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Liquidation risks in the Rotemberg-Saloner implicit collusion model

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Abstract

We extend the Rotemberg-Saloner's (1986) [Rotemberg, J., Saloner, G., 1986. A supergame-theoretic model of price wars during booms. American Economic Review 76:390–407] "implicit collusion" framework to the consideration of capital market imperfections, captured by a non-zero probability of liquidation of firms in recessionary periods. We show that the Rotemberg-Saloner result of countercyclical markups is quite robust to the extension and, moreover, liquidation risks may even strengthen the degree of markup countercyclicality.

Keywords: Implicit collusion; Countercyclical markups; Capital market imperfections

JEL classification: E30; L13; L16

1. Introduction

In a well-known paper, Rotemberg and Saloner (1986) showed that if the rate at which oligopolistic firms discount future profits is sufficiently high, implicit collusion over monopoly prices cannot be sustained during high-demand periods. Thus, booms may generate "price wars" leading to countercyclical markups (see also Bagwell and Staiger, 1997, and the literature quoted therein). More recently, Chevalier and Scharfstein (1996) (henceforth CS) have offered an alternative explanation of countercyclical markups, based on capital market imperfections. When the probability of surviving a recession is low, a financially-constrained firm will have an incentive to raise prices. CS (1996, p. 705) also conclude that when capital market imperfections are relevant, the Rotemberg-Saloner implicit collusion model cannot generate countercyclical markups.

We believe, however, that the implications of liquidation risk within the Rotemberg-Saloner implicit collusion model need to be investigated. Although we do not model debt explicitly – as in CS (1996) – we capture the potential problems associated with the existence of financial constraints by assuming that oligopolistic firms survive downturns with positive probability: e.g. liquidation is stochastically enforced during recessions. For example, in Bolton and Scharfstein's (Bolton and Scharfstein, 1990, p. 101) agency model with competitive lenders, a firm will be re-financed with

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certainty in good states, but it will be able to borrow with a probability between zero and one in bad states.

We show that the modified ‘‘implicit collusion’’ model proposed here can still generate countercyclical markups for non-negligible ranges of the relevant parameters. Furthermore, when markups are countercyclical, the introduction of ‘‘capital market imperfections’’ increases the degree of countercyclicality relative to the benchmark Rotemberg-Saloner model, in which firms always survive downturns. The next section presents the model and gives the main results.

2. The model

We consider a simple extension of the basic Rotemberg-Saloner (1986) setup, as presented in Tirole (1988), where two firms, producing an homogeneous good, compete in a market with stochastic demand. In every period, the demand for each firm can be either ‘‘high’’ or ‘‘low’’, with equal probability. Each firm chooses prices so as to maximize the discounted value of profits over the entire future infinite horizon, earning profits Π_H (Π_L) if a good (bad) realization of demand occurs. In what follows, we solve for a pair of prices $\{p_L, p_H\}$ such that: (i) both firms set the same price p_s when the state of demand is s, (ii) the pair $\{p_L, p_H\}$ is sustainable as an equilibrium (i.e., deviating from p_s in state s is not privately optimal), and (iii) the expected present discounted value of each firm's profit, calculated for $\{p_L, p_H\}$, is not dominated by any other pair of prices which satisfy (i) and (ii) (i.e., in case there are other pairs of prices sustainable as equilibria, both firms prefer the pair $\{p_L, p_H\}$ considered; (see Tirole, 1988, p. 248)).

In CS, liquidity constraints due to capital market imperfections lead to liquidation when low demand states occur: thus, a liquidity-constrained firm never survives a recession. In the specific agency model used by CS a recession implies that the entrepreneur does not have enough cash to make debt repayments and avoid liquidation. In the Rotemberg-Saloner framework, the assumption that recessions imply firm's liquidation rules out *countercyclical* markups. Nevertheless, although recessions are likely to exacerbate financial difficulties, firms may sometimes avoid liquidation by raising fresh external funds. In this perspective, we assume that when a bad realization of demand occurs, each firm has a probability $0 \le \rho \le 1$ of surviving to the next period and, conversely, a probability $1-\rho$ of being liquidated and cease operations. By doing so, we mimick the polar cases of Rotemberg-Saloner ($\rho=1$) and CS (1996), who assume that firms never survive recessions ($\rho=0$). Therefore, for a firm in period 0, the probability of being operative in period t is $(1+\rho/2)^{t-1}$ if in period 0 demand is high, and $\rho(1+\rho/2)^{t-1}$ if demand is currently low.[1] Given the above probabilities, we have the following expressions for the profit stream, discounted by a factor $0 \le \delta \le 1$, expected at time 0:

$$V_H = \Pi_H + \sum_{t=1}^{\infty} \delta^t \left(\frac{1+\rho}{2}\right)^{t-1} \left(\frac{\Pi_H + \Pi_L}{2}\right) = \Pi_H + \frac{\delta}{2-\delta(1+\rho)} (\Pi_H + \Pi_L) \tag{1}$$

[1]Suppose, for example, that at $t=0$ the state of demand is good. The firm will survive to period $t=1$ with probability 1. Either a bad or a good state can then occur at $t=1$, each with probability $\frac{1}{2}$. In the former case, the firm will survive to $t=2$ with probability ρ; in the latter case, the firm will survive with certainty. Hence the probability of ‘‘being around’’ at $t=2$, conditional to a good state realized at $t=0$. is equal to $(1+\rho/2)$.

when demand is currently high, and

$$V_L = \Pi_L + \sum_{t=1}^{\infty} \delta^t \rho \left(\frac{1+\rho}{2}\right)^{t-1} \left(\frac{\Pi_H + \Pi_L}{2}\right) = \Pi_L + \frac{\delta\rho}{2-\delta(1+\rho)} (\Pi_H + \Pi_L) \tag{2}$$

when demand is currently low.

If firms adopt a fully-collusive behaviour, prices are set at the monopoly level corresponding to each state of demand, p_H^m and p_L^m, yielding profits Π_H^m and Π_L^m in the good and bad state respectively. For the collusive outcome to be sustainable, the future losses from deviating from monopoly pricing must be larger than the (current) gains accruing to the deviating firm. Suppose that the rival firms adopt a trigger-strategy behaviour such that the deviation from collusive (monopoly) pricing in one period determines the reversion to the competitive (zero-profit) pricing in all future periods (''maximal-punishment principle''). Thus the gains from deviation amount to either Π_H^m or Π_L^m, whereas the losses are given by the second term in the right-hand side of either Eq. (1) or Eq. (2). Therefore, for collusion to be sustainable in periods of high current demand we must have:

$$\Pi_H^m \leq \frac{\delta}{2-\delta(1+\rho)} (\Pi_H^m + \Pi_L^m) \tag{3}$$

yielding the following condition on the discount factor δ:

$$\delta \geq \delta_H \equiv \frac{2}{K^m + (2+\rho)} \tag{4}$$

where $K^m \equiv (\Pi_L^m / \Pi_H^m)$ is the ratio between the level of monopoly profits in the low and high demand states, proxying for the amplitude of cyclical fluctuations ($0 \leq K^m \leq 1$). In periods of low demand collusion is sustainable if:

$$\Pi_L^m \leq \frac{\rho\delta}{2-\delta(1+\rho)} (\Pi_H^m + \Pi_L^m) \tag{5}$$

implying the following condition on δ:

$$\delta \geq \delta_L \equiv \frac{2K^m}{(1+2\rho)K^m + \rho} \tag{6}$$

From Eqs. (3) and (4) we see that a lower probability of avoiding liquidation in periods of low demand raises the critical values δ_H and δ_L necessary to sustain collusion: in both cases the future loss to the deviating firm is reduced by a lower ρ. Thus, a higher discount factor δ would be needed to compensate for the resulting greater incentive to deviate.

The case for $\rho = 1$ (certain survival in low demand states) yields the original Rotemberg-Saloner result: for $\delta_L < \delta < \delta_H$ collusion is sustainable only in low-demand states and markups display countercyclical behaviour. As shown in Fig. 1(a) the range of values for the discount factor yielding countercyclical markups (the shaded area in the figure) is wider the lower is K^m: when the amplitude of cyclical fluctuations is large (K^m tends to 0), current profits are high in favourable states, yielding a greater incentive to deviate, whereas profits are low in bad states, making collusion more likely. Indeed, when the firm incurs no liquidation risk in either state, it becomes easier to enforce monopoly

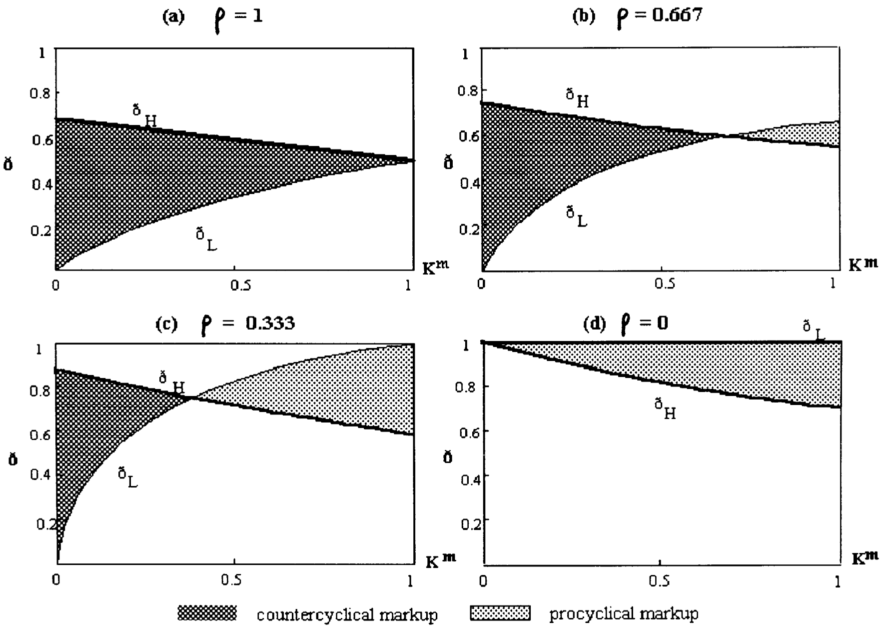

Fig. 1. Combinations of the discount rate δ and K^m (ratio of monopoly profits in the low and high demand states) yielding counter- and procyclical markups for different values of the ‘‘survival probability’’ ρ.

prices in recessions, when the gain from deviation is relatively low. Note also that, if there are no cyclical fluctuations ($K^m = 1$), collusion is sustainable in both high and low emand states if $\delta \geq \frac{1}{2}$, as in Friedman (1971).

In the above setting, the assumptions in CS lead to the termination of the firms with certainty if a low demand state occurs, corresponding to $\rho = 0$. In this case, δ_L is always greater than δ_H, which rules out the possibility of countercyclical markups. Hence, under the extreme assumption of certain liquidation in downturns, the claim put forward by CS (1996, p. 705) is correct: the Rotemberg-Saloner setup is unable to rationalize countercyclical markups; instead, it may even generate procyclical markups if $\delta_H < \delta < \delta_L$, as shown in Fig. 1(d).

In the less extreme case of a positive survival probability for firms in low demand states ($0 < \rho < 1$), markups may display counter- or procyclicality according to the magnitudes of ρ (capturing the relevance of financial constraints) and K^m (the amplitude of fluctuations). The following proposition summarizes the main results:

Proposition 1. *With $\rho \in (0,1)$, markups are countercyclical whenever $\delta_L < \delta < \delta_H$ holds, and procyclical if $\delta_H < \delta < \delta_L$.*

The proof goes as follows. From Eqs. (3) and (4), the direction of the inequality between δ_L and δ_H depends, for any given ρ, on the value of K^m. Denoting by K^* the (admissible) value of K^m which solves the equation $\delta_L = \delta_H$, it turns out that $K^* = \rho$. Then, if $K < K^*$, $\delta_L < \delta_H$: as in the Rotemberg-Saloner's original model, if $\delta_L < \delta < \delta_H$ collusion at monopoly prices is sustained only in low demand states, whereas in high demand states the price is p_H^*, lower than the corresponding monopoly level p_H^m, so that the following condition is satisfied:

$$\delta = \frac{2}{\dfrac{\Pi_L^m(p_L^m)}{\Pi_H^*(p_H^*)} + (2+\rho)} \tag{7}$$

On the other hand, if $K > K^*$, $\delta_L > \delta_H$: thus, when $\delta_H < \delta < \delta_L$, collusion occurs only in high demand states ($p_H = p_H^m$), whereas in low demand states the price is p_L^*, lower than the corresponding monopoly level p_L^m, such that:

$$\delta = \frac{2\,\dfrac{\Pi_L^*(p_L^*)}{\Pi_H^m(p_H^m)}}{(1+2\rho)\,\dfrac{\Pi_L^*(p_L^*)}{\Pi_H^m(p_H^m)} + \rho} \tag{8}$$

Fig. 1(b) and 1(c) illustrate examples with $\rho < 1$, showing the ranges of δ implying counter- and procyclicality of markups. (Recall also that, if $\delta > (\delta_L, \delta_H)$, firms always collude on monopoly prices (p_L^m, p_H^m). On the contrary, when $\delta < (\delta_L, \delta_H)$, firms collude in neither state of demand.)

The relevant implication of Proposition 1 is that, in contrast with the argument put forward by CS, the introduction of a ''survival probability'' in the Rotemberg-Saloner setup does not destroy in general the possibility that markups remain countercyclical. As the graph shows, the possibility of countercyclical markups is crucially related to the magnitude of the survival probability ρ, measuring the rate at which oligopolistic firms escape liquidation during recessions. One may also argue that, since oligopolistic firms are in general relatively big, their liquidation risk is rather small (''deep-pockets''): thus, the Rotemberg-Saloner explanation of markup countercyclicality may look as a plausible alternative to the liquidity-constraint explanation of CS.

Interestingly, ''survival probabilities'' may play a specific role also in the implicit-collusion model. In fact, it can be shown that when countercyclical behaviour occurs, the degree of markup countercyclicality is even magnified with respect to the standard Rotemberg-Saloner case, holding for $\rho = 1$. The following proposition holds:

Proposition 2. *Consider the case with countercyclical markups ($\delta_L < \delta < \delta_H$). It holds that: (i) The price set in low demand states is equal to p_L^* (the monopoly price), independently of ρ. (ii) Denoting as p_H^* the price set in a high demand state when $\rho < 1$, and as $p_H^{*\prime}$ the price set when $\rho = 1$ (the standard Rotemberg-Saloner case), it follows that $p_H^* < p_H^{*\prime}$.*

The proof of part (i) of Proposition 2 is straightforward, since p_L^m maximises current profits in low demand states (recall that the current period profit function is independent of ρ). As for part (ii), the argument goes as follows. In a high demand state, expression Eq. (7) must hold: thus, the lower ρ, the higher the ratio (Π_L^m/Π_H^*). As a consequence, given Π_L^m, a ρ smaller than one implies a lower Π_H^* and, hence, a p_H^* lower than $p_H^{*\prime}$ (the positive relation between p_H and Π_H is ensured by the fact that prices higher than the monopoly level, p_H^m, would always make undercutting profitable: see Tirole (1988, note 17, p. 249)).

The rationale for this result can be found by recalling that, according to Eq. (3), uncertain survival decreases the potential future loss for the deviating firm, enhancing the incentive to deviate in high demand states. Therefore, prices must be relatively lower in equilibrium.

Proposition 2 has an empirically relevant implication. Since liquidation risks can offer a specific contribution to the extent of markup countercyclicality also in the Rotemberg-Saloner model, it becomes quite difficult to sort out the implicit-collusion approach from the CS approach on the basis of regressions that mainly test the significance of liquidity-constraint variables on pricing behavior.

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