Consequences of Corporate Debt Financing in Price Agreements' Stability

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Abstract

The present article aims to show that price agreements are more unstable if their companies use debt as a financing instrument. Moreover, the higher the number of companies (that use debt) in a price agreement, the more instable the price agreement will be. Even when companies compete à la Bertrand and if debt financing is high, the duopoly of price agreement will be instable. When debt financing is present, we found there is a higher number of sub-game perfect Equilibria, in an a posteriori à la Cournot competition, then when debt financing is not present and that this (possible) existence of sub-game perfect Equilibria increases as the debt level of financing increases.

Keywords: *price agreement; debt financing; sub-game perfect equilibrium*

JEL Classification: G32, L13

1. Introduction

Stability in price agreements depends on various factors such as: asymmetric information, number of companies present in the market, companies' marginal costs and existence of product differentiation, among others.

Some authors such as, Cheng (1985), Vives (1985), Dastidar (1997) and Manzini and Mariotti (2005) say that the higher the number of companies operating in the market the more instable the price agreement will be. This happens, essentially, due to two main reasons: there is more difficulty in coordinating companies' price strategies and the profit *per* company is lower because the monopoly profit has to be divided by a higher number of companies (players).

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These two aspects will act as further disincentives for each and every company to comply with the initial price agreement.

We further suppose that after the price agreement is broken, companies can either adopt the Bertrand, the Cournot or the Stackelberg model. In the Bertrand model, the strategic variable is price (this means that companies in this model will compete *via* price), whereas in the other two models the relevant variable is quantity. We must say that the Nash equilibrium concept is inherent to these three models, since companies will choose the best option (i.e. the best decision) given the other companies' options/decisions.

In the Bertrand model, with product's homogeneity and same marginal cost in each and every company, if companies set the same price, then they will divide the market among them. Despite this, companies have incentives in lowering the price, because in this situation they will get the totality of the market. Following this, the other companies will also lower their price, and so on. This all process ends when the firm's price is set to marginal cost, because in this situation the best strategy is to maintain price equal to marginal cost, otherwise profits would become less than zero.

In the Cournot model companies decide, which quantity to set, simultaneously. In equilibrium, companies won't change their decisions since they have chosen the best possible option given the rivals' decisions.

The Stackelberg model is in fact an extension of the Cournot model. In fact, companies don't act simultaneously, instead, some companies (or it can be just one) anticipate their rivals' decisions by setting the quantity (this is actually the quantity in the Monopoly model), which is then divided among them. These companies are the market leaders and the remaining are the followers. These last ones will choose quantities, given the initial quantity set by the leaders (the quantity set by the followers is, thus, the best option given the leaders' decisions).

When companies seek external capital (i.e. debt) they expose themselves to an additional financial risk (i.e. the probability of defaulting) because they will have future obligations to pay their debt services. Debt financing will thus increase risk in two ways: (1) it implies the financial payments and debt repayment (otherwise the companies will default) and (2) as debt financing increases, companies' available net results for dividend purposes or for re-invèstment increase, for a given equity level (Myers and Robichek, 1965). Consequently, debt financing increases the probability of company's bankruptcy (Stiglitz, 1972; Petty and Walker, 1978; McConnell and Pettit, 1984; Sunder and Myers, 1999).

Although price agreement stability and companies' debt financing, each by itself, are widely studied in economic and financial literature, the consequences of companies' debt financing on price agreement stability lacks of analysis.

The present article has the following objectives: (1) show the implications of corporate debt financing in price agreements' stability, supposing the existence of different strategic behaviours[1] after the agreement is broken, and (2) show the implications of corporate debt financing on companies'[2] interests in future equal strategic behaviours, thus allowing for more stability after the price agreement is broken.

2. Theoretical Model

We start by considering the existence of n ($n = 1, 2, 3...$) companies in a specific market with product homogeneity. We further say that each and every company has the same marginal cost, implying the existence of conditions for the formation of a stable price agreement.

We also suppose that there are m ($m = 1, 2, 3...$) companies that are willing to break the (initial) price agreement (with $m \leq n$).

As previously stated, we aim to analyse the possibilities of existence of stability in the price agreement composed by n companies, studying the eventual presence of advantages to the m companies that will forfeit the previous agreement. We further suppose that the re-negotiation of (price) agreements is not possible due to loss of confidence (i.e. credibility) in company behaviour, as suggested by Myerson and Satterthwaite (1983) and Lee (2005). This is to say that after the „breaking" occurs there will be a lack of confidence making impossible the existence of a price agreement (i.e. the companies that do comply with the agreement will never again make another agreement with the non compliance companies). As a result, companies will compete in one of three possible ways: *à la Bertrand*, *à la Cournot* or *à la Stackelberg*. If companies compete *à la Cournot* (supposing $n \to \infty$) the quantity and price in equilibrium will tend to those of Perfect Competition and Bertrand models (i.e. $\lim Q_{n\to\infty} = \frac{a-c}{b}$ and $\lim P_{n\to\infty} = c$).

As previously mentioned, the existence of debt financing will increase the probability of company bankruptcy. We use ρ as the probability that a bankruptcy will occur and obviously $0 \leq \rho \leq 1$ (also, the probability that a bankruptcy will not occur is given by $1 - \rho$).

We define „present" (moment in time) as the time when companies seek debt financing, so that the following time periods are the only ones affected by ρ (the probability of a company going bankrupt).

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[1] By this we are referring to the Bertrand, Cournot and Stackelberg models.

[2] This set comprises of both companies that have and have not broken the initial price agreement.

2.1. Price Agreement Stability When Debt Financing is not Present

We will start by studying the price agreement stability when companies don't have any debt financing in their capital structure, in the three types of competition.[3]

Competition *à la Bertrand*

In this first scenario, after the price agreement no longer exists, all companies will compete *à la Bertrand*, thus, the condition for price agreement stability is:

$$\frac{\pi_M}{n}+\frac{\pi_M}{n(1+r)}+\frac{\pi_M}{n(1+r)^2}+\ldots>\frac{\pi_M}{m}+0+0+\ldots \tag{1}$$

where π_M is the monopoly profit and r is the market interest rate (i.e. the discount factor). If we solve for m, the condition for price agreement stability can be presented as:

$$m>\frac{n.r}{1+r} \tag{2}$$

Competition *à la Cournot*

In this situation, as the m companies break the initial price agreement every company (including those who broke the agreement) will compete *à la Cournot*. As a result the condition for price agreement stability can be viewed as:

$$\frac{\pi_M}{n}+\frac{\pi_M}{n(1+r)}+\frac{\pi_M}{n(1+r)^2}+\ldots>\frac{\pi_M}{m}+\frac{4\pi_M}{(n+1)^2(1+r)}+\frac{4\pi_M}{(n+1)^2(1+r)^2}+\ldots \tag{3}$$

again, we can simplify this expression by applying limits to each side, yielding:

$$\frac{(1+r)}{nr}>\frac{1}{m}+\frac{4}{(n+1)^2 r} \tag{4}$$

Competition *à la Stackelberg*

In this final scenario we assume that after the price agreement no longer exists, companies will compete *à la Stackelberg* and that the m companies are the market leaders (the same that broke the initial price agreement), leaving the remaining $m - n$ companies as followers. The price agreement stability condition can then be stated as

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[3] We suppose that the demand curve is linear and of type: $P = a - bQ$, with P being the market price and Q is the market quantity. As put by Qiu (1997), Lee (2005) and Vignolo (2005), we suppose $b = 1$. Since our final results are shown in comparison with those of the Monopoly model, the final equations are not functions of b.

$$\frac{\pi_M}{n}+\frac{\pi_M}{n(1+r)}+\frac{\pi_M}{n(1+r)^2}+\ldots>$$

$$>\frac{\pi_M}{m}+\frac{4\pi_M}{(n-m+1)(m+1)^2(1+r)}+\frac{4\pi_M}{(n-m+1)(m+1)^2(1+r)^2} \quad (5)$$

this can also be simplified to:

$$\frac{(1+r)}{nr}>\frac{1}{m}+\frac{4}{(n-m+1)(m+1)^2 r} \quad (6)$$

At this point we consider that the value of the market interest rate is 10 per cent (i.e. $r = 10$ *per cent*). We also suppose that the number of companies operating in this market can vary, and we assume specific values for this (i.e. n = 2; 3; 4; 5; 10; 20; 30; 50; 100; 500; 1 000; 10 000). With this set of assumptions we can find the value for m so that the price agreement is stable in the three scenarios previously considered (i.e. competition *à la Bertrand*, competition *à la Cournot* and competition *à la Stackelberg*). Using expressions (2), (4) and (6), results are shown in Table 1 of the Appendix.

In duopoly, if we suppose an *à la Stackelberg* behaviour there is an incentive in breaking the initial price agreement, as opposed to the case when competition is *à la Bertrand* or *à la Cournot*. We also find that the price agreement is more stable if companies compete *à la Bertrand* then when they compete *à la Cournot* or *à la Stackelberg*. Furthermore, as the number of companies in the market increase ($n \to \infty$) the incentive to break the agreement increases, regardless of the type of competition chosen by companies (*Bertrand*, *Cournot* or *Stackelberg*).

2.2. Price Agreement Stability When Debt Financing is Present

As mentioned before, when debt financing is present, the probability of a company going bankrupted increases. At this point we will study the conditions for price agreement stability when debt financing occurs. Again, this is analysed in three possible *post* breaking agreement scenarios: competition *à la Bertrand*, competition *à la Cournot* and competition *à la Stackelberg*.

Competition *à la Bertrand*

As done in the previous section, we find that the condition for price agreement stability when companies compete *à la Bertrand* can then be stated as:

$$\frac{\pi_M}{n}+\frac{\pi_M(1-\rho)}{n(1+r)}+\frac{\pi_M(1-\rho)^2}{n(1+r)^2}+\ldots>\frac{\pi_M}{m}+0+0+\ldots \quad (7)$$

which can be simplified to:

$$m > \frac{n(r+\rho)}{1+r} \tag{8}$$

Competition *à la Cournot*

In this situation, companies will compete *à la Cournot* after the initial agreement is broke, implying the following condition for price agreement stability:

$$\frac{\pi_M}{n} + \frac{\pi_M(1-\rho)}{n(1+r)} + \frac{\pi_M(1-\rho)^2}{n(1+r)^2} + \ldots > \frac{\pi_M}{m} + \frac{4\pi_M(1-\rho)}{(n+1)^2(1+r)} + \frac{4\pi_M(1-\rho)^2}{(n+1)^2(1+r)^2} + \ldots \tag{9}$$

simplifying, this yields the following expression:

$$\frac{(1+r)}{n(r+\rho)} > \frac{1}{m} + \frac{4(1-\rho)}{(n+1)^2(r+\rho)} \tag{10}$$

Competition *à la Stackelberg*

Finally, when competition *à la Stackelberg* occurs, the condition for price agreement stability can be seen as:

$$\frac{\pi_M}{n} + \frac{\pi_M(1-\rho)}{n(1+r)} + \frac{\pi_M(1-\rho)^2}{n(1+r)^2} + \ldots. >$$

$$> \frac{\pi_M}{m} + \frac{4\pi_M(1-\rho)}{(n-m+1)(m+1)^2(1+r)} + \frac{4\pi_M(1-\rho)^2}{(n-m+1)(m+1)^2(1+r)^2} + \ldots \tag{11}$$

which can be simplified to:

$$\frac{(1+r)}{n(r+\rho)} > \frac{1}{m} + \frac{4(1-\rho)}{(n-m+1)(m+1)^2(r+\rho)} \tag{12}$$

As done in the previous section, we consider a discount factor (i.e. interest rate) of 10 per cent and that the number of companies operating in this market can vary, for which we assume specific values (i.e. n = 2; 3; 4; 5; 10; 20; 30; 50; 100; 500; 1 000; 10 000). With this set of assumptions, and following what we did on the previous section, we can find the value for m so that the price agreement is stable, in the three scenarios considered: competition *à la Bertrand*, competition *à la Cournot* and competition *à la Stackelberg*. Using expressions (8), (10) and (12), results are shown in Tables 2, 3 and 4 of the Appendix.

We can conclude that regardless of the type of competition (i.e. *à la Bertrand*, or *à la Cournot* or *à la Stackelberg*) the price agreement is less stable when the probability of bankruptcy (i.e. ρ) increases *via* a higher debt structure. We also say that regardless of the level of debt and of type of competition, as the number of companies that exist in the price agreement increases then the probability of the price agreement becoming unstable will be higher.

Moreover, the price agreement is less stable if companies compete *à la Stackelberg* or *à la Cournot* (as opposed to *à la Bertrand*), regardless of the number of companies and debt level present in these same companies. Also, when competing *à la Bertrand* if companies choose debt financing and as the probability of bankruptcy increases the price agreement is less stable (even when a duopoly occurs).

Finally, when competing *à la Stackelberg* or *à la Cournot* the price agreement will be always unstable, regardless of the number of companies in the price agreement and their level of debt, since at least one company will be willing to break the agreement and thus increase its profit.

2.3. Sub-Game Perfect *Equilibria*

When analysing Sub-Game Perfect *Equilibria*, we can say that those companies that belong in the price agreement may not be willing to adopt a strategy *à la Bertrand*, at least in many periods, because in this scenario every company becomes worse. In fact, after the price agreement is broke, companies should avoid the worst possible solution, which is to adopt a price war. Bernheim (1984), Moulin (1984), Pearce (1984), Borgers (1993) and Ghirardato and Breton (2000) suggest that adopting a strategy that is not the best one is a non rational behaviour. Torng (2002) and Vignolo (2005) conclude that in the presence of symmetric oligopoly markets it is possible to enhance a company's situation without making another one worse off.

As a result, we consider that after the price agreement is broke, companies might not be willing to go into a price war and prefer, in the following period, to compete *à la Cournot* or *à la Stackelberg*. Additionally, regardless of the existence of debt financing and after the initial price agreement no longer exists, the solution of the *à la Bertrand* scenario is not a Sub-Game Perfect Equilibrium, because it is possible to augment every companies' final solution by competing *à la Cournot* or *à la Stackelberg*.

If one compares the profits in every period, after the price agreement is broken, in the *à la Cournot* situation as opposed to the *à la Stackelberg* one, we can find the favourite competition scenario from the companies' point of view (regardless of the presence of debt financing).

So, the condition for companies that have broken the agreement, to prefer to compete *à la Cournot* as opposed to competite *à la Stackelberg*, regardless of the existence of debt financing is given by:

$$(n-m+1)(m+1)^2 > (n+1)^2 \tag{14}$$

Then, the condition for companies that have not broken the agreement, to prefer to compete *à la Cournot* as opposed to competite *à la Stackelberg*, regardless of the existence of debt financing is given by:

$$(n-m+1)^2(m+1)^2 > (n+1)^2 \tag{15}$$

We again analyse the presence of Sub-Game Perfect *Equilibria* after the initial agreement is broke. Results are shown in Tables 5, 6 and 7 of the Appendix.

We can say that, following the results from Table 5, those companies that have not broken the agreement (regardless of the existence of debt in their capital structure) always prefer to compete *à la Cournot* than to compete *à la Stackelberg*. Also, we verify that if only one company breaks the agreement, it will be preferable to compete *à la Stackelberg*. Nevertheless, this situation is not a Sub-Game Perfect Equilibrium, since the remaining $n - 1$ companies prefer to compete *à la Cournot*. Furthermore, the non existence of this Sub-Game Perfect Equilibrium could *a priori* lead companies to compete *à la Bertrand*, but this scenario is not desirable for any of those companies.

In the case when debt financing is not present, the results for the Sub-Game Perfect *Equilibria* are shown in Table 6. We can see that there will only be equilibrium when the number of companies is fairly high. For example, if there are 500 companies operating in the market, there will only be a Sub-Game Perfect Equilibrium if the number of companies that have broken the agreement is between 22 and 45. This is to say there will never be a Sub-Game Perfect Equilibrium if only one company is willing to break the agreement.

Analysing the Sub-Game Perfect *Equilibria* in the situation when debt financing is present, we can say that (see Table 7) as the level of debt increases (and the probability of bankruptcy also increases), companies will have more and more incentives to break the agreement and compete *a posteriori à la Cournot*. Imagining the case where there are three companies competing in a market and each one has a probability of bankruptcy of at least 50 per cent, then two companies will be willing to break the agreement and all of them (i.e. three) are willing to compete *a posteriori à la Cournot*, which will lead to a Sub-Game Perfect Equilibrium. With the existence of debt financing, the possibility of existence of Sub-Game Perfect *Equilibria* is higher and increases with the level of debt financing.

Conclusion

In this paper we have shown that it is unlikely that companies prefer to compete *à la Bertrand* for a high number of periods. In fact, it would be more rational for companies to compete *à la Cournot* or *à la Stackelberg*, since in

these situations their profits would be higher, thus the existence of Sub-Game Perfect *Equilibria*. Nevertheless, competition *à la Bertrand* is a credible threat which can contribute to lower companies' incentives in breaking the initial price agreement.

When debt financing is not present in companies' capital structure there will be price agreement stability if the number of companies is fairly low. This will happen if companies, after the price agreement is broke, compete *à la Stackelberg*, although this will be unlikely because the companies who were *betrayed* will not be willing to compete in this way. We also saw that be linking companies' incentives in breaking the agreement with incentives to compete, *a posteriori*, *à la Cournot*, there would only be Sub-Game Perfect *Equilibria* when the number of companies is fairly high.

In the situation of debt financing, price agreement are quite unstable. In fact, after the agreement is broke, if companies compete *à la Cournot* or *à la Stackelberg*, even in duopoly, the price agreement is unstable. When debt financing presence is high in duopoly, if companies decide to compete *à la Bertrand*, the price agreement will also be unstable. We can thus conclude that the existence of debt in companies' capital structure increases the instability of price agreements.

Also, after the price agreement is broken, the betrayed companies will prefer to compete *à la Cournot* than to compete *à la Bertrand* or *à la Stackelberg*. If the number of companies that have broken the initial agreement is fairly low, then they will prefer to be market leaders. Despite this, if the number of companies that have broken the initial agreement is fairly high, then they will prefer to compete *à la Cournot*.

We also saw that, the possibility of existence of Sub-Game Perfect *Equilibria* is higher in this situation than when debt is not present in companies' capital structure. Furthermore, this possibility increases as the level of debt financing increases, causing more instability when debt financing is high.

Concluding, we argue that the existence of corporate debt financing leads to a higher instability in price agreements. We further conclude that after the (possible) breaking in price agreement, there is a higher possibility for companies (including those that have broken and have not broken the initial agreement) to behave *à la Cournot* and that this possibility increases as the level of debt increases in their capital structure.

Appendix

Table 1

Price Agreement Stability When Debt Financing is not Present ($r = 10$ %) in Three Types of Competition

Number of Companies (n)	Competition *à la Bertrand*	Competition *à la Cournot*	Competition *à la Stackelberg*
2	[1, 2]	[1, 2]	2
3	[1, 3]	[1, 3]	[2, 3]
4	[1, 4]	[1, 4]	[2, 4]
5	[1, 5]	[1, 5]	[2, 5]
10	[1, 10]	[2, 10]	[2, 10]
20	[2, 20]	[3, 20]	[3, 20]
30	[3, 30]	[4, 30]	[4, 30]
50	[5, 50]	[5, 50]	[6, 50]
100	[10, 100]	[10, 100]	[10, 100]
500	[46, 500]	[46, 500]	[46, 500]
1 000	[91, 1 000]	[92, 1 000]	[91, 1 000]
1 0000	[910, 10 000]	[910, 10 000]	[910, 10 000]

Table interpretation: When debt financing is not present and if the number of companies operating in the market (i.e. n) equals 500, with a discount factor of 10 per cent (i.e. $r = 10$ per cent) then the number of companies willing to break the agreement so there is price agreement stability varies between 46 and 500 (when competing *à la Bertrand*).

Table 2

Price Agreement Stability When Debt Financing is Present ($r = 10$ %) and Companies Compete *à la Bertrand*

Number of Companies (n)	Probability of Bankruptcy				
	$p = 5$ %	$p = 10$ %	$p = 25$ %	$p = 50$ %	$p = 75$ %
2	[1, 2]	[1, 2]	[1, 2]	2	2
3	[1, 3]	[1, 3]	[1, 3]	[2, 3]	3
4	[1, 4]	[1, 4]	[2, 4]	[3, 4]	4
5	[1, 5]	[1, 5]	[2, 5]	[3, 5]	[4, 5]
10	[2, 10]	[2, 10]	[4, 10]	[6, 10]	[8, 10]
20	[3, 20]	[4, 20]	[7, 20]	[11, 20]	[16, 20]
30	[5, 30]	[6, 30]	[10, 30]	[17, 30]	[24, 30]
50	[7, 50]	[10, 50]	[16, 50]	[28, 50]	[39, 50]
100	[14, 100]	[19, 100]	[32, 100]	[55, 100]	[78, 100]
500	[69, 500]	[91, 500]	[160, 500]	[273, 500]	[387, 500]
1 000	[137, 1 000]	[182,1 000]	[319, 1 000]	[546, 1 000]	[773, 1 000]
10 000	[1 364, 1 000]	[1 819, 1 000]	[3 182, 1 000]	[5 455, 1 000]	[7 728, 10 000]

Table 3

Price Agreement Stability When Debt Financing is Present ($r = 10\ \%$) and Companies Compete *à la Cournot*

Number of Companies (n)	Probability of Bankruptcy				
	$p = 5\ \%$	$p = 10\ \%$	$p = 25\ \%$	$p = 50\ \%$	$p = 75\ \%$
2	2	2	2	2	2
3	[2, 3]	[2, 3]	[2, 3]	3	3
4	[2, 4]	[2, 4]	[3, 4]	4	4
5	[2, 5]	[2, 5]	[3, 5]	[4, 5]	5
10	[2, 10]	[3, 10]	[5, 10]	[7, 10]	[9, 10]
20	[4, 20]	[5, 20]	[8, 20]	[12, 20]	[17, 20]
30	[5, 30]	[7, 30]	[11, 30]	[18, 30]	[24, 30]
50	[8, 50]	[10, 50]	[17, 50]	[29, 50]	[40, 50]
100	[15, 100]	[19, 100]	[33, 100]	[56, 100]	[78, 100]
500	[69, 500]	[92, 500]	[160, 500]	[274, 500]	[388, 500]
1 000	[137, 1 000]	[183, 1 000]	[320, 1 000]	[547, 1 000]	[774, 1 000]
10 000	[1 365, 10 000]	[1 819, 10 000]	[3 183, 10 000]	[5 456, 10 000]	[7 729, 10 000]

Table 4

Price Agreement Stability When Debt Financing is Present ($r = 10\ \%$) and Companies Compete *à la Stackelberg*

Number of Companies (n)	Probability of Bankruptcy				
	$p = 5\ \%$	$p = 10\ \%$	$p = 25\ \%$	$p = 50\ \%$	$p = 75\ \%$
2	2	2	2	2	2
3	[2, 3]	[2, 3]	[2, 3]	3	3
4	[2, 4]	[2, 4]	[3, 4]	[3, 4]	4
5	[2, 5]	[2, 5]	[3, 5]	[4, 5]	5
10	[3, 10]	[3, 10]	[4, 10]	[6, 10]	[9, 10]
20	[4, 20]	[5, 20]	[7, 20]	[12, 20]	[16, 20]
30	[5, 30]	[6, 30]	[10, 30]	[17, 30]	[24, 30]
50	[8, 50]	[10, 50]	[17, 50]	[28, 50]	[39, 50]
100	[14, 100]	[19, 100]	[32, 100]	[55, 100]	[78, 100]
500	[69, 500]	[91, 500]	[160, 500]	[273, 500]	[387, 500]
1 000	[137, 1 000]	[182, 1000]	[319, 1 000]	[546, 1 000]	[773, 1 000]
10 000	[1 364, 10 000]	[1 819, 10 000]	[3 182, 10 000]	[5 455, 10 000]	[7 728, 10 000]

Table 5

Companies' Preferences for Competition *à la Cournot* as Opposed to Competition *à la Stackelberg*, with or without Debt Financing ($r = 10\ \%$)

Number of Companies (n)	Number of Company Market Leaders	Number of Company Market Followers	Number of Companies in Agreement
2	2	[1, 2]	2
3	[2, 3]	[1, 3]	[2, 3]
4	[2, 4]	[1, 4]	[2, 4]
5	[2, 5]	[1, 5]	[2, 5]
10	[3, 10]	[1, 10]	[3, 10]
20	[5, 20]	[1, 20]	[5, 20]
30	[6, 30]	[1, 30]	[6, 30]
50	[7, 50]	[1, 50]	[7, 50]
100	[10, 100]	[1, 100]	[10, 100]
500	[22, 500]	[1, 500]	[22, 500]
1 000	[32, 1 000]	[1, 1 000]	[32, 1 000]
10 000	[100, 10 000]	[1, 10 000]	[100, 10 000]

Table 6

Sub-Game Perfect *Equilibria* with Competition *à la Cournot* without Debt Financing *(r = 10 %)*

Number of Companies (n)	*à la Cournot* Competition
2	–
3	–
4	–
5	–
10	–
20	–
30	–
50	–
100	–
500	[22, 45]
1 000	[32, 91]
10 000	[100, 909]

Table 7

Sub-Game Perfect *Equilibria* with Competition *à la Cournot* with Debt Financing *(r = 10 %)*

Number of Companies (n)	Probability of Bankruptcy				
	$P = 5$ %	$\rho = 10$ %	$\rho = 25$ %	$\rho = 50$ %	$\rho = 75$ %
2	–	–	–	–	–
3	–	–	–	2	2
4	–	–	2	[2, 3]	[2, 3]
5	–	–	2	[2, 3]	[2, 4]
10	–	–	[3, 4]	[3, 6]	[3, 8]
20	–	–	[5, 7]	[5, 11]	[5, 16]
30	–	6	[6, 10]	[6, 17]	[6, 23]
50	7	[7, 9]	[7, 16]	[7, 28]	[7, 39]
100	[10, 14]	[10, 18]	[10, 32]	[10, 55]	[10, 77]
500	[22, 68]	[22, 91]	[22, 159]	[22, 273]	[22, 387]
1 000	[32, 136]	[32, 182]	[32, 319]	[32, 546]	[32, 773]
10 000	[100, 1 364]	[100, 1 818]	[100, 3 182]	[100, 5 455]	[100, 7 728]

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