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**NEW DEBT ISSUE  
IN A COMPETITIVE ENVIRONMENT.  
AGENCY COSTS OF DEBT**

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**Summary:** The paper analyzes issues related to equity holder – bondholder conflict on a competitive market. We deal with a model firm which has an opportunity to realize an investment project but the entry of a competitor wastes the value of the firm's investment option – it becomes worthless. The project may be financed by equity or debt. We examine how the market competition influences the optimal timing of investment decision, firm's market value, equity market value, old debt value and new debt risk premium and agency costs of debt. It appears that competitive intensity has an important influence on considered items.

**Keywords:** investment option, equity holder–bondholder conflict, agency costs of debt, product market competition.

## **1. Introduction**

A firm operating on a competitive market must consider competitors activities in its investment decisions. It has to take into account the threat that other firm could accomplish the same project first and could gain market shares and profits.

On the other hand the immediate realization of the project could be also unprofitable for the firm. It must compare immediate investment against the alternative of waiting to reassess the situation. Waiting allows it to reduce the downside risk of investment. The firm is waiting for appropriate market condition and new information increasing the chance of success which makes waiting more valuable.

We will model the situation when the firm can delay the execution of the investment project but it has no a monopoly right to make use of it. The entry of a competitor wastes the value of the firm's investment opportunity – its investment option becomes worthless.

The firm uses capital markets to obtain financing its investment projects and to issue corporate bonds. The presence of debt could create a divergence of interest

between bondholders and equityholders which generates agency costs of debt. The form of this conflict depends on the initial capital structure. The all-equity financing firm which issues debt immediately prior to make the investment (exercise the investment option) has a strong incentive to overinvest in risky assets to transfer wealth from bondholders to itself. This overinvestment is caused by investing too early, at too low commodity price [Mauer, Sarkar 2005]. If the firm is partially financed with debt and finances the investment project with equity, the equityholders underinvest in the investment project by delaying the exercise of the option. The option is exercised at too high commodity price [Mauer, Ott 2000].

However, on the competitive market these operating and investment strategies can change. Can competitive market mitigate agency problems? This is an interesting question that has already been discussed in literature. Mauer and Ott [2000] mentioned the effect of competition on the underinvestment problem (without specification). They point out that if competition intensity rises the option is exercised earlier (at lower output price than that for the no competition case), but, surprisingly, the agency costs increase sharply. The authors explain that the reason is that equity holders consider the wealth transfer to bondholders.

The influence of competition on the overinvestment problem was considered by Rychłowska-Musiał [2011b]. Obtained results also indicate that if competition intensity increases the option is exercised earlier (at lower output price) and the agency costs increase, what is not strange in this case.

The main aim of this paper is to investigate the influence of market competition on firm's operating and investment strategies, values of its equity, initial debt, additional debt issued to finance the investment option and agency costs of debt. The key contribution of this study considers both initial and additional debt in capital structure of the firm operating on the competitive market. Additionally, we can formulate the same interesting statements about risk premium on the competitive market.

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 introduces a measure of the agency costs of debt. Section 4 reports the numerical solutions of the model. Section 5 concludes the paper.

## **2. The model**

### **2.1. Basic assumptions**

The model we will consider is related to literature on investment and operating decisions using dynamics models. The papers closest complementary to this are the works by Mauer and Ott [2000], Mauer and Sarkar [2005] and Rychłowska-Musiał [2011b].

Consider a firm holding as an opportunity to continuously produce a single, infinitely divisible commodity through time. The key in our model is the assumption that at every point in time  $t$ , commodity price ( $P(t)$ ) evolves according to a geometric Brownian motion with initial value  $P(0)=1$ , drift  $\alpha$  and volatility  $\sigma$ .

The firm produces  $q$  units of commodity annually and the unit cost of production is constant and equals  $C$ . Operating profits are taxed immediately at a constant rate  $\tau$ . Assume that a risk-free asset yields a constant instantaneous rate of return of  $r$  and the convenience yield of the commodity price is a constant proportion ( $\delta$ ) of the price.

The initially capital structure of the firm includes equity and debt. This initial debt has infinite maturity and is paid by a continuous coupon payment of  $R1$  per unit time. The firm has an opportunity to make an investment paying a fixed cost  $I$ . Investment leads to increasing the production level from  $q=1$  to  $q>1$  and operating profits arise, as well. To finance the investment costs  $I$ , the firm may employ equity or may issue additional debt which has also infinite maturity, the same priority and is paid by a continuous coupon  $R2$  per unit time.

The firm's optimal operating policy is characterized by two endogenously determined "trigger" commodity prices: the price at which the firm defaults on the debt and the price at which it exercises its investment option.

Furthermore, the firm does not have a monopoly right to operations and could be preempted by a competitor, canceling its investment option. Specifically, the elimination of the investment opportunity by competition follows a Poisson process with a constant intensity parameter  $\lambda \geq 0$  [Mauer, Ott 2000]. That is, the expected time for the elimination is  $\lambda^{-1}$  and the probability rate that the opportunity to invest vanishes during a time interval of infinitesimal length  $dt$  is given by  $\lambda dt$  [Dixit, Pindyck 1994, p. 85].

The market firm value, its equity and debt values depend on the commodity price and the standard risk-neutral valuation arguments and Itô's Lemma require that they must satisfy the differential equation.

### After investment

$$\frac{1}{2}\sigma^2 P^2 f_{pp} + (r - \delta)Pf_p - rf + CF(f) = 0. \quad (1)$$

Function  $f$  means by turns: the firms' equity value after investment ( $E_q$ ), the market value of initial debt after investment ( $D1_q$ ) and value of the additional debt ( $D2_q$ );  $f$  is at least twice differentiable in  $P$ . The constant  $CF(f)$  denotes cash flows related to each function. A closed-form expression of  $E_q$ ,  $D1_q$  and  $D2_q$  we

can be derived as solutions of (1) satisfying some boundary conditions [Rychłowska-Musiał 2011a, Rychłowska-Musiał 2011b].

### Before investment

$$\frac{1}{2}\sigma^2 P^2 f_{pp} + (r - \delta)Pf_p - (r + \lambda)f + CF(f) = 0. \quad (2)$$

Now, the function  $f$  determines: the market value of the firm before investment ( $V$ ) and the firms' equity value before investment ( $E$ ).

The market value of the initial debt issue ( $D1$ ) is received from:

$$D1(P) = V(P) - E(P). \quad (3)$$

To find required values we also have to formulate same boundary conditions.

For the presence of debt and the stockholder-bondholder conflict of interests the equity holders are incentive to choose the exercise policy to secure their own benefits. So we will have to consider two types of optimal strategies. *First-best* strategy means that equity holders choose the optimal operating policy to maximize total firm value. Furthermore there may be chosen *second-best* strategy that maximizes equity value only [Rychłowska-Musiał 2011b].

### 3. The agency costs of debt

The divergence of interest between bondholders and equity holders generates agency costs of debt which we define as the difference between the values of the value-maximizing (*first-best*) and the equity-maximizing (*second-best*) firms, expressed as a percentage of the value of the value-maximizing firm. This difference reflects the loss in value that arises from the execution of the suboptimal strategy [Titman, Tsyplakov 2006]:

$$AC(P) = \frac{V^F(P) - V^S(P)}{V^F(P)} \cdot 100\%, \quad \max\{P_D^F, P_D^S\} < P < \min\{P_I^F, P_I^S\}, \quad (4)$$

where:  $V^F(P)$  – the *first-best* market value of the firm,

$V^S(P)$  – the *second-best* market value of the firm,

$P_D^k$  – the default trigger price,  $k = F, S$ ,

$P_I^k$  – the investment option exercise trigger price,  $k = F, S$ ,

$k$  – denotes the type of strategy: *first-best* ( $F$ ) or *second-best* ( $S$ ).

Furthermore we will examine the risk premium required by bondholders of additional debt:

$$\text{risk premium} = \frac{R2}{D2_q(P_t^k)} \cdot 100\% - r. \quad (5)$$

#### 4. Analysis of the model

Since analytic comparison of optimal policies is impossible and our objective is to quantify the agency costs of debt, we numerically solve the model by using the base case parameter values:  $q=1$  (before investment);  $q=2$  (after investment);  $C=0,8$ ;  $I=10$ ;  $R1=0,5$ ;  $R2$  from 0 to 1;  $r=5\%$ ;  $\delta=5\%$ ;  $\tau=19\%$ ;  $\sigma=20\%$ ;  $b=30\%$  (bankruptcy costs);  $\lambda$  from 0 (no competition, value of investment option does not vanish) to 2 (the expected time to option value elimination is the half year).

Several other papers focus on investment policy of a firm operating on a competitive market [Trigeorgis 1991; Dixit, Pindyck 1994; Smit, Ankum 1993]. Some general statements are common for all papers: the threat from competition forces the decision to exercise the investment option too early relative to policy with a monopoly right to exercise the option, with lower commodity price to reduce the risk of elimination of the market. The first conclusion from our analysis remains consistent with the results of predecessors (see Table 1). The investment option exercise price is the lower the higher the probability is the investment option opportunity vanishes (the higher value of the competition intensity  $\lambda$ ). However, the analysis becomes more complicated when we allow debt issue to finance the investment.

**Table 1.** Trigger prices [in monetary unit]

$\lambda$	Trigger prices							
	$P_D^F$	$P_D^S$	$P_I^F$	$P_I^S$	$P_D^F$	$P_D^S$	$P_I^F$	$P_I^S$
	<b>Panel A <math>R2 = 0</math></b>				<b>Panel C <math>R2 = 0,5</math></b>			
0	0,61	0,61	2,48	2,50	0,61	0,61	2,39	2,18
0,1	0,69	0,69	1,55	1,68	0,68	0,68	1,53	1,53
0,5	0,83	0,78	1,20	1,39	0,79	0,76	1,20	1,30
1	0,94	0,82	1,16	1,32	0,86	0,80	1,14	1,24
2	1,03	0,87	1,15	1,26	0,95	0,85	1,11	1,20
	<b>Panel B <math>R2 = 0,1</math></b>				<b>Panel D <math>R2 = 1</math></b>			
0	0,61	0,61	2,45	2,44	0,60	0,61	2,36	1,84
0,1	0,69	0,69	1,54	1,65	0,67	0,68	1,56	1,39
0,5	0,82	0,77	1,20	1,37	0,76	0,76	1,23	1,23
1	0,92	0,82	1,15	1,30	0,82	0,80	1,16	1,19
2	1,02	0,87	1,14	1,25	0,89	0,85	1,12	1,16

Source: own calculations.



Note with strong competition, when the probability that the firm could be preempted by a competitor is high (the high value of  $\lambda$ ), the way of financing (equity or debt) and the amount of additional debt issue have a weaker effect on the optimal investment policy both under *first-best* and *second-best* strategies. Of course, differences between optimal operating policies are more marked in the *second-best* strategy (Table 1). This leads us to the second conclusion: when the intensity of competition increases, the way of project financing (equity or debt) becomes less important. The reason is a decreasing value of investment option and the threat of losing investment opportunities and market shares to rivals. This effect is particularly evident in the *second-best* strategy.

Next, we examine the relationship between trigger prices and the type of agency problem of debt in the competitive environment. This analysis is divided into two parts: no additional debt issue and new debt issue to finance investment project.

### **The first case: no additional debt issue ( $R2 = 0$ )**

When the investment project is financed by equity only (but the firm has paid the initially debt already) and the firm has a monopoly right to exercise the investment option, then the agency problem is underinvesting. Equity holders underinvest in the investment option in the *second-best* strategy by waiting for higher commodity price ( $P_t^S > P_t^F$ ). This leads to lower than in the *first-best* strategy expected value of investment for probability of exercise investment option by any future date decreases. Equity holders delay investment decision under the *second-best* strategy although they pay the full cost of investment and they share benefits with bondholders [Mauer, Ott 2000].

The presence of market competition intensifies the problem of underinvestment. Although under both *first-best* and *second-best* strategies equity holders exercise the investment option earlier with lower commodity price, under *first-best* strategy this difference is wider, which causes an increase in the agency costs.

When the intensity of competition increases the value of equity sharply decreases in both strategies, but this value reduction is more severe in the *first-best* strategy because it is not accompanied by the reduction in debt value. Under *second-best* strategy we observe the diminution of both equity and debt values. (Table 2).

### **The second case: new debt issue ( $R2 > 0$ )**

However, when the investment project is financed by new debt issue, equity holders can transfer costs and risk to new bondholders and investment option can be exercised too early (at lower commodity price  $P_t^S < P_t^F$ ). Then the probability that investment takes place by any given future date increases, the expected value of investment by that date is greater and we face the problem of overinvestment (Table 1).

**Table 2.** Market values of equity and debt *before* exercise the investment option (with no additional debt issue) as function of the output price

Price $P$	Panel A $\lambda = 0$				Panel B $\lambda = 0,5$				Panel C $\lambda = 1$			
	$E^F(P)$	$D1^F(P)$	$E^S(P)$	$D1^S(P)$	$E^F(P)$	$D1^F(P)$	$E^S(P)$	$D1^S(P)$	$E^F(P)$	$D1^F(P)$	$E^S(P)$	$D1^S(P)$
0,7	0,26	2,38	0,24	2,38								
0,8	0,99	3,47	0,99	3,47								
0,9	2,10	4,31	2,10	4,31	0,03	3,69	0,19	2,85				
1,0	3,48	4,97	3,48	4,97	0,29	3,69	0,66	2,65	-0,00	4,17	0,36	2,13
1,1	5,07	5,50	5,07	5,50	0,76	4,48	1,45	2,94	0,13	4,81	0,99	2,44
1,2	6,84	5,94	6,84	5,94	1,47	6,09	2,63	3,71				
1,3	8,75	6,30	8,75	6,30								
1,4	10,79	6,61	10,79	6,61								
1,5	12,95	6,88	12,95	6,88								
1,6	15,22	7,11	15,22	7,11								
1,8	20,05	7,50	20,05	7,50								
2,0	25,25	7,80	25,25	7,80								
2,2	30,80	8,06	30,80	8,05								
2,4	36,69	8,27	36,69	8,26								

Source: own calculations.

**Table 3.** Agency costs of debt for various levels of debt financing and competition intensity [in %]

Price $P$	Panel A $R2 = 0$			Panel B $R2 = 0,5$			Panel C $R2 = 1$		
	$AC(P)$			$AC(P)$			$AC(P)$		
	$\lambda = 0$	$\lambda = 0,5$	$\lambda = 1$	$\lambda = 0$	$\lambda = 0,5$	$\lambda = 1$	$\lambda = 0$	$\lambda = 0,5$	$\lambda = 1$
0,7	0,000			0,29			3,16		
0,8	0,001			0,29	9,61		3,11	-0,24	
0,9	0,001	18,54		0,29	8,10	27,37	3,12	-0,15	7,20
1,0	0,002	16,88	40,35	0,30	6,83	19,85	3,17	-0,07	3,98
1,1	0,002	16,13	30,65	0,30	6,20	14,85	3,23	-0,02	1,98
1,2	0,002	16,04		0,31			3,31		
1,3	0,002			0,32			3,39		
1,4	0,002			0,33			3,48		
1,5	0,002			0,34			3,58		
1,6	0,002			0,35			3,67		
1,8	0,002			0,37			3,87		
2,0	0,002			0,38					
2,2	0,003								
2,4	0,003								

Source: own calculations.

Note that there are two opposing incentives: equity holders' reluctance to share profits with initial bondholders who do not bear the costs of the project but benefit

from its implementation (delaying the investment exercise decision and underinvestment) and equity holders' enticement of enjoying earlier receipt of new debt issue (the investment option is exercised too early, the overinvestment problem).

The intensity of each incentives depends on initial and new debt issues and intensity of competition. Because these incentives have two opposite directions we can face the situations when they balance out. When the intensity of competition is weak there is an "optimal" new debt coupon payment which eliminates both problems of underinvestment and overinvestment and the agency costs of debt are equal to zero while with severe competition the incentive of delaying investment is dominating.

### Agency costs

The agency costs of debt are generally higher on the competitive market. This is related to the fact that if the threat of being preempted by a competitor increases the market value of equity decreases and wealth transfer from equity holders to bondholders is more painful.

With the severe competition intensity the agency costs of debt are observable in the shorter window. The period of appearing agency costs is shorter. What is worth stressing though is that the highest level of the agency costs of debt is almost always associated with a difficult market situation, i.e. the low commodity price closed to the default price (Table 3).

The next general conclusion produced by our model is as follows: in the face of financial distress (the low commodity price) or market difficulties (severe competition) even small changes in an optimal strategy are important for market value of the firm and generate higher agency costs of debt.

### Risk premium

The competition intensity has also important implications for market value of corporate bonds issued to cover investment expenditures.

As described earlier, competition significantly affects an investment decision by force to invest earlier and issue additional debt under lower commodity price. For that reason (low commodity price could lead to financial distress) new bondholders claim for the higher risk premium the more severe competition intensity (higher value of  $\lambda$ ).

**Table 4.** Risk premium for various levels of debt financing and competition intensity

Competition intensity $\lambda$	Panel A $R2 = 0$					Panel B $R2 = 0,5$				
	0	0,1	0,5	1	2	0	0,1	0,5	1	2
Risk premium in the <i>first-best</i> strategy [%]	1,06	2,15	3,35	3,65	3,72	1,34	2,72	4,40	4,95	5,22
Risk premium in the <i>second-best</i> strategy [%]	1,07	1,92	2,62	2,88	3,10	1,53	2,73	3,73	4,10	4,41

Source: own calculations.

We could expect that the risk premium will be higher under *the second-best* scenario (suboptimal policy), but surprisingly it does not happen in all cases. The risk premium in the cost of additional debt is higher under the *second-best* scenario only when the agency conflict is connected with a new debt, otherwise it is higher under the *first-best* policy (Table 4). The agency conflict related to new debt means that the investment option is exercised too early and the firm is overinvested. However, when the agency conflict related to initial debt is stronger and equity holders delay investment decision and underinvest it, then the risk premium in the cost of additional debt is lower in the *second-best* strategy. It means that new bondholders request lower risk premium when the debt is issued under favorable market circumstances.

## 5. Conclusions

In the paper we analyze links between firm's value, its equity and debt and investment decisions. We study the impact of competition on the type of agency conflict and the level of agency costs of debt. Overall, the results emphasize the importance of considering the linkages between the product market competition and firm's investment decisions. The main findings can be summarized as follows:

1. A firm which does not enjoy the monopoly rights to invest, but has to consider the possible entry of a competitor will exercise the investment option earlier (i.e. with lower commodity price) regardless of the way of project financing (equity or debt).

2. If a firm has monopoly rights to invest the way of project financing (equity or debt) is important for optimal investment timing (it is more noticeable for suboptimal strategies). When the intensity of competition increases, the way of project financing (equity or debt) becomes less important for a decrease of the value of investment option and the threat of losing investment opportunities and market shares to competitors.

3. The agency costs of debt are higher in the face of financial distress (low commodity price) or market difficulties (severe competition), because then even small changes in optimal strategies are important for market value of a firm.

4. The risk premium in the cost of a new debt issued to finance investment project depends on the competition intensity. Under the threat of the possible entry of a competitor the risk premium and the cost of debt are much higher than in the case of monopoly rights to invest.

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## EMISJA NOWEGO DŁUGU W WARUNKACH KONKURENCJI NA RYNKU. KOSZTY AGENCJI

**Streszczenie:** W artykule analizujemy problemy związane z konfliktem właściciel-wierzyciel na rynku konkurencyjnym. Rozważamy spółkę, która ma możliwość realizacji projektu inwestycyjnego, ale wejście konkurencji na rynek pozbawia spółkę tej możliwości – wartość opcji inwestycyjnej spada do zera. Projekt ten może być finansowany kapitałem własnym lub długiem. Badamy wpływ konkurencji na wybór optymalnego momentu realizacji projektu oraz na wartość rynkową spółki, jej kapitału własnego, wartość wcześniej zaciągniętego długu oraz premię za ryzyko nowo zaciągniętego długu i wysokość kosztów agencji. Okazuje się, że natężenie konkurencji na rynku, na którym działa spółka, ma istotne znaczenie przy wyznaczaniu rozważanych wielkości.

**Słowa kluczowe:** opcja inwestycyjna, konflikt właściciel-wierzyciel, koszty agencji długu, konkurencja na rynku.