shield, generated from the tax relief: interest on the loan is entirely included into the cost and thus reduces the tax base. After–tax flow of capital for each period in this case is equal to

$$\mathrm{NOI}\left(1-t\right)+k_{\mathrm{d}}Dt \tag{1}$$

and the value of investments at the initial time moment $T=0$ is equal to $-I = -S - D$.

Here NOI stands for net operating income (before taxes).

In the second 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 $k_{\mathrm{d}}\ Dt$ it includes a payment of interest on a loan $-k_{\mathrm{d}}D$):

$$\left(\mathrm{NOI}-k_{\mathrm{d}}D\right)\left(1-t\right). \tag{2}$$

Here, for simplicity, we suppose that interest on the loan will be paid in equal shares $k_{\mathrm{d}}\ D$ 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 $k_{\mathrm{e}} > k_{\mathrm{d}}; k_{\mathrm{p}} > k_{\mathrm{d}}$. 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.

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

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

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

$$\begin{aligned}\mathrm{NPV} &= -S+\frac{\mathrm{NOI}\left(1-t\right)-k_{\mathrm{d}}D\left(1-t\right)}{\mathrm{WACC}}\\ &\left(1-\frac{1}{\left(1+\mathrm{WACC}\right)^{n}}\right)-\frac{D}{\left(1+\mathrm{WACC}\right)^{n}},\end{aligned} \tag{4}$$

$$\begin{aligned}\mathrm{NPV} &= -S\left[1+\frac{Lk_{\mathrm{d}}\left(1-t\right)}{\mathrm{WACC}}\left(1-\frac{1}{\left(1+\mathrm{WACC}\right)^{n}}\right)+\frac{L}{\left(1+\mathrm{WACC}\right)^{n}}\right]\\ &\quad+\frac{\beta S\left(1+L\right)\left(1-t\right)}{\mathrm{WACC}}\left(1-\frac{1}{\left(1+\mathrm{WACC}\right)^{n}}\right).\end{aligned} \tag{5}$$

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

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

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

$$\text{NPV} = -S + \frac{\text{NOI}\left(1-t\right) - k_{\text{d}} D\left(1-t\right)}{\text{WACC}} \tag{7}$$

Substituting $D = LS$, we get

$$\begin{aligned}\text{NPV} &= -S\left[1 + \frac{Lk_{\text{d}}\left(1-t\right)}{\text{WACC}}\right] + \frac{\text{NOI}\left(1-t\right)}{\text{WACC}} \\ &= -S\left[1 + \frac{Lk_{\text{d}}\left(1-t\right)}{k_0\left(1 - Lt/\left(1+L\right)\right)}\right] + \frac{\beta S\left(1+L\right)\left(1-t\right)}{k_0\left(1 - Lt/\left(1+L\right)\right)}.\end{aligned} \tag{8}$$

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

$$WACC = k_0\left(1 - \frac{Lt}{1+L}\right). \tag{9}$$

Below we will investigate the dependence of the efficiency of investments on the level of debt financing within a wide range of values of equity costs k_0 and debt capital costs k_d under different project terms (long–term projects as well as projects of arbitrary duration) and different investment profitability coefficients β.

For long–term project calculations we use formulas (8) and (9), while for arbitrary duration project calculations we use formula (5) for NPV and BFO formula for WACC

$$\frac{1-\left(1+\text{WACC}\right)^{-n}}{\text{WACC}} = \frac{1-\left(1+k_0\right)^{-n}}{k_0\left[1-\omega_{\text{d}}T\left(1-\left(1+k_{\text{d}}\right)^{-n}\right)\right]}. \tag{10}$$

Here, S is the value of equity capital of the company, $w_{\text{d}} = \frac{D}{D+S}$ – the share of debt capital, $k_{\text{e}}, w_{\text{e}} = \frac{S}{D+S}$ – the cost and the share of the equity capital of the company, and $L = D/S$—financial leverage.

3. MODIGLIANI–MILLER LIMIT (LONG –TERM (PERPETUITY) PROJECTS)

Let us start from the long–term projects. We will study the dependence of the efficiency of investments on the level of debt financing *L* for the values of equity costs k_0 from 6% up to 32% and for different debt capital costs and different investment profitability coefficient β values.

3.1. The Dependence of the Efficiency of Investments NPV on the Level of Debt Financing *L* for the Values of Equity Costs k_0=0.2

Below we represent the results of calculations for equity costs k_0=0.2; debt capital costs k_d=0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; *S*=250; tax on profit rate *t*=0.2.

Results are shown in Tables **1-3** and Figures **1-3**.

1. β = 0.1

From Table **1** and Figure **1** it is seen that NPV depends practically linearly on leverage level L, increasing or decreasing depending on credit rate value k_d. NPV(L) increases at credit rate k_d=0.06 and k_d=0.08. The cut off credit rate k_d* values, separating the range of increasing NPV(L) from range of decreasing NPV(L) for investment profitability coefficient β =0.1, is equal to 0.1. At higher credit rate k_d values NPV(L) represents decreasing function.

2. β = 0.12

From Table **2** and Figure **2** it is seen that NPV depends practically linearly on leverage level L, increasing or decreasing depending on credit rate value k_d. NPV(L) increases at credit rate k_d=0.06; k_d=0.08 and k_d=0.1. The cut off credit rate values k_d*, separating the range of increasing NPV(L) from range of decreasing NPV(L) for investment profitability coefficient β =0.12, is equal to 0.12. At higher credit rate k_d values NPV(L) represents decreasing function.

3. β = 0.14

From Table **3** and Figure **3** it is seen that NPV depends practically linearly on leverage level L, increasing or decreasing depending on credit rate value k_d. NPV(L) increases at credit rate k_d=0.06; k_d=0.08; k_d=0.1 and k_d=0.12. The cut off credit rate k_d* values separating the range of increasing NPV(L) from range of decreasing NPV(L) for investment profitability coefficient β =0.14 is equal to 0.14. At higher credit rate k_d values NPV(L) represents decreasing function.

One can see that the cut off credit rate k_d* values separating the range of increasing NPV(L) from range of decreasing NPV(L) strongly correlates with investment profitability coefficient β and practically linearly depends on it.

For long–term projects (Modigliani–Miller limit) it was found that the cut off credit rate values k_d* are proportional to investment profitability coefficients β: it

Table 1:

L	NPV (kd=0.18)	NPV (kd=0.16)	NPV (kd=0.14)	NPV (kd=0.12)	NPV (kd=0.1)	NPV (kd=0.08)	NPV (kd=0.06)
0	–150.00	–150.00	–150.00	–150.00	–150.00	–150.00	–150.00
1	–227.78	–205.56	–183.33	–161.11	–138.89	–116.67	–94.44
2	–319.23	–273.08	–226.92	–180.77	–134.62	–88.46	–42.31
3	–414.71	–344.12	–273.53	–202.94	–132.35	–61.76	8.82
4	–511.90	–416.67	–321.43	–226.19	–130.95	–35.71	59.52
5	–610.00	–490.00	–370.00	–250.00	–130.00	–10.00	110.00
6	–708.62	–563.79	–418.97	–274.14	–129.31	15.52	160.34
7	–807.58	–637.88	–468.18	–298.48	–128.79	40.91	210.61
8	–906.76	–712.16	–517.57	–322.97	–128.38	66.22	260.81
9	–1006.10	–786.59	–567.07	–347.56	–128.05	91.46	310.98
10	–1105.56	–861.11	–616.67	–372.22	–127.78	116.67	361.11

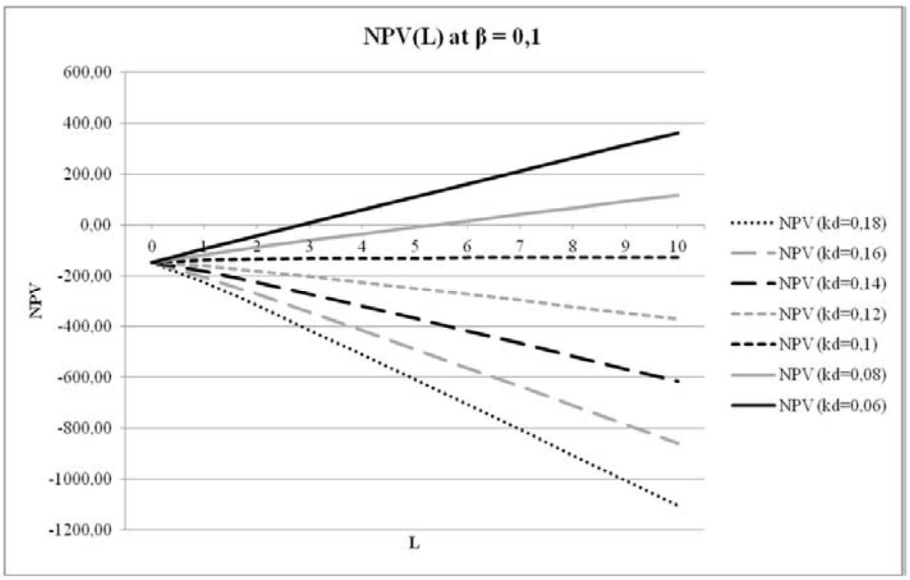

Figure 1: The dependence of the Net Present Value, NPV on the leverage level L for the equity value k_0=20% and for different debt capital costs k_d=0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2 and investment profitability coefficient β =0.1.

Table 2:

L	NPV (kd=0.18)	NPV (kd=0.16)	NPV (kd=0.14)	NPV (kd=0.12)	NPV (kd=0.1)	NPV (kd=0.08)	NPV (kd=0.06)
0	–130.00	–130.00	–130.00	–130.00	–130.00	–130.00	–130.00
1	–183.33	–161.11	–138.89	–116.67	–94.44	–72.22	–50.00
2	–250.00	–203.85	–157.69	–111.54	–65.38	–19.23	26.92
3	–320.59	–250.00	–179.41	–108.82	–38.24	32.35	102.94
4	–392.86	–297.62	–202.38	–107.14	–11.90	83.33	178.57
5	–466.00	–346.00	–226.00	–106.00	14.00	134.00	254.00
6	–539.66	–394.83	–250.00	–105.17	39.66	184.48	329.31
7	–613.64	–443.94	–274.24	–104.55	65.15	234.85	404.55
8	–687.84	–493.24	–298.65	–104.05	90.54	285.14	479.73
9	–762.20	–542.68	–323.17	–103.66	115.85	335.37	554.88
10	–836.67	–592.22	–347.78	–103.33	141.11	385.56	630.00

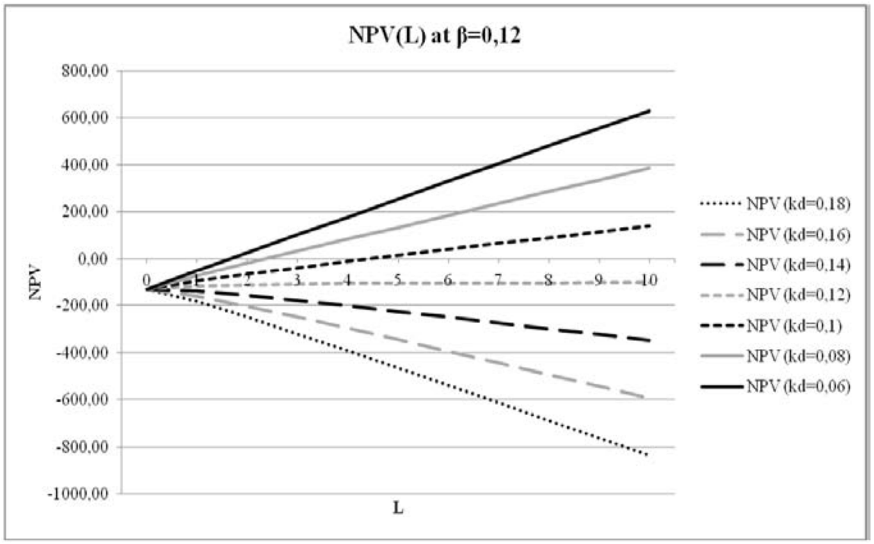

Figure 2: The dependence of the Net Present Value, NPV, on the leverage level L for the equity value k_0=20% and for different debt capital costs k_d=0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2 and investment profitability coefficient β =0.12.

Table 3:

L	NPV (kd=0.18)	NPV (kd=0.16)	NPV (kd=0.14)	NPV (kd=0.12)	NPV (kd=0.1)	NPV (kd=0.08)	NPV (kd=0.06)
0	–110.00	–110.00	–110.00	–110.00	–110.00	–110.00	–110.00
1	–138.89	–116.67	–94.44	–72.22	–50.00	–27.78	–5.56
2	–180.77	–134.62	–88.46	–42.31	3.85	50.00	96.15
3	–226.47	–155.88	–85.29	–14.71	55.88	126.47	197.06
4	–273.81	–178.57	–83.33	11.90	107.14	202.38	297.62
5	–322.00	–202.00	–82.00	38.00	158.00	278.00	398.00
6	–370.69	–225.86	–81.03	63.79	208.62	353.45	498.28
7	–419.70	–250.00	–80.30	89.39	259.09	428.79	598.48
8	–468.92	–274.32	–79.73	114.86	309.46	504.05	698.65
9	–518.29	–298.78	–79.27	140.24	359.76	579.27	798.78
10	–567.78	–323.33	–78.89	165.56	410.00	654.44	898.89

turns out that for equity capital cost $\mathbf{k_0=0.2}$ the cut off credit rate values k_d* separating the range of increasing NPV(L) from range of decreasing NPV(L) are approximately equal to investment profitability coefficient β: for investment profitability coefficient β =0.1 k_d* is equal to 0.1; for β=0.12 k_d* is equal to 0.12; and for investment profitability coefficient β =0.14 k_d* is equal to 0.14. The slope of the curve NPV(L) increases with investment profitability coefficient β for the same value of credit rate k_d.

3.2. The Dependence of the Efficiency of Investments NPV on the Level of Debt Financing L for the Value of Equity Costs k_0=0.28

Let us consider also the case of equity capital cost k_0=0,28 and debt capital cost k_d=6%;8%;10%;12%; 14%;16%;18%;20%;22%;24%.

It is seen from Figure **4** that the cut off credit rate k_d* value separating the range of increasing NPV(L) from range of decreasing NPV(L) is equal to 10%.

It is seen from Figure **5** that the cut off credit rate value k_d*, separating the range of increasing NPV(L) from range of decreasing NPV(L), is equal to 20%.

From Figures **4** and **5** it follows that for β =0.1 k_d* is equal to 0.1; and for investment profitability coefficient β =0.2 k_d* is equal to 0.2.

We could come to conclusion that in perpetuity limit for both cases for the equity values k_0=20% and k_0=28% it turns out that the cut off credit rate k_d* values are equal to investment profitability coefficient β (and does not depend on the equity values k_0).

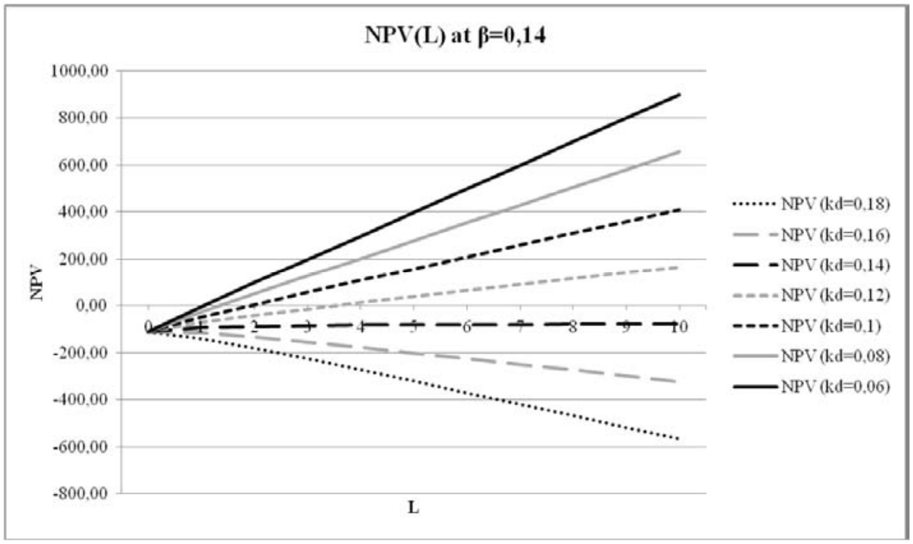

Figure 3: The dependence of the Net Present Value, NPV, on the leverage level L for the equity value k_0=20% and for different debt capital costs k_d=0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2 and investment profitability coefficient β =0.14.

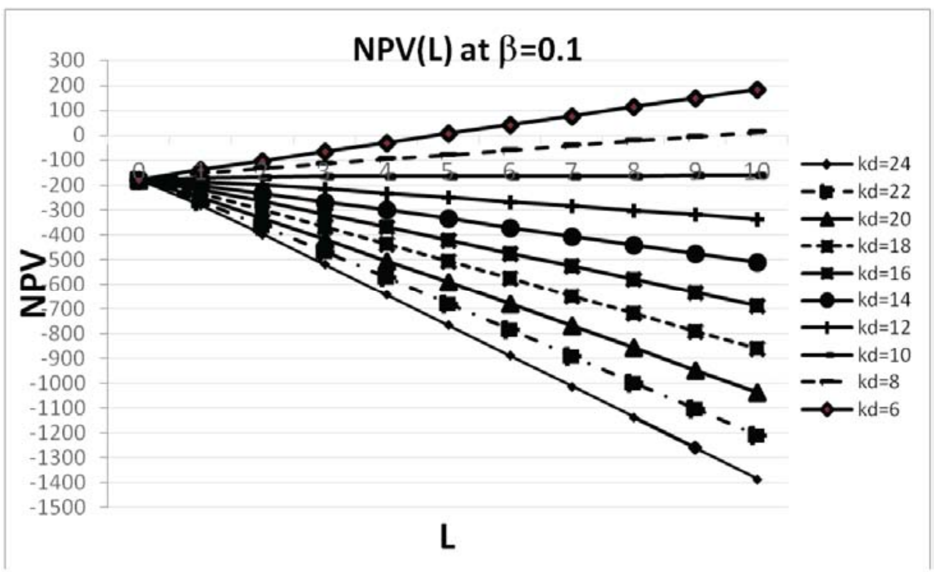

Figure 4: The dependence of the Net Present Value, NPV on the leverage level L for the equity value k_0=28% and for different debt capital costs k_d=6%;8%;10%;12%;14%;16%;18%;20%;22%;24%; S=250; tax on profit rate t=0,2 and investment profitability coefficient β =0.1.

As we will see below this statement is not valid for the projects of arbitrary durations.

4. PROJECTS OF FINITE (ARBITRARY) DURATION

Let us consider now the projects of arbitrary durations. We will study the dependence of the efficiency of investments on the level of debt financing L for the same values of equity costs k_0 from 6% up to 32%; for different debt capital costs k_d and different investment profitability coefficient β values as well as for different project durations.

For arbitrary duration project calculations we use formula (5) for NPV

$$\mathrm{NPV} = -S\left[1+\frac{Lk_{\mathrm{d}}(1-t)}{\mathrm{WACC}}\left(1-\frac{1}{(1+\mathrm{WACC})^n}\right)+\frac{L}{(1+\mathrm{WACC})^n}\right] + \frac{\beta S(1+L)(1-t)}{\mathrm{WACC}}\left(1-\frac{1}{(1+\mathrm{WACC})^n}\right).$$

and BFO formula (10) for WACC

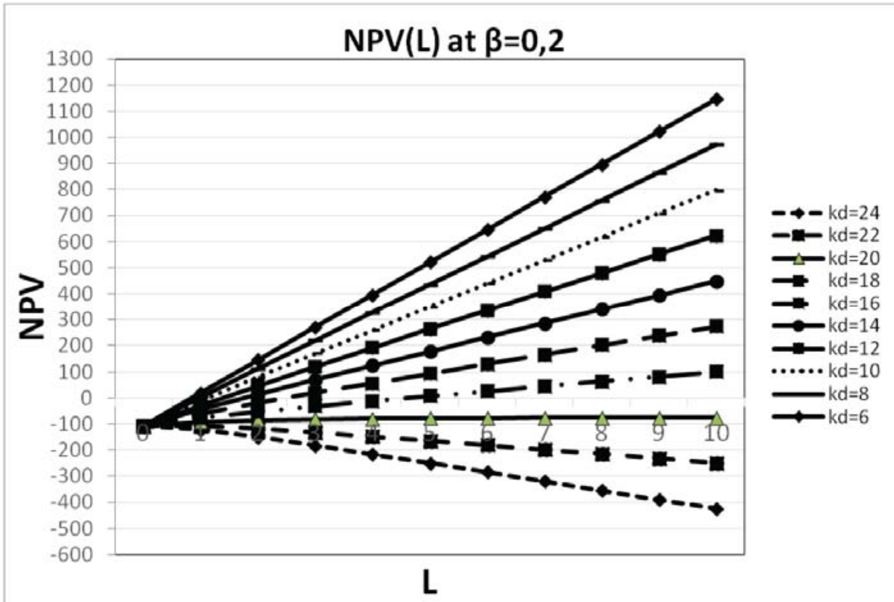

Figure 5: The dependence of the Net Present Value, NPV on the leverage level L for the equity value k_0=28% and for different debt capital costs k_d=6%;8%;10%;12%;14%;16%;18%;20%;22%;24%; S=250; tax on profit rate t=0,2 and investment profitability coefficient β =0.2.

$$\frac{1-\left(1+\mathrm{WACC}\right)^{-n}}{\mathrm{WACC}}=\frac{1-\left(1+k_0\right)^{-n}}{k_0\left[1-\omega_d T\left(1-\left(1+k_d\right)^{-n}\right)\right]}.$$

4.1. The Dependence of the Efficiency of Investments NPV on the Level of Debt Financing L for the Values of Equity Costs k_0=0.2

Below we represent the results of calculations for equity costs k_0=0.2; debt capital costs k_d=0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0.2 and project duration n=5. In next part we will compare the results for project durations n=5 and n=3.

For arbitrary duration project calculations we use formula (5) for NPV and BFO formula for WACC (10).

Results are shown in Tables **4-6** and Figures **4-6**.

1. β = 0.325

From Table **4** and Figure **6** it is seen that NPV depends practically linearly on leverage level L, increasing or decreasing depending on credit rate value k_d. NPV(L) increases at credit rate k_d=0.06; k_d=0.08; k_d=0.1 and k_d=0.12. The cut off credit rate value k_d*, separating the range of increasing NPV(L) from range of decreasing NPV(L) for investment

Table 4:

L	NPV (kd=0.18)	NPV (kd=0.16)	NPV (kd=0.14)	NPV (kd=0.12)	NPV (kd=0.1)	NPV (kd=0.08)	NPV (kd=0.06)
0	–55.62	–55.62	–55.62	–55.62	–55.62	–55.62	–55.62
1	–64.27	–51.88	–39.78	–27.84	–16.10	–4.63	6.60
2	–84.87	–58.97	–33.37	–8.12	16.70	41.06	64.88
3	–109.00	–69.04	–29.55	9.40	47.74	85.35	122.14
4	–134.55	–80.39	–26.81	26.01	78.04	129.06	178.95
5	–160.82	–92.33	–24.61	42.16	107.96	172.47	235.56
6	–187.68	–104.63	–22.73	58.04	137.67	215.71	292.05
7	–214.48	–117.19	–21.05	73.87	167.24	258.85	348.47
8	–241.83	–129.90	–19.51	89.50	196.72	301.91	404.83
9	–269.07	–142.72	–18.06	105.05	226.13	344.92	461.15
10	–296.16	–155.62	–16.68	120.54	255.50	387.89	517.45

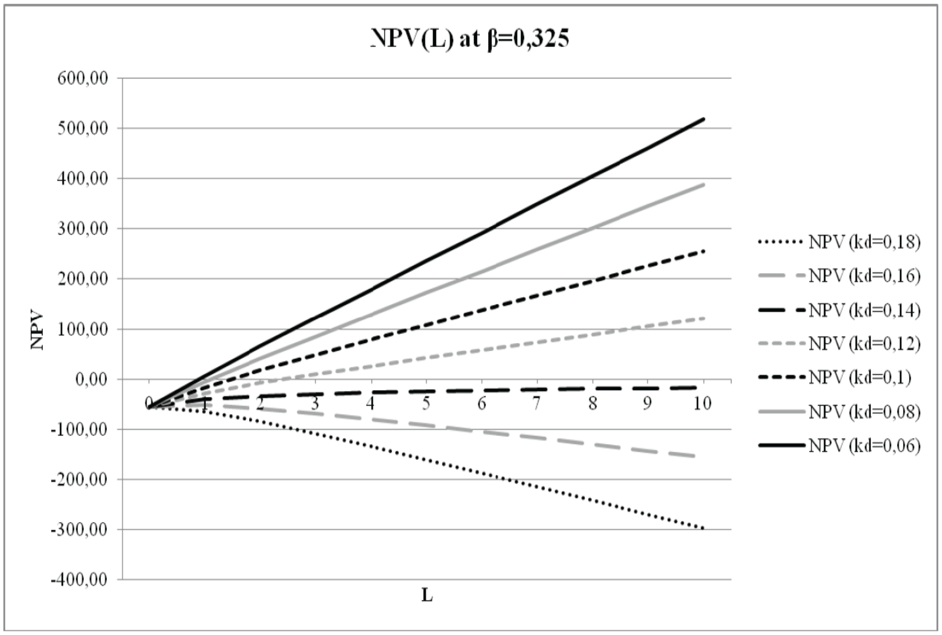

Figure 6: The dependence of the Net Present Value, NPV, on the leverage level L for the equity value k_0=20% and for different debt capital costs k_d=0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2; investment profitability coefficient β =0.325 and project duration n=5.

profitability coefficient β =0.325, is equal to 0.14. At higher credit rates k_d values NPV(L) represents decreasing function.

2. β = 0.345

From Table **5** and Figure **7** it is seen that NPV depends practically linearly on leverage level L, increasing or decreasing depending on credit rate value k_d. NPV(L) increases at credit rates k_d=0.06; k_d=0.08; k_d=0.1; k_d=0.12 and k_d=0.14. The cut off credit rate value k_d*, separating the range of increasing NPV(L) from range of decreasing NPV(L) for investment profitability coefficient β =0.345 is equal to 0.16. At higher credit rates k_d values NPV(L) represents decreasing function.

3. β = 0.365

From Table **6** and Figure **8** it is seen that NPV depends practically linearly on leverage level L, increasing or decreasing depending on credit rate value k_d. NPV(L) increases at credit rate k_d=0.06; k_d=0.08; k_d=0.1; k_d=0.12; k_d=0.14 and k_d=0.16. The cut off credit rate value k_d*, separating the range of increasing NPV(L) from the range of decreasing

Table 5:

L	NPV (kd=0.18)	NPV (kd=0.16)	NPV (kd=0.14)	NPV (kd=0.12)	NPV (kd=0.1)	NPV (kd=0.08)	NPV (kd=0.06)
0	–43.66	–43.66	–43.66	–43.66	–43.66	–43.66	–43.66
1	–38.96	–26.63	–14.64	–2.83	8.77	20.08	31.15
2	–46.07	–20.39	4.97	29.97	54.50	78.55	102.02
3	–56.74	–17.11	22.02	60.58	98.47	135.61	171.89
4	–68.82	–15.10	37.99	90.29	141.71	192.09	241.28
5	–81.62	–13.68	53.42	119.54	184.58	248.28	310.49
6	–94.98	–12.63	68.53	148.51	227.22	304.31	379.58
7	–108.32	–11.83	83.45	177.41	269.74	360.22	448.59
8	–122.17	–11.18	98.22	206.13	312.16	416.07	517.55
9	–135.93	–10.64	112.91	234.77	354.52	471.86	586.48
10	–149.58	–10.18	127.53	263.36	396.83	527.61	655.38

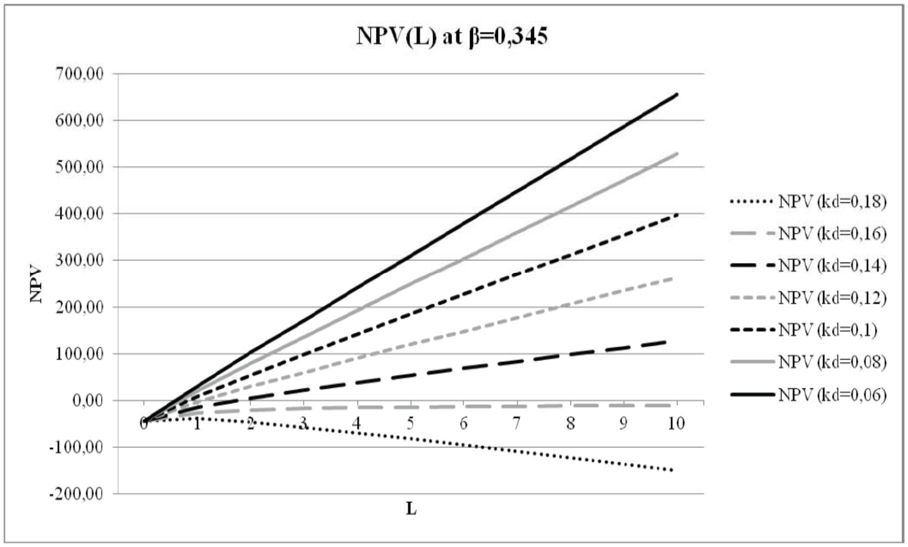

Figure 7: The dependence of the Net Present Value, NPV, on the leverage level L for the equity value k_0=20% and for different debt capital costs k_d=0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; *S*=250; tax on profit rate *t*=0,2; investment profitability coefficient β =0.345 and project duration n=5.

Table 6:

L	NPV (kd=0.18)	NPV (kd=0.16)	NPV (kd=0.14)	NPV (kd=0.12)	NPV (kd=0.1)	NPV (kd=0.08)	NPV (kd=0.06)
0	–31.70	–31.70	–31.70	–31.70	–31.70	–31.70	–31.70
1	–13.65	–1.39	10.49	22.18	33.65	44.80	55.69
2	–7.27	18.20	43.32	68.06	92.30	116.03	139.16
3	–4.48	34.82	73.59	111.76	149.21	185.87	221.64
4	–3.08	50.20	102.79	154.56	205.39	255.13	303.62
5	–2.41	64.96	131.45	196.91	261.19	324.10	385.43
6	–2.27	79.37	159.80	238.99	316.78	392.90	467.11
7	–2.17	93.53	187.94	280.94	372.24	461.60	548.72
8	–2.50	107.54	215.96	322.76	427.60	530.22	630.28
9	–2.79	121.44	243.87	364.50	482.91	598.80	711.81
10	–3.01	135.26	271.73	406.18	538.16	667.33	793.30

NPV(L) for investment profitability coefficient β =0.365, is equal to 0.18. At higher credit rates k_d values NPV(L) represents decreasing function.

One can see that the cut off credit rate values k_d*, separating the range of increasing NPV(L) from the range of decreasing NPV(L), strongly correlate with investment profitability coefficient β and practically linearly depends on it: k_d* linearly increases with profitability coefficient β.

For arbitrary duration projects results are as following. The efficiency of investments strongly depends on project duration and increases with duration. One can see, that the slope of the curve NPV(L) at project duration n=5 is always higher, than for project duration n=3. The efficiency of investments increases with project duration and is less than for long–term (perpetuity) projects. Transition to increasing NPV(L) behavior for finite duration projects requires much higher values of investment profitability coefficient β than in case of long–term (perpetuity) projects, where k_d* is approximately equal to β : for five–years projects the cut off credit rate values k_d* for investment profitability coefficient β =0.325 is equal to 0.14; for investment profitability coefficient β =0.345 is equal to 0.16; for investment profitability coefficient β =0.365 is equal to 0.18. Thus, for finite duration projects as well as for the long–term projects cut off credit rate values k_d* turn out to be proportional to

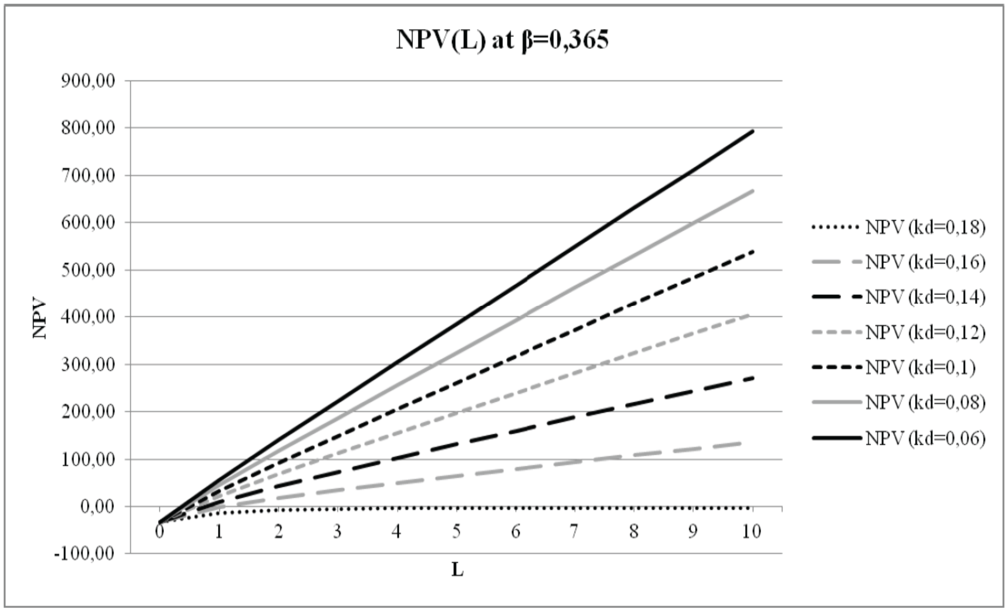

Figure 8: The dependence of the Net Present Value, NPV, on the leverage level L for the equity value k_0=20% and for different debt capital costs k_d=0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; *S*=250; tax on profit rate *t*=0,2; investment profitability coefficient β =0.365 and project duration n=5.

investment profitability coefficients β, but investment profitability coefficients β, is approximately twice higher than k_d*.

4.2. The Dependence of the Efficiency of Investments NPV on the Level of Debt Financing L for the Values of Equity Costs k_0=0.28

Below at Figures **9-12** we present the results of calculations of the dependence of the Net Present Value, NPV, on the leverage level L for the equity value k_0=28% and for different debt capital costs k_d=0.24; 0.22;0.20;0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2; investment profitability coefficient β =0.1 and project durations n=3 and n=5.

From the Figures **9-12** one can make the following conclusions:

1. NPV decreases with debt capital cost k_d.
2. NPV increases with investment profitability coefficient β as well as with project duration.

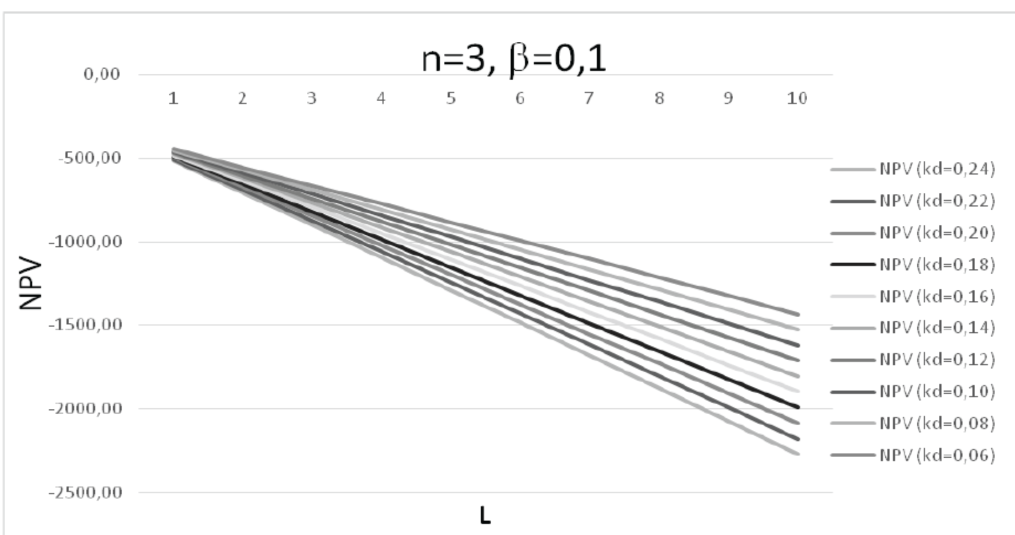

Figure 9: The dependence of the Net Present Value, NPV on the leverage level L for the equity value k_0=28% and for different debt capital costs k_d=0.24;0.22;0.20;0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2; investment profitability coefficient β =0.1 and project duration n=3.

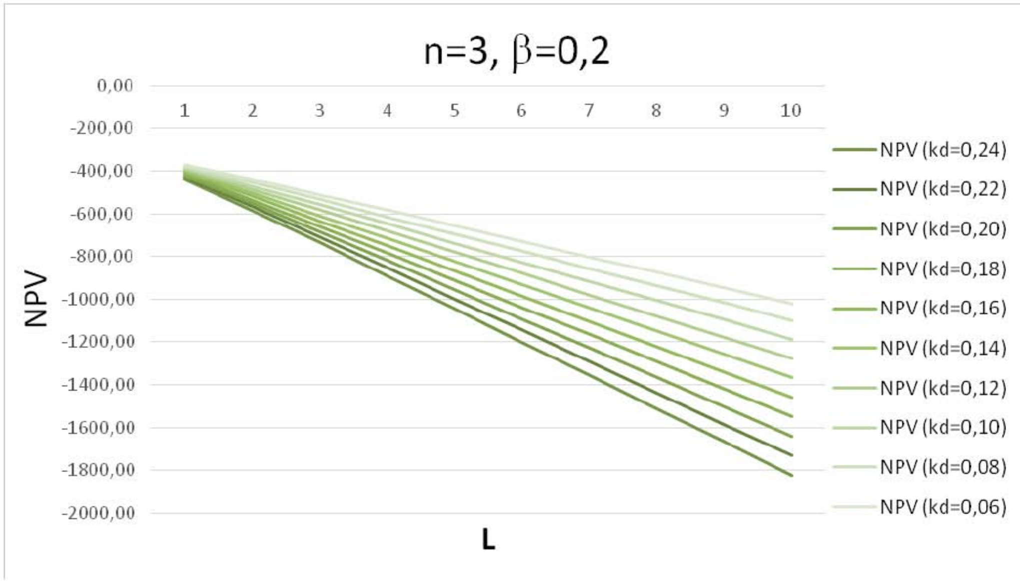

Figure 10: The dependence of the Net Present Value, NPV on the leverage level L for the equity value k_0=28% and for different debt capital costs k_d=0.24;0.22;0.20;0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2; investment profitability coefficient β =0.2 and project duration n=3.

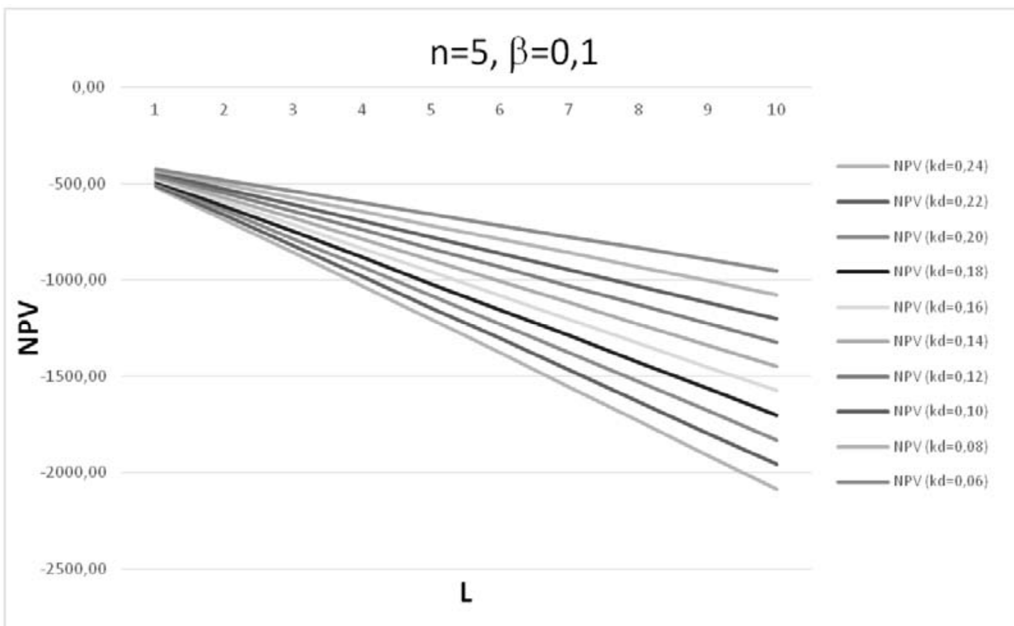

Figure 11: The dependence of the Net Present Value, NPV on the leverage level L for the equity value k_0=28% and for different debt capital costs k_d=0.24;0.22;0.20;0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2; investment profitability coefficient β =0.1 and project duration n=5.

3. The cut off value k_d^* has been reached at Figures **9-12** only at profitability coefficient β=0.2 for 5-year project and is equal to 6%; it will increases with investment profitability coefficient β. Bigger values of β, and/or longer durations n, and/or bigger values of equity capital *S* are required in order to demonstrate the presence of a cut off value k_d^* for particular project.

5. THE DEPENDENCE OF THE NET PRESENT VALUE, NPV, ON THE LEVERAGE LEVEL L FOR PROJECTS OF DIFFERENT DURATIONS

We consider the case of equity cost (at L=0) k_0=14% and fixed value of debt cost k_d=0,04; 0,06; 0,08; 0,1; 0,12 and compare the results for projects of different duration: n=3 years and n=5 years.

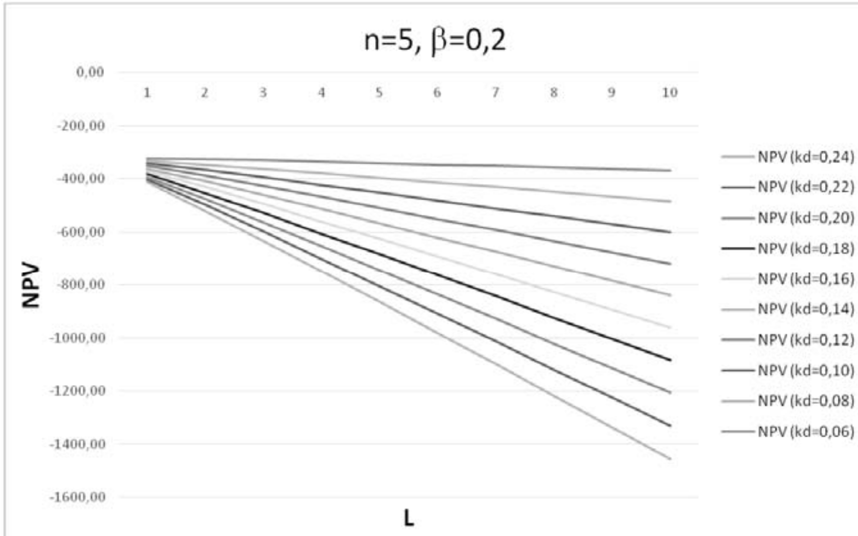

Figure 12: The dependence of the Net Present Value, NPV, on the leverage level L for the equity value k_0=28% and for different debt capital costs k_d=0.24;0.22;0.20;0.18; 0.16; 0.14; 0.12; 0.10; 0.08; 0.06; S=250; tax on profit rate t=0,2; investment profitability coefficient β=0.2 and project duration n=5.

Table 7:

S	L	WACC	k_0	k_d	w_d	t	n	β	k_e	NPV
250	0	14.00%	0.14	0.04	0.00	0.2	3	0.1	0.14	–203.57
250	1	13.34%	0.14	0.04	0.50	0.2	3	0.1	0.23	–346.60
250	2	13.11%	0.14	0.04	0.67	0.2	3	0.1	0.33	–491.78
250	3	13.00%	0.14	0.04	0.75	0.2	3	0.1	0.42	–637.53
250	4	12.94%	0.14	0.04	0.80	0.2	3	0.1	0.52	–783.49
250	5	12.89%	0.14	0.04	0.83	0.2	3	0.1	0.61	–929.57
250	6	12.86%	0.14	0.04	0.86	0.2	3	0.1	0.71	–1075.71
250	7	12.84%	0.14	0.04	0.88	0.2	3	0.1	0.80	–1221.89
250	8	12.82%	0.14	0.04	0.89	0.2	3	0.1	0.90	–1368.10
250	9	12.80%	0.14	0.04	0.90	0.2	3	0.1	0.99	–1514.33
250	10	12.79%	0.14	0.04	0.91	0.2	3	0.1	1.09	–1660.57

Table 8:

S	L	WACC	k_0	k_d	w_d	t	n	β	k_e	NPV
250	0	14.00%	0.14	0.04	0.00	0.2	5	0.1	0.14	–181.34
250	1	13.26%	0.14	0.04	0.50	0.2	5	0.1	0.23	–272.31
250	2	13.01%	0.14	0.04	0.67	0.2	5	0.1	0.33	–366.58
250	3	12.88%	0.14	0.04	0.75	0.2	5	0.1	0.42	–461.70
250	4	12.80%	0.14	0.04	0.80	0.2	5	0.1	0.51	–557.17
250	5	12.75%	0.14	0.04	0.83	0.2	5	0.1	0.61	–652.81
250	6	12.72%	0.14	0.04	0.86	0.2	5	0.1	0.70	–748.55
250	7	12.69%	0.14	0.04	0.88	0.2	5	0.1	0.79	–844.36
250	8	12.67%	0.14	0.04	0.89	0.2	5	0.1	0.88	–940.21
250	9	12.65%	0.14	0.04	0.90	0.2	5	0.1	0.98	–1036.09
250	10	12.64%	0.14	0.04	0.91	0.2	5	0.1	1.07	–1131.99

Table 9:

S	L	WACC	k_0	k_d	w_d	t	n	β	k_e	NPV
250	0	14.00%	0.14	0.04	0.00	0.2	3	0.2	0.14	–157.14
250	1	13.34%	0.14	0.04	0.50	0.2	3	0.2	0.23	–252.69
250	2	13.11%	0.14	0.04	0.67	0.2	3	0.2	0.33	–350.39
250	3	13.00%	0.14	0.04	0.75	0.2	3	0.2	0.42	–448.64
250	4	12.94%	0.14	0.04	0.80	0.2	3	0.2	0.52	–547.12
250	5	12.89%	0.14	0.04	0.83	0.2	3	0.2	0.61	–645.71
250	6	12.86%	0.14	0.04	0.86	0.2	3	0.2	0.71	–744.36
250	7	12.84%	0.14	0.04	0.88	0.2	3	0.2	0.80	–843.05
250	8	12.82%	0.14	0.04	0.89	0.2	3	0.2	0.90	–941.77
250	9	12.80%	0.14	0.04	0.90	0.2	3	0.2	0.99	–1040.51
250	10	12.79%	0.14	0.04	0.91	0.2	3	0.2	1.09	–1139.26

Table 10:

S	L	WACC	k_0	k_d	w_d	t	n	β	k_e	NPV
250	0	14.00%	0.14	0.04	0.00	0.2	5	0.2	0.14	–112.68
250	1	13.26%	0.14	0.04	0.50	0.2	5	0.2	0.23	–132.50
250	2	13.01%	0.14	0.04	0.67	0.2	5	0.2	0.33	–155.57
250	3	12.88%	0.14	0.04	0.75	0.2	5	0.2	0.42	–179.49
250	4	12.80%	0.14	0.04	0.80	0.2	5	0.2	0.51	–203.76
250	5	12.75%	0.14	0.04	0.83	0.2	5	0.2	0.61	–228.20
250	6	12.72%	0.14	0.04	0.86	0.2	5	0.2	0.70	–252.73
250	7	12.69%	0.14	0.04	0.88	0.2	5	0.2	0.79	–277.33
250	8	12.67%	0.14	0.04	0.89	0.2	5	0.2	0.88	–301.97
250	9	12.65%	0.14	0.04	0.90	0.2	5	0.2	0.98	–326.65
250	10	12.64%	0.14	0.04	0.91	0.2	5	0.2	1.07	–351.34

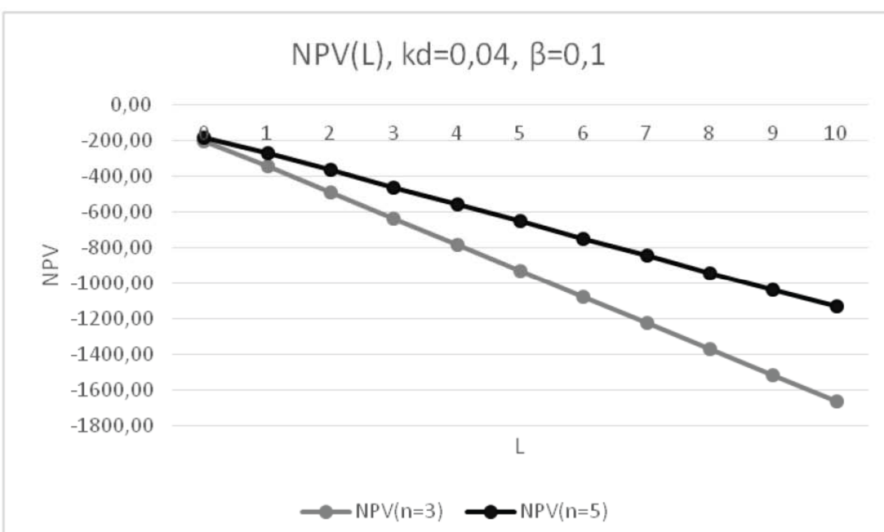

Figure 13: The dependence of the Net Present Value, NPV, on the leverage level L for the equity cost value k_0=14% and for debt capital costs k_d=0.04; S=250; tax on profit rate t=0.2; investment profitability coefficient β =0.1 and for two project durations n=3 and n=5.

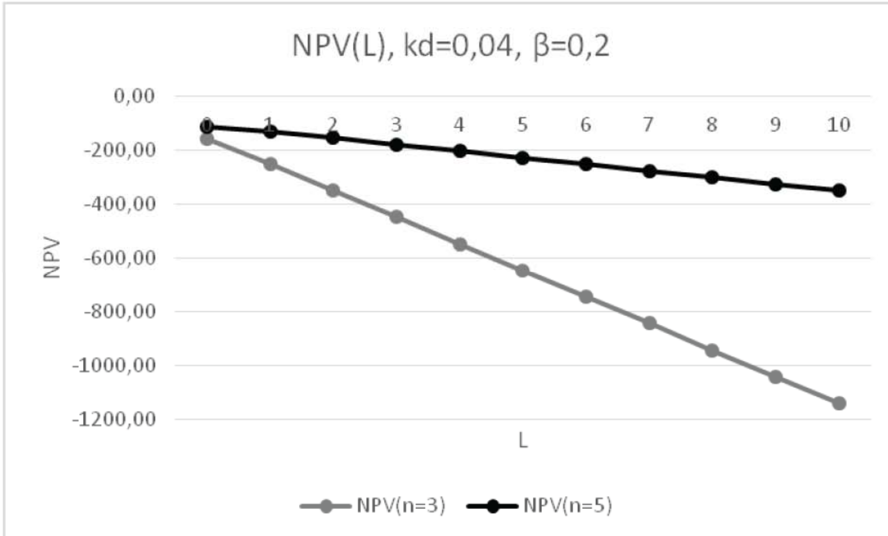

Figure 14: The dependence of the Net Present Value, NPV, on the leverage level L for the equity cost value k_0=14% and for debt capital costs k_d=0.04; S=250; tax on profit rate t=0.2; investment profitability coefficient β =0.2 and for two project durations n=3 and n=5.

kd=0.1

Table 11:

S	L	WACC	k_0	k_d	w_d	t	n	β	k_e	NPV
250	0	14.00%	0.14	0.10	0.00	0.2	3	0.1	0.14	–203.57
250	1	12.51%	0.14	0.10	0.50	0.2	3	0.1	0.17	–377.91
250	2	12.01%	0.14	0.10	0.67	0.2	3	0.1	0.20	–557.74
250	3	11.76%	0.14	0.10	0.75	0.2	3	0.1	0.23	–739.00
250	4	11.61%	0.14	0.10	0.80	0.2	3	0.1	0.26	–920.85
250	5	11.51%	0.14	0.10	0.83	0.2	3	0.1	0.29	–1103.00
250	6	11.44%	0.14	0.10	0.86	0.2	3	0.1	0.32	–1285.31
250	7	11.39%	0.14	0.10	0.88	0.2	3	0.1	0.35	–1467.73
250	8	11.35%	0.14	0.10	0.89	0.2	3	0.1	0.38	–1650.23
250	9	11.31%	0.14	0.10	0.90	0.2	3	0.1	0.41	–1832.77
250	10	11.28%	0.14	0.10	0.91	0.2	3	0.1	0.44	–2015.35

Table 12:

S	L	WACC	k_0	k_d	w_d	t	n	β	k_e	NPV
250	0	14.00%	0.14	0.10	0.00	0.2	5	0.1	0.14	–181.34
250	1	12.41%	0.14	0.10	0.50	0.2	5	0.1	0.17	–317.91
250	2	11.88%	0.14	0.10	0.67	0.2	5	0.1	0.20	–462.97
250	3	11.61%	0.14	0.10	0.75	0.2	5	0.1	0.22	–610.30
250	4	11.45%	0.14	0.10	0.80	0.2	5	0.1	0.25	–758.57
250	5	11.34%	0.14	0.10	0.83	0.2	5	0.1	0.28	–907.31
250	6	11.26%	0.14	0.10	0.86	0.2	5	0.1	0.31	–1056.33
250	7	11.20%	0.14	0.10	0.88	0.2	5	0.1	0.34	–1205.52
250	8	11.16%	0.14	0.10	0.89	0.2	5	0.1	0.36	–1354.83
250	9	11.12%	0.14	0.10	0.90	0.2	5	0.1	0.39	–1504.22
250	10	11.09%	0.14	0.10	0.91	0.2	5	0.1	0.42	–1653.67

Table 13:

S	L	WACC	k_0	k_d	w_d	t	n	β	k_e	NPV
250	0	14.00%	0.14	0.10	0.00	0.2	3	0.2	0.14	–157.14
250	1	12.51%	0.14	0.10	0.50	0.2	3	0.2	0.17	–282.68
250	2	12.01%	0.14	0.10	0.67	0.2	3	0.2	0.20	–413.66
250	3	11.76%	0.14	0.10	0.75	0.2	3	0.2	0.23	–546.07
250	4	11.61%	0.14	0.10	0.80	0.2	3	0.2	0.26	–679.06
250	5	11.51%	0.14	0.10	0.83	0.2	3	0.2	0.29	–812.35
250	6	11.44%	0.14	0.10	0.86	0.2	3	0.2	0.32	–945.80
250	7	11.39%	0.14	0.10	0.88	0.2	3	0.2	0.35	–1079.36
250	8	11.35%	0.14	0.10	0.89	0.2	3	0.2	0.38	–1212.99
250	9	11.31%	0.14	0.10	0.90	0.2	3	0.2	0.41	–1346.67
250	10	11.28%	0.14	0.10	0.91	0.2	3	0.2	0.44	–1480.38

Table 14:

S	L	WACC	k_0	k_d	w_d	t	n	β	k_e	NPV
250	0	14.00%	0.14	0.10	0.00	0.2	5	0.2	0.14	–112.68
250	1	12.41%	0.14	0.10	0.50	0.2	5	0.2	0.17	–175.18
250	2	11.88%	0.14	0.10	0.67	0.2	5	0.2	0.20	–246.02
250	3	11.61%	0.14	0.10	0.75	0.2	5	0.2	0.22	–319.09
250	4	11.45%	0.14	0.10	0.80	0.2	5	0.2	0.25	–393.09
250	5	11.34%	0.14	0.10	0.83	0.2	5	0.2	0.28	–467.55
250	6	11.26%	0.14	0.10	0.86	0.2	5	0.2	0.31	–542.29
250	7	11.20%	0.14	0.10	0.88	0.2	5	0.2	0.34	–617.20
250	8	11.16%	0.14	0.10	0.89	0.2	5	0.2	0.36	–692.22
250	9	11.12%	0.14	0.10	0.90	0.2	5	0.2	0.39	–767.32
250	10	11.09%	0.14	0.10	0.91	0.2	5	0.2	0.42	–842.47

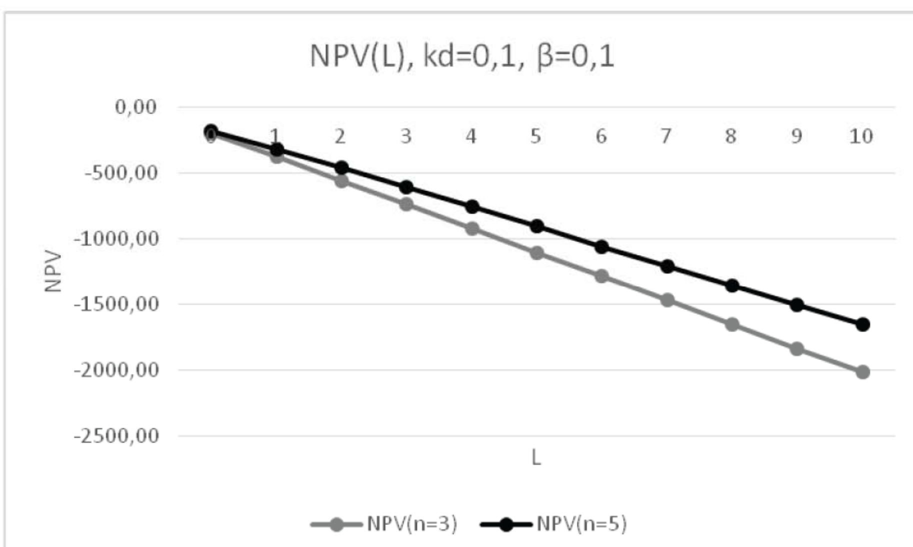

Figure 15: The dependence of the Net Present Value, NPV on the leverage level L for the equity cost value k_0=14% and for debt capital costs k_d=0.1; S=250; tax on profit rate t=0.2; investment profitability coefficient β =0.1 and for two project durations n=3 and n=5.

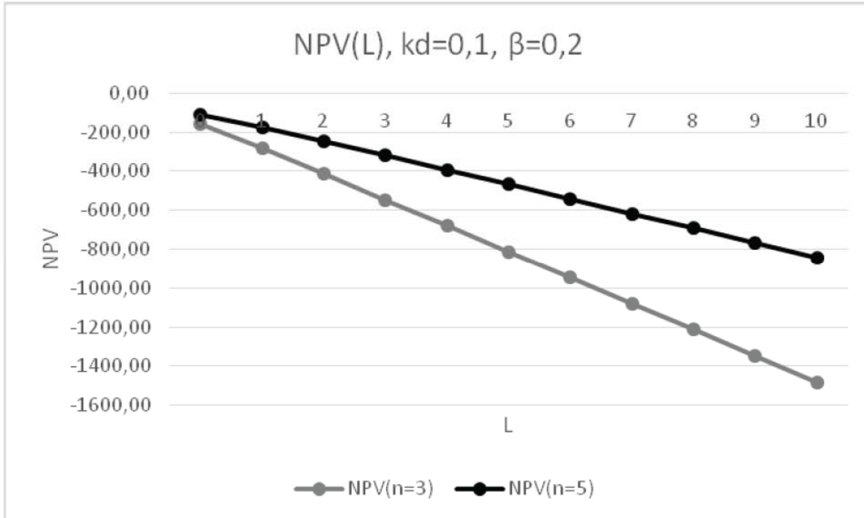

Figure 16: The dependence of the Net Present Value, NPV, on the leverage level L for the equity cost value k_0=14% and for debt capital costs k_d=0.1; S=250; tax on profit rate t=0.2; investment profitability coefficient β =0.2 and for two project durations n=3 and n=5.

One can see, that at fixed credit rates k_0 NPV increases with project duration. The (negative) slope of NPV(L) curves decreases with project duration.

CONCLUSIONS

We study the role of the Central Bank and commercial banks in creating and maintaining of a favorable investment climate in the country. Within the framework of modern investment models created by the authors, the dependence of the efficiency of investments on the level of debt financing within a wide range of values of equity capital costs and debt capital costs under different project terms (long–term projects as well as projects of arbitrary duration) and different investment profitability coefficients β is investigated. The effectiveness of investments is determined by net present value (Net Present Value, NPV). The study is conducted within the framework of investment models with debt repayment at the end of the project term.

It is found that NPV depends practically linearly on leverage level L, increasing or decreasing depending on profitability coefficient β and credit rate value k_d. The cut off credit rate values k_d* separating the range of increasing NPV(L) from range of decreasing NPV(L) are determined.

For long–term projects (Modigliani–Miller limit) it was found that the cut off credit rate values k_d* are proportional to investment profitability coefficients β: it turns out that for equity capital cost k_0=0.2 the cut off credit rate value k_d* separating the range of increasing NPV(L) from range of decreasing NPV(L) is approximately equal to investment profitability coefficient β: for investment profitability coefficient β =0.1 k_d* is equal to 0.1; for β =0.12 k_d* is equal to 0.12; and for investment profitability coefficient β =0.14 k_d* is equal to 0.14. The slope of the curve NPV(L) increases with investment profitability coefficient β for the same value of credit rate k_d.

We come to conclusion that for long–term projects (in perpetuity limit) for both cases for the equity values k_0=20% and k_0=28% it turns out that the cut off credit rate values k_d* are equal to investment profitability coefficient β (and does not depend on the equity values k_0). This statement is not valid for the projects of arbitrary (finite) durations.

For arbitrary duration projects results are as following. The efficiency of investments strongly depends on project duration and increases with duration. One can see, that the slope of the curve NPV(L) at project duration n=5 is always higher, than for project duration n=3. The efficiency of investments increases with project duration and is less than for long–term (perpetuity) projects. Transition to increasing NPV(L) behavior for finite duration projects requires much higher values of investment profitability coefficient β than in case of long–term (perpetuity) projects, where k_d* is approximately equal to β : for example, for equity cost k_0=0.20 and five–years projects the cut off credit rate values k_d* for investment profitability coefficient β =0.325 is equal to 0.14; for investment profitability coefficient β =0.345 is equal to 0.16; for investment profitability coefficient β =0.365 is equal to 0.18. Thus, for finite duration projects as well as for the long–term projects cut off credit rate values k_d* turn out to be proportional to investment profitability coefficients β, but investment profitability coefficients β, is approximately twice higher than k_d*.

We develop a method of determination of the cut off credit rate values k_d*, separating the range of increasing NPV(L) from range of decreasing NPV(L). We have found the cut off credit rate k_d* values within a wide range of values of equity costs k_0 and debt capital costs k_d under different project terms (long–term projects as well as projects of arbitrary duration) and different investment profitability coefficients β. Obtained results will help to the Central Bank to keep its key rate at the level, which allows to commercial banks keep their credit rates below the cut off credit rate values k_d* in order to create and maintain a favorable investment climate in the country.

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