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On the Sustainability of Product Market Collusion Under Credit Market Imperfection

by

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Abstract

We study the implication of credit constraints for the sustainability of product market collusion in a bank financed Cournot duopoly when firms face an imperfect credit market. We consider two situations without or with credit rationing. When there is no credit rationing moderately higher cost of external finance may affect the degree of collusion, but a substantial increase keeps it unaffected. Permanent adverse demand shock in this set up does not affect the possibility of collusion, but may aggravate the finance constraint and eventually lead to collusion. We also discuss the case with credit rationing.

JEL Classification: D21, D43, G21

Keywords: Collusion, Credit Market

Outline

1. Introduction

Financial crises in recent times have renewed interest in research on the causes and consequences of such crises. The Asian crisis of 1990s and the most recent one originating in the United Sates have affected large number of business houses across the globe. Line of credit is an essential input in business processes world-wide, large or small. If you do not have access to credit, you cannot run a business. Thus working capital and day to day availability of credit is of utmost importance to any firm. The choice of the capital structure of a firm in an oligopoly was discussed way back in the 80s by Brander and Lewis in their famous paper [Brander and Lewis (1986)]. The nature of competitive strategies in the product market could determine firm choice between debt and equity capital. In this paper we consider the case where firms have to depend on bank finance for production and their internal capital or finance is inadequate for their desirable levels of production. Thus the firms do not have any choice in terms of the capital structure once they decide the level of production. This characterization of the financing process echoes the concern that credit market is essentially imperfect and internal cash flow of a firm is very important since borrowing is costly relative to the opportunity cost of self owned capital or credit, terms which we use interchangeably throughout the paper. In a way we draw from the well known work of Glenn Hubbard (1990) and others. That credit is a critical element in explaining macroeconomic implications of business cycles was also demonstrated in Bernanke and Gertler(1989).

In this paper we are interested in the relationship between sustainability of collusion and the level of credit in a Cournot oligopoly. First, we focus on a case where firms are not credit rationed, but have to pay a higher borrowing rate than the lending rate. This is the simplest way of characterizing imperfect credit market and has been used extensively in macro and development economics such as in Gal-Or and Zeira (1993), Banerjee and Newman (1993), Basu (2003) etc. It is quite natural that to understand the consequence of credit constraints on the strategic decisions of firms, one needs to use an oligopolistic structure. Unfortunately models that discuss strategic decisions of firms under credit constraints are rare. To the best of our knowledge non-cooperative and collusive strategies of firms under credit constraints has been discussed by Bagliano and Dalmazzo (1999) and Bevia, Corchon and Yasuda (2014) and in the context of bankruptcies of firms. Their papers are different from ours as we focus on the collusive strategies of firms when they face credit constraint without uncertainty. We do not consider possibilities of bankruptcies but point towards a rather interesting result that severe constraints may not impact the degree of collusion, but moderate ones do. We also suggest that if we follow Cournot or Bertrand models, then permanent adverse demand shocks will not affect collusion until and unless we bring in explicitly the role of internal finance. Therefore, the case for product market shocks as standalone reasons for collusion as in Rothemberg and Saloner (1986) gets weaker.

Fixed and working capital related issues in imperfect product market and their implications for macroeconomic outcomes have been studied by Das (2004). More recently Dellas and Fernandes (2014) discuss financial structure and imperfect markets within a macro framework deriving many interesting implications. But their model does not look at the possibility of collusion in a repeated game as we do in this paper. In a different context the credit market and trade policy reforms were analyzed in a set up when firms choose to outsource their production to unorganized extra legal entities by Marjit, Ghosh and Biswas (2007) and in the context of outsourcing under financial crisis by Bandopadhyay, Marjit and Yang (2014). The way they model the use of working capital is related to this paper, but both deal with a competitive structure and the focus is entirely different from this paper. Credit constraints may affect the pattern of joint ventures and can lead to a buy-out. Marjit and RayChaudhuri (2004) discusses such an issue without explicitly modeling the credit market aspect of the problem.

A related paper to ours is the well cited work of Rothemberg and Saloner (1986) who explained the existence of the counter cyclical mark up in a dynamic model of oligopoly. They explain why during a boom it is hard to sustain collusion and hence mark ups falter because of the increasing possibility of deviations from tacit collusive agreement. In our paper we try to argue that if firms are hit very hard by financial constraints and they think that the shock is permanent, it may not impact the degree of collusion. In fact the linear Cournot example and the general Bertrand case, the degree of collusion is exactly the same when there was no such constraint. While their concern is with the size of the market, ours is with the availability of finance. We return to this comparison later in the paper. Our case also captures situations where firms may have very little of their own capital or they may be extremely well endowed. But as long as credit is available at a price, such extreme situations may imply similar possibility of collusion. In brief we bring in the credit side of product market collusion, as a complementary element to Rothemberg and Saloner (1986).

In the next section we develop the basic model and results. Section 3 discusses the credit rationing problem and its impact on collusion and in the last we conclude the paper.

2. Cournot Model and Results

Consider a market with two firms producing a homogeneous product X competing in Cournot fashion. If a represents the market size of the world, the inverse-demand function for our product is given by $P = a - q$, where P is the price of the product and q the quantity produced. We stick to the linearity assumption for closed from solution and as a follow up of Rothemberg and Saloner (1985) who also uses the linear structure. For simplicity, we assume the production of good X to require labor alone. Let α denote the labor requirement to produce one unit of output X. To simplify the analysis, we assume that the wage rate is equal to one; hence, the unit production cost for X is α. Each firm is endowed with k amount of own capital. We also assume that the labor cost has to be paid before production, which implies that firms require credit to pay wages if they do not have sufficient capital stock.

There are two features of the imperfect credit market. First, borrowing rate R is greater than the lending rate r because banks have cost of intermediation. This implies that firms lend out their capital at interest rate r, but have to pay interest rate R to the bank ($R > r$) if they face credit constraints. Second, the credit amount could be restricted, which implies firms cannot borrow enough money even if firms pay lending rate R and the amount of loan they get will be related to their own wealth.

We initially analyze the scenario without credit amount restriction. In this case firms can get any amount of loan if they pay lending rate R. In next section we will relax this assumption and analyze the changes in equilibrium results.

2.1 Under No Credit Constraints

We began by analyzing the scenario where firms do not have credit constraints. Let q_1 and q_2 represent the output of firm 1 and firm 2 respectively. As net lenders can lend out their surplus wealth at interest rate r, they can obtain a return of $(k - \alpha q_1)r$ where r to be read as $(1 + r)$.

Therefore firm 1's profit under production is

$$\pi_1 = (a - q_1 - q_2)q_1 + (k - \alpha q_1)r$$

If firm 1 does not engage in production, he can lend out all of its wealth, and earn kr.

Therefore, firm 1's net profit from production is

$$\pi_1 = (a - q_1 - q_2)q_1 - \alpha q_1 r \qquad \dots\ (1)$$

In the Oligopoly market, each firm earns Cournot profit if they do not collude with each other. Each of them will earn half of the Monopoly profit if they collude with each other. However, they can earn more profit by deviating even though they have agreed to collude with each other. Let $q_{Cournot}$, q_M and $q_{Cheating}$ denote the output level under Cournot, Monopoly and the deviating from collusion respectively. Accordingly $\pi_{Cournot}$, π_M and $\pi_{Cheating}$ represent the profit level under Cournot competition, the Monopoly profit and the profit of deviating from collusion respectively.

From standard solution in Cournot model, we find that

$$\pi_{Cournot} = \frac{[a-\alpha r]^2}{9} \qquad \text{…. (2)}$$

If two firms collude with each other, each will earn half of the Monopoly profit, Hence we have

$$\frac{1}{2}\pi_M = \frac{[a-\alpha r]^2}{8} \qquad \text{… (3)}$$

If firm 1 deviates from collusion, his profit becomes

$$\pi_{Cheating} = \left[a - q_1 - \frac{a-\alpha r}{4}\right] q_1 - \alpha r q_1$$

From the first order condition, we have

$$\pi_{Cheating} = \frac{9[a-\alpha r]^2}{64} \qquad \text{… (4)}$$

We follow the simplest procedure for modeling collusion as the trigger strategy equilibrium in infinitely repeated games a la Friedman (1971) and as exposited in Gibbons (1992). We abstract from more finer refinements as in Abreau (1988), since our purpose is to focus on the impact of credit availability on collusion rather than collusion per se.

Let δ_1 denote the critical value for the trigger strategy equilibrium under no credit constraints. We have

$$\delta_1 = \frac{\pi_{Cheating} - \frac{1}{2}\pi_M}{\pi_{Cheating} - \pi_{Cournot}} = \frac{9}{17}. \qquad \ldots (5)$$

2.2 Under Full Credit Constraints

Consider now when credit constraints binds, i.e. $\alpha \frac{1}{2} q_M > k$. This implies that

$\alpha q_{Cournot} > k$ and $\alpha q_{Cheating} > k$ because as $\frac{1}{2} q_M < q_{Cournot} < q_{Cheating}$.

Severity of the constraint is characterized by the fact that the firms cannot produce the optimum amount in any regime. If they cannot produce the monopoly output, they surely cannot produce Cournot or the deviation output.

In this case the net profit of firm 1 is

$\pi_1 = (a - q_1 - q_2)q_1 - (\alpha q_1 - k)R - kr$ where R to be read as $(1+R)$

$$= (a - q_1 - q_2)q_1 + \alpha q_1 R + k(R - r) \qquad \ldots (6)$$

Similar to the analysis in the previous section, we have

$$\pi_{Cournot} = \frac{[a-\alpha R]^2}{9} + k(R - r) \qquad \ldots (7)$$

$$\frac{1}{2}\pi_M = \frac{[a-\alpha R]^2}{8} + k(R - r) \qquad \ldots (8)$$

$$\pi_{Cheating} = \frac{9[a-\alpha R]^2}{64} + k(R - r) \qquad \ldots (9)$$

Let δ_2 denote the critical value for the trigger strategy equilibrium under full credit constraints. We have

$$\delta_2 = \frac{\pi_{Cheating} - \frac{1}{2}\pi_M}{\pi_{Cheating} - \pi_{Cournot}} = \frac{9}{17} = \delta_1. \qquad \ldots (10)$$

This leads to the following Proposition.

Proposition - 1

Collusion is equally sustainable under no constraints and full constraints.

The intuition is clear. The degree of collusion depends on relative pay offs or the differences in them. Since firms having k amount of internal finance will always earn k(R-r) as the premium no matter whatever their strategy, that does not feature anywhere in the determination of delta. In the linear example the ratios between various pay offs are constant independent of marginal cost i.e. r or R, hence the result.

One can interpret the story we have been telling so far in terms of firms which have fairly low or fairly high capital endowment. It is a story that befits the case of large number of potential entrepreneurs of developing countries with very little endowment of capital as well as richer sections of firms in the developed as well as in the developing countries. In the simple structure developed above, degree of collusion among firms in those separate groups, very poor and very rich, should be the same. Of course there will be factors such as number of firms in each group, possibility of monitoring etc. But the intuition that in both of these rather extreme cases all relevant pay offs are symmetrically affected essentially does the trick. In the linear example the result becomes exactly symmetric.

2.3 Under Partial Credit Constraints

We consider two possible situations to focus on partial credit constraints. In the first, we analyze the consequence of a slight relaxation of the constraint starting with the fully constrained case. In the second we discuss the case when starting from the unconstrained case we enter the zone with constraints.

In the first case the credit constraint does not bind under collusion, but bind under Counot competition and cheating. This implies that $\alpha q_{Cheating} > \alpha q_{Cournot} > k$ while $\alpha \frac{1}{2} q_M < k$. Hence firms do not need to borrow from the bank if they share the monopoly output.

In this case we have

$$\pi_{Cournot} = \frac{[a-\alpha R]^2}{9} + k(R-r) \quad \dots (11)$$

$$\frac{1}{2}\pi_M = \frac{[a-\alpha r]^2}{8} \quad \dots (12)$$

$$\pi_{Cheating} = \frac{9[a-\alpha R]^2}{64} + k(R-r) \quad \dots (13)$$

Let δ_3 denote the critical value for the trigger strategy equilibrium under partial credit constraints.

$$\delta_3 = \frac{\pi_{Cheating} - \frac{1}{2}\pi_M}{\pi_{Cheating} - \pi_{Cournot}}$$

$$= \frac{\frac{9[a-\alpha R]^2}{64} + k(R-r) - \frac{[a-\alpha r]^2}{8}}{\frac{9[a-\alpha R]^2}{64} - \frac{[a-\alpha R]^2}{9}} \quad \dots (14)$$

To compare the Monopoly profit under credit constraints and that under no credit constraints, we take derivatives of π_M with respect to R. We have

$$\frac{\partial \pi_M}{\partial R} = -\alpha q_M + 2k .$$

If the monopolist needs to borrow then we have $k < \frac{1}{2}\alpha q_m$. Hence we have $\frac{\partial \pi_M}{\partial R} < 0$. This implies that the monopoly profit decreases when R increases. We also have

$$\frac{1}{2}\pi_M(R=r) = \frac{[a-\alpha r]^2}{8}$$

$$\frac{1}{2}\frac{[a-\alpha R]^2}{4} + k(R-r) < \frac{1}{2}\frac{[a-\alpha r]^2}{4}$$

Hence we have $\frac{1}{2}\frac{[a-\alpha R]^2}{4} + k(R-r) < \frac{1}{2}\frac{[a-\alpha r]^2}{4}$ when $R > r$. This implies that the Monopoly profit under credit constraints is less than that under no credit constraints even if there is a premium for having greater internal finance ($k(R-r)$).Thus we can show $\delta_3 < \delta_1 = \delta_2$, hence collusion is more sustainable under partial credit constraints.

It is interesting to recast the problem in a different way by suggesting that we study the impact on delta as we move from an unconstrained to a constrained situation. This is the second case. It is possible that for some reason the level of internal equity falls and the constraint becomes binding.

It is obvious that the cheating output should be the first to be affected since it requires highest credit, other two pay offs are not affected. Cheating output will fall.

Consider the case where $\bar{k}$ is such that $3/8(a-\alpha R) \leq \bar{k}$ i.e. the deviation output is less than or equal to $\bar{k}$. We consider reducing k a little bit from $3/8(a-\alpha R)$. We can show that the gross profit Ω denoted as

$$\Omega = \frac{9}{64}(a-\alpha R)^2 + k(R-r) < \frac{9}{64}(a-\alpha r)^2 \qquad \ldots (15)$$

As k drops further Duopoly profit is affected but $\pi_d + k(R-r)$ can increase with R iff $^2/_9\,(a-\alpha R) < k < \frac{1}{5}((a-\alpha R)$ …. (16)

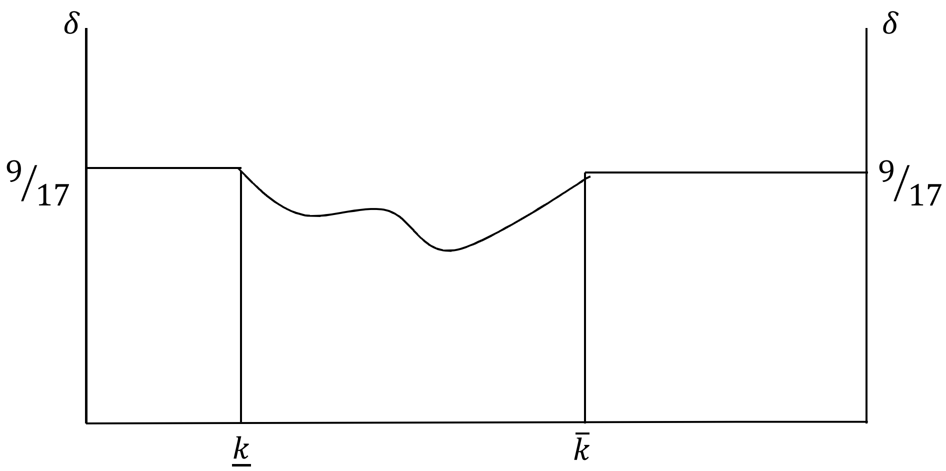

Figure – 1

Figure-1 describes the movement of δ with respect k. As k drops from $\underline{k}$, cheating profit goes down, δ falls, but cournot output is constraint free. Once k drops further and Cournot output is constrained, (16) shows for a range Cournot profit may go up, raising δ because of “rising rival’s cost” effect. Finally in the neighbourhood of $\underline{k}$, δ must be lower than $\tilde{\delta}$ as the monopoly output is free of constraint.

Proposition 2 - Response of δ to the level of equity capital is non monotonic. However, for low enough initial k collusion possibility will increase with a rise in k. Similarly for a high enough k collusion possibility will increase with a drop in k. In the middle range the collusion possibility will go down when the non cooperative pay off is favorably affected by a rise in the interest.

Proof: See the discussion above and Figure-1. QED

3. Credit Rationing

We follow the simple framework developed in Aghion and Banerjee (2005). If L is the loan given by the bank, q represents the probability of default and βk is the penalty that can be imposed by the bank, then bank will choose maximum

$L = \bar{L}$ s.t. $\pi(L + K) - Kr \leq \pi(L + K) - LR - kr - q\beta k$

or $L \leq \frac{q\beta k}{k}$ or $\bar{L} = \frac{q\beta}{R}.k$ …. (18)

Let us define $\bar{L} = f(k)$and $\bar{L} + k = f(k), \phi' > 0$ … (19)

Earlier for the case with no credit rationing we have defined $\tilde{\delta}$ such that

$$1/_2\,\pi_M + k(R - r) = \left(1 - \tilde{\delta}\right)\pi_C + \tilde{\delta}\pi_d + \left(1 - \tilde{\delta}\right)k(R - r) + \tilde{\delta}k(R - r)$$

$$1/_2\,\pi_M = \left(1 - \tilde{\delta}\right)\pi_C + \tilde{\delta}\pi_d \qquad \text{… (20)}$$

As soon as $\phi(k)$ binds, π_c drops making collusion more likely, though π_m and π_d and free of rationing.

As long as q_d is unconstrained, q_c keeps falling with k increasing the possibility of collusion. But as soon as q_d is constrained π_d starts rising due to capacity commitment effect. Hence RHS in (20) rises due to that effect. But π_c keeps falling and when $\pi_c = \pi_d$, $1/_2\,\pi_m > \pi_d$. Hence $\forall\, \delta$ collusion is the outcome.

4. Concluding Remarks

What we have shown in this paper is that the sustainable degree of collusion is non-monotonic with respect to the debt-equity ratio. But a drastic fall in own equity will increase the possibility of collusion. Larger debt/equity ratio has a greater chance of sustaining collusion provided the non cooperative pay off is not favorably affected. Adverse demand shock by itself may not affect collusion, but will affect k and hence will lead to collusion. Similarly positive demand shock will relax constraints and reduce the mark up. Thus financial factors determine the counter cyclical behavior of mark up.

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