Monopolization through acquisition

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Introduction

The regulations imposed by anti-trust authorities on the behaviour of firms include merger guidelines aimed at preventing the monopolization of an industry through acquisition of rivals. As with any regulatory measures, they make sense only when the market mechanism produces some undesired effects. The theoretical viability of monopolizing an industry through acquisition of rivals in the absence of the prohibitions imposed by the antitrust authorities has been discussed in several papers[1].

[Kamien and Zang, 1990] proved that in a one-period game complete monopolization of an industry is impossible if, at least, three firms operate in it, i.e. one company cannot become a monopolist by simultaneous acquisition of the other firms. The impossibility of monopolization in the case of three firms results from an analysis based only on pure strategy equilibria. A question arises whether the outcome may differ when we allow each firm owner to use mixed strategies in his decision whether to sell his firm at an offered price or not.

In another paper, [Kamien and Zang, 1993] proved that a single bidder could monopolize an industry composed of three firms through a sequential acquisition, and will not succeed in monopolizing industries where more than three enterprises operate. The viability of such monopolization with three-firm industries stems from the assumption that one of the companies' owners will be successfully persuaded to sell his enterprise first and gain less than the one who will sell the company later. The justification of this assumption raises serious doubts when all the firms analyzed by the authors are identical.

In this paper, we would like to close the gap between different results obtained by [Kamien and Zang, 1990] and [Kamien and Zang, 1993], and to provide a new insight into the possibility of monopolization through acquisition in a three-firm industry. We will relax constraints imposed on the set of company strategies to include mixed strategies without making any assumptions regarding the order in which companies can be purchased. In the case when the firm owners are allowed to randomise in their decisions whether to sell enterprises at the offered price or not, we will prove that the buyer can monopolize an industry with a positive probability, realizing a positive expected profit. Mixed strategies can result in one of three possible scenarios depending on the number of enterprises sold in the first period. Monopolization will not take place when the realization of probability of sale equals zero, i.e. the owners decide not to sell their firms; this scenario is similar to one presented in the article [Kamien and Zang, 1990]. If the randomisation results in one owner selling his firm, the acquirer will monopolize the industry by purchasing the other firm with certainty in the next period; this scenario is similar to the sequential acquisition of [Kamien and Zang 1993]. Full monopolization can also be accomplished when both owners sell their firms in the first period. By means of numerical analysis we will prove that the bidder will

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[1]For a review of the literature see, e.g., in [Kamien and Zang,1993], or [Lehto and Tombak,1996].

have a positive expected profit from engaging in the process of monopolization through acquisition of enterprises.

In showing that the monopolization can be profitable in the industry with three firms, we left a crucial issue unresolved. When application of mixed strategies leads to the situation in which none of the companies is sold, a potential buyer has no opportunity to make further bids. This constitutes a static approach to the monopolization process. Since an acquisition process in any industry often requires more than just one purchase attempt, a static model creates a premature ending to the dynamic story.

Therefore, we also formulate in this paper a dynamic model of a single-firm owner's quest to monopolize an industry through acquisition of rival companies. The buyer has an opportunity to make several bids for an any number of firms. The purchase offer is derived as part of a Markov perfect equilibrium of an infinite horizon game. Our main objective is to study the process of monopolization by means of a new dynamic approach to the challenges presented by the three-company industry.

Although a potential buyer has more opportunities to take over rival enterprises in a dynamic setting, our analysis shows that his expected profit is strictly less than that predicted by equilibria of the static game. When acquisition fails in a static game the owner of an unsold company will suffer a considerable loss, because he will not be able to sell the company at a profit. However, while a potential buyer can make future purchase offers in the future, the owner of an enterprise knows that an initially failed acquisition attempt does not preclude further bids tomorrow, even from the same buyer. This situation intensifies "the free riding" among the owners of firms considerably reducing their probability of selling, and consequently driving down the bidder's expected profit from the acquisition of rivals.

Taking into account the dynamics of the acquisition process, we show that the bidder's expected profit made as a result of an attempt to monopolize a three-company industry by acquisition of rival companies is rather low. It means that existence of some transaction costs could prevent monopolization of an industry composed of three firms. For instance, at the real interest rate of 5 per cent, the symmetric equilibrium of the static game predicts the buyer's expected profit from engaging in monopolization through acquisition is about 4.2 per cent of the initial value of his firm. However, when we allow for multiple (and uncontested) purchase offers from the same bidder, the symmetric equilibrium of the dynamic game predicts that his expected profit is about 1/3 of 1 per cent of the initial value of his firm.

This finding - that the equilibrium expected profit of a potential acquirer in the three firm industry is very small - has an important regulatory implication: the market itself will not allow a single firm to acquire the remaining two and monopolize the industry. Keeping in mind the earlier results of Kamien and Zang (1990, 1993), we conclude that an industry with at least three firms cannot be profitably monopolized by a single buyer.

The remainder of this paper includes an analysis of an attempt to monopolize a three-firm industry by considering mixed strategies in a static model, a proposal of a dynamic theory of monopolization, and an analysis of the equilibrium behaviour of firm owners.

Monopoly Game

Let us consider an industry which consists of N=3 identical firms producing a homogeneous product and competing according to the Cournot model i.e. they set their output at the same time[2]. The function of company costs is denoted by $C(q) = cq$, where q stands for the volume of production, and c is a constant marginal (and average) cost. Let us denote the total production of the industry by Q. We assume that inverse demand function is linear, i.e. $P(Q) = a — Q$. Without loss of generality let $a - c = 1$. In this case the profit of a company in an industry with N identical firms is $\pi(N)= 1/(N + 1)^2$. We assume that the owners of enterprises are risk neutral and have a common discount factor α ($0 \leq a < 1$).

We assume that entry of new companies to the industry is impossible (high entry barriers).In the beginning each company is owned by an individual owner who, at the same time, is its manager. The owners participate in the game in which one of them – let us call him a bidder or a raider – may attempt to acquire any number of firms in the sector[3]. We will call each company that has not been taken over yet an acquisition target. Only whole companies are traded. Thus, after the sale an enterprise will be controlled by a new owner as a whole. Moreover, we will assume that an owner manages all companies taken over as if they constitute one enterprise. As marginal costs are constant it means that after taking over any of the rivals he manages only one firm[4].

The game starts in period t=1 and proceeds as follows. At the beginning of period t=1 a bidder makes an unconditional bid for the remaining companies, i.e. shows he is ready to purchase an unlimited number of enterprises at the price he offers. After they get to know the bid the owners of the other firms simultaneously take a decision about the possible sale of their enterprises. Contrary to the situation described by [Kamien and Zang, 1990, 1993], who consider only the area of pure strategies we assume in this paper that owners of enterprises have a possibility to apply mixed strategies. We assume that after selling their companies the owners leave the game.

If all rivals sell their firms to the buyer at the beginning of period t=1, he will always remain a monopolist, i.e. in periods t=1, 2, … . If no transaction is concluded in t=1, the firms will constitute a Cournot triopoly for ever.

If, however, in period t=1 the buyer takes over precisely one competitor then a Cournot duopoly will exist. At the beginning of period t=2 the buyer will be given another chance to make a bid for a remaining competitor. If the bid is accepted the buyer will become a monopolist in period t=2, 3 … . If the bid is turned down a Cournot duopoly will exist forever.

The payoff for every owner of a potential target company is the sum of discounted profits from production and, possibly, the company's sale price. The payoff for the buyer is a sum of discounted profit from production less the expenditure on the acquisition of competitors.

Let us move on now to finding the subgame perfect equilibrium[5]. Consider the subgame after the takeover of precisely one rival. The raider makes another purchase offer of r_1. The owner of the company unsold in the period t=1 may guarantee himself the duopoly profit by refusing to sell. Thus the raider has to offer at least the present value of the infinite stream of duopoly profits: $\pi(2)/(1-\alpha) = 1/[9 (1 - \alpha)]$. In an equilibrium the buyer offers $r_1^* = \pi(2)/(1-\alpha) = 1/[9(1-\alpha)]$, and

[2] See e.g. [Varian, 1999, pp. 477-482], [Samuelson and Marks, 2003, pp. 404-407], [Carlton and Perloff, 2000, pp.157-165].
[3] In this paper we assume that a buyer is determined exogenously. [Kamien and Zang, 1990 and 1993] allow every owner either to sell his company, or become a bidder. The buyer is determined endogenously also in the paper by [Harris,1994].
[4] Other assumptions concerning the situation before and after takeover, which can change bidder's behaviour are possible. E.g. [Perry and Porter, 1985] and [Compte, Jenny and Rey, 2002] consider companies that differ in the production capacity and manufacture homogeneous product, while [Kuhn and Motta, 1999] assume that a combination of differentiated products contributes to the value of a company.
[5] See, e.g., [Church and Ware, 2000, pp. 287-290].

the target owner sells his firm for sure. The equilibrium payoff to the raider from this subgame is

(1) $$V_1^* = \frac{\pi(1)}{1-\alpha} - r_1^* = \frac{1}{4(1-\alpha)} - \frac{1}{9(1-\alpha)} = \frac{5}{36(1-\alpha)}.$$

Since $V_1^* = \frac{5}{36(1-\alpha)} > \frac{\pi(2)}{1-\alpha}$, the offer r_1^* is indeed consistent with subgame perfection.

Let us consider a subgame in which a bidder has not taken over any of the rivals yet. We will denote the offered purchase price by *r*. Given *r* we will derive the optimal behaviour of the owners of remaining enterprises.

If the bid is lower than a triopoly profit $\pi(3)/(1\text{-}\alpha)$, then the weakly dominant strategy of the target owners is not to sell.

For $r \in (\pi(3(/(1-\alpha), \pi(2)/(1-\alpha))$, a symmetric pure-strategy equilibrium does not exist. However, there exists a symmetric mixed strategy equilibrium, and it entails each target owner selling his firm with probability *p* defined by

(2) $$r = p\frac{\pi(2)}{1-\alpha} + (1-p)\frac{\pi(3)}{1-\alpha}\ \text{, or}\quad \boldsymbol{r = p\frac{1}{9(1-\alpha)} + (1-p)\frac{1}{16(1-\alpha)}}$$

The l.h.s. of equality (2) denotes payoff for the owner upon selling his enterprise, the r.h.s. denotes the value expected in case he does not sell his enterprise.

If the bid *r* is not lower than duopoly profit $\pi(2)/(1\text{-}\alpha)$, both owners will sell their companies at a symmetric equilibrium point.

Thus at the unique symmetric equilibrium each target owner will sell his company with the probability:

(3) $$\hat{p}(r) = \begin{cases} 0 & \textit{if} \quad r \in [0, \pi(3)/(1-\alpha)], \\ \dfrac{144(1-\alpha)r - 9}{7} & \textit{if} \quad r \in (\pi(3)/(1-\alpha), \pi(2)/(1-\alpha)), \\ 1 & \textit{if} \quad r \geq \pi(2)/(1-\alpha). \end{cases}$$

The buyer offering the bid *r* expects that each rival will sell his company with the probability $\hat{p}(r)$. The expected payoff for the buyer is:

(4) $$V = \max_r p^2\left[\frac{\pi(1)}{1-\alpha} - 2r\right] + 2(1-p)p\left[\pi(2) - r + \alpha V_1^*\right] + (1-p)^2\frac{\pi(3)}{1-\alpha}.$$

Thus, the optimal tender offer is that value of *r* which maximizes

(5) $$\hat{p}^2\left[\frac{1}{4(1-\alpha)} - 2r\right] + 2(1-\hat{p})\hat{p}\left[\frac{1}{9} - r + \alpha\frac{5}{36(1-\alpha)}\right] + (1-p)^2\frac{1}{16(1-\alpha)}.$$

Hence we obtain the purchase price *r** and the probability of selling the company *p** at the equilibrium point[6] to be:

(6) $$r^* = \begin{cases} \dfrac{1}{16(1-\alpha)} & \textit{if} \quad \alpha \in [0, .5), \\ \dfrac{5(20\alpha - 1)}{144(1-\alpha)(8\alpha + 1)} & \textit{if} \quad \alpha \in [.5, 1). \end{cases}$$

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[6] To be more precise for α∈[0, 0.5), the bid is in the interval $\left[\mathbf{0}, \boldsymbol{\frac{1}{16(1-\alpha)}}\right]$. In this case equation (7) indicates that the probability of selling a firm is 0. Therefore further considerations will be conducted for α∈[0.5; 1).

$$(7) \qquad p^* = \begin{cases} 0 & if \quad \alpha \in [0,.5), \\ \dfrac{2(2\alpha-1)}{8\alpha+1} & if \quad \alpha \in [.5,1). \end{cases}$$

At the equilibrium point the payoff for the buyer will be:

$$(8) \qquad V^* = \begin{cases} \dfrac{1}{16(1-\alpha)} & if \quad \alpha \in [0,.5), \\ \dfrac{(4\alpha+1)(4\alpha+13)}{144(1-\alpha)(8\alpha+1)} & if \quad \alpha \in [.5,1). \end{cases}$$

Because the profit expected from a monopoly game is bigger than the triopoly profit, $V^* \geq \dfrac{\pi(3)}{1-\alpha}$, so r^* is consistent with subgame perfection.

Let us analyse the behaviour of enterprise owners at the equilibrium point. We should notice that if both target owners sell their firms already at the beginning of the game (at t=1), the buyer will make a net profit from the takeover because $\left[\dfrac{\pi(1)}{1-\alpha} - 2r^*\right] > \dfrac{\pi(3)}{1-\alpha}$ for every $\alpha \in [0, 1)$.

However, if the realization of the probabilities of selling the firm by their owners leads to a takeover of exactly one company in period t=1, the raider will be able to complete the process of monopolization by acquiring the remaining company in period t=2. Realized economic profit, in this case, will be positive for $\alpha \in (0.75, 1)$, because only then: $\left[\pi(2) - r^* + \alpha V_1^*\right] > \dfrac{\pi(3)}{1-\alpha}$. If $\alpha \in (0.5, 0.75)$, then $\left[\pi(2) - r^* + \alpha V_1^*\right] < \dfrac{\pi(3)}{1-\alpha}$, and the realization of the probability of selling will lead to monopolization of the sector but at an economic loss for the buyer. At a relatively low discount factor *(α* < 0.75) the buyer bidding at r^* hopes to take over both companies simultaneously already after the first bid. It indicates that despite expected net profit from the monopoly game there may be a risk of a loss. In this situation a risk averse bidder may abandon the attempt to take over competitors.

Table 1 shows the results of a numerical analysis for various values of the discount factor in the case of a static game. For reasonable values of the real interest rate, α will exceed 0.8. For example, even if the real interest rate is 25 per cent, the discount factor will be at least 0.8. A real interest rate of 5 percent yields a discount factor of about 0.95.

Table 1 indicates that if α = 0.8, the buyer may expect that by monopolizing the industry he will achieve an economic profit of 2 per cent of the present value of the infinite stream of triopoly profits. From (8) it follows that for α close to 1 the expected profit grows to about 4.94 per cent of the value of the company operating under triopoly[7]. It means that an attempt to acquire all rivals in the industry is *ex ante* profitable in expected terms.

Looking at the probabilities of selling their firms by the targets' owners shown in table 1 allows us to infer that they are above 0.16 for $\alpha \geq 0.8$. Expression (7) indicates that individual probability of selling a company converges to 0.22, when α goes to 1. It means that the probability of monopolization of an industry through acquisition of competitors is lower than 0.40.[8]

[7] For $\alpha \to 1$ expression (8) implies that $V^*/[\pi(3)/(1-\alpha)] \to 85/81 \approx 1.0494$.

[8] The probability that rivals will sell their companies to the bidder is $1-\left(1-p^*\right)^2 < 1-(1-0.22)^2 < 0.40$.

It is interesting that during the monopolization process, the owners of companies which are acquisition targets can earn a higher price than the initial value of their enterprises. The expected premium is about 15 per cent of the initial value of a company in the industry.

The above analysis, which showed that monopolization through acquisition of rivals can be profitable in a three-company industry, is based on an important assumption regarding the number of bids. It has been assumed that the buyer will never make another bid again in case no owner sells his company in response to the first bid, i.e. in period t=1. Since consolidation of any industry requires numerous purchase attempts, preventing a buyer from making several bids causes premature termination of the process which is dynamic in itself. Therefore in the next section we will formulate a dynamic model of a single-firm owner's quest to monopolize an industry through acquisition of competitors.

Table 1

Symmetric equilibrium of a static game: effect of the discount factor

α	r^*	p^*	V^*	$\pi(3)/(1-\alpha)$	$V^*/\pi(3)/(1-\alpha)$
0.5	0.125	0	0.125	0.125	1.000
0.6	0.165	0.069	0.157	0.156	1.006
0.7	0.228	0.121	0.211	0.208	1.014
0.8	0.352	0.162	0.319	0.313	1.019
0.85	0.475	0.179	0.428	0.417	1.026
0.9	0.720	0.195	0.647	0.625	1.035
0.95	1.453	0.209	1.302	1.250	1.042
0.99	7.318	0.220	6.549	6.250	1.048

α ≡ discount factor
r^* ≡ equilibrium tender offer
p^* ≡ equilibrium probability of a target owner selling his firm
V^* ≡ raider's equilibrium payoff
$\pi(3)$ ≡ company profit in triopoly

Dynamic Theory of the Monopolization Process

Dynamic Model

We will formulate a dynamic model of monopolization through acquisition on the basis of a repeated monopoly game. The game begins in the period t=1 and proceeds as follows. At the beginning of each period the raider makes an unconditional bid for all remaining companies, i.e. declares readiness to buy any number of existing companies at an offered price. Given the purchase offer, the owners of the target companies simultaneously decide whether to sell their firms or to wait. As in our static game the owners are allowed to randomise.

In each period the companies which have not been sold (including the bidder's enterprise) engage in Cournot competition. The game is terminated when the raider acquires all the companies in the industry and becomes a monopolist. The payoff for each target owner is the sum of his discounted production profits and, possibly, the revenue from the sale of his firm. The raider's payoff is the sum of discounted production profits less the cost of rivals' acquisition. There is no limit on the number of periods when a bidder can make an attempt to acquire existing competitors.

A history of the game in period t is defined as a sequence composed of past purchase offers and the number of firms owned by the raider. Let H^t denote the space of possible histories at t. A raider's strategy is a sequence of functions, $\{\psi^t(\cdot)\}_{t=1}^{\infty}$, where ψ^t: $H^t \to \mathbf{R}_+$. Function ψ^t tells the raider what tender offer to make in period t conditional on the history at t. A target owner's strategy is a sequence of functions, $\{\varphi^t(\cdot)\}_{t=1}^{\infty}$, where φ^t: $H^t \times \mathbf{R}_+ \to [0, 1]$. Given he has not already sold his firm, φ^t is the probability that the target owner sells given the history at t and the current purchase offer. We assume that all firm owners (the targets' owners and the raider) are risk neutral and have a common discount factor of $\alpha \in [0, 1)$.

Since the targets' owners are identical, our solution concept is symmetric Markov perfect equilibrium. The payoff-relevant state variable m is the number of the firms sold, or equivalently, the number of targets purchased by the raider. At a Markov perfect equilibrium, the raider's strategy is a function that maps from $\{0,1\}$ into $\mathbf{R}_+$ and a shareholder's strategy maps from $\{0,1\} \times \mathbf{R}_+$ into $[0, 1]$.

Symmetric Markov Perfect Equilibrium

In this section, we describe the method for constructing a symmetric Markov perfect equilibrium. An equilibrium is defined by a recursive system of equations and can be solved by backward induction. Since the game ends as soon as the raider owns all firms, payoffs are uniquely determined when the state variable, m, equals 2. The first step is to solve for a symmetric Markov perfect equilibrium when m=1. Having solved for that equilibrium, payoffs are determined for $m \geq 1$. Next, we solve for the Markov perfect equilibrium when m=0, which is also an equilibrium for the entire game.

Consider the subgame m=1, when the raider acquired all but one firm and makes a purchase offer of r_1. Here the situation is not different from our previous considerations of the static monopoly game: the target owner can guarantee himself the duopoly profit. Thus, in an equilibrium, the raider offers $r_1^* = \pi(2)/(1-\alpha) = 1/[9(1-\alpha)]$, and the target owner sells his firm for sure. The equilibrium payoff to the raider from this subgame is

(9) $$V_1^* = \frac{\pi(1)}{1-\alpha} - r_1 = \frac{1}{4(1-\alpha)} - \frac{1}{9(1-\alpha)} = \frac{5}{36(1-\alpha)}$$

Next, we will solve for an equilibrium when the raider has not acquired any target firms yet, i.e. m=0. Let $\hat{r}$ denote expectation of the targets' owners on next period's value of their firms when the state variable is unchanged; that is, no firms were sold this period. Without loss of generality, we can assume $\frac{\pi(3)}{1-\alpha} \leq \hat{r} \leq r_1^* = \frac{\pi(2)}{1-\alpha}$ since this must be true in equilibrium. Ultimately, $\hat{r}$ will be derived, but for the time being it is taken as exogenous.

Given (r; $\hat{r}$), let us derive the optimal target owner's behaviour. If $r \leq \alpha\hat{r}$ then the weakly dominant strategy is not to sell. Selling yields r, whereas not selling yields $\alpha\hat{r}$ when no one else sells and $r_1^* = \pi(2)/(1-\alpha) = 1/[9(1-\alpha)]$ when the other target owner sells his firm. The unique equilibrium is for each target owner not to sell when $r \leq \alpha\hat{r}$.

For $r \in (\alpha\hat{r}, r_1^*)$, selling is not a symmetric equilibrium because it yields r, whereas not selling yields r_1^* due to the purchase of one firm by the raider. Nor is not selling a symmetric equilibrium, because it yields $\alpha\hat{r}$ while selling, given everyone else is not selling yields r. Hence, a symmetric pure-strategy equilibrium does not exist when $r \in (\alpha\hat{r}, r_1^*)$. However, a symmetric mixed-strategy equilibrium does exist, and it entails each target owner selling his firm with probability p defined by

$$(10)\quad r = p\frac{\pi(2)}{1-\alpha} + (1-p)(\pi(3) + \alpha\hat{r}), \text{ or } r = p\frac{1}{9(1-\alpha)} + (1-p)\left(\frac{1}{16} + \alpha\hat{r}\right).$$

The term r is the payoff from selling, and the r.h.s. of (10) is the payoff from not selling. It is derived as follows. In the event when the other target owner sells his firm with probability p, the target owner who did not sell his firm earns $\pi(2)/(1-\alpha)$. If instead the other target owner does not sell either, which occurs with probability $(1 - p)$, each of them receive a payoff of $\pi(3)$ this period plus $\hat{r}$ in the next period. The final case is when $r \geq \pi(2)/(1-\alpha)$. It is easy to show that the unique symmetric equilibrium is for all shareholders to tender. It follows from the above analysis that a target owner's strategy at the unique symmetric equilibrium is

$$(11)\qquad \hat{p}(r;\hat{r}) = \begin{cases} 0 & \text{if} \quad r \in [0, \alpha\hat{r}], \\ \dfrac{r - \alpha\hat{r} - 1/16}{1/[9(1-\alpha)] - \alpha\hat{r} - 1/16} & \text{if} \quad r \in (\alpha\hat{r}, r_1^*), \\ 1 & \text{if} \quad r \geq r_1^*. \end{cases}$$

When he makes a tender offer of r, a raider expects a target owner to sell his firms with probability $\hat{p}(r;\hat{r})$. Let $V(\hat{r})$ denote the value function for the raider when m=0 given $\hat{r}$:

$$(12)\qquad \boldsymbol{V(\hat{r}) = \max_r p^2\left[\frac{\pi(1)}{1-\alpha} - 2r\right] + 2(1-p)p\left[\pi(2) - r + \alpha V_1^*\right] + (1-p)^2\left[\pi(3) + \alpha V(\hat{r})\right].}$$

Recall that $\hat{p}$ is a function of r as well as $\hat{r}$. With probability p^2 both targets' owners sell their firms in which case the raider earns a returm of $\pi(1)/(1-\alpha)$. Note that these two firms cost him $2r$. With probability $2p(1-p)$ exactly one target owner sells his firm in which case the raider earns $[\pi(2) - r + \alpha V_1^*]$. When none of the targets' owners sells, the state variable is unchanged so that his payoff is $\pi(3) + \alpha V(\hat{r})$. Solving (12) for $V(\hat{r})$, the optimal tender offer is that value of r which maximizes

$$(13)\qquad \frac{\hat{p}^2\left[\dfrac{\pi(1)}{1-\alpha} - 2r\right] + 2(1-\hat{p})\hat{p}\left[\pi(2) - r + \alpha V_1^*\right] + (1-\hat{p})^2\pi(3)}{1 - \alpha(1-\hat{p})},$$

or

$$\frac{\hat{p}^2\left[\dfrac{1}{4(1-\alpha)} - 2r\right] + 2(1-\hat{p})\hat{p}\left[\dfrac{1}{9} - r + \alpha\dfrac{5}{36(1-\alpha)}\right] + (1-\hat{p})^2\dfrac{1}{16}}{1 - \alpha(1-\hat{p})}.$$

Since $\hat{p}$ is continuous in r, then a maximum to (13) exists. Assuming it is unique, denote it $r^0(\hat{r})$. It is straightforward to show that $r^0 < \pi(2)/(1-\alpha)$.

Thus far, equilibrium strategies for the raider and the targets' owners have been derived when m=0 and $\hat{r}$ is expectation of the targets' owners on the value of a firm next period given that the state variable is unchanged. The final step in deriving a symmetric Markov perfect equilibrium is to ensure that the owners' expectation of tomorrow's firm value is correct. At a Markov perfect equilibrium the value of a firm tomorrow, given the state variable is the same as today, must equal the value of a firm today. The latter is $r^0(\hat{r})$, and the former is $\hat{r}$. Thus the equilibrium purchase offer when m=0, denoted r^*, is defined by the following fixed point:

(14) $$r^* = r^0(r^*).$$

Since $r^* \in (\alpha r^*, \pi(2)/(1-\alpha))$ then, according to (10) the targets' owners randomise when the equilibrium purchase offer is made. Letting p^* denote the equilibrium probability of selling a firm given that the equilibrium purchase offer of r^* is made, it is defined by

(15) $$p^* = \frac{r^* - \alpha r^* - 1/16}{1/[9(1-\alpha)] - \alpha r^* - 1/16}.$$

The equilibrium outcome of the game is then (r^*, p^*). Finally, let V^* denote the raider's equilibrium payoff: $V^*=V(r^*)$.

Equilibrium Behaviour of the Raider and the Targets' Owners

The assumption that the raider can make multiple offers to acquire rivals brings in a potentially relevant feature of the environment. The downside to this extension is that the closed form solution cannot be found. We conducted numerical analysis to explore the properties of equilibrium. The equilibrium of our game is particularly amendable to numerical analysis since there is only one unspecified parameter, namely the discount factor, α.

Numerical analysis generated values for r^*, p^*, V^* that are defined in the preceding section. Table 2 shows equilibrium values for various discount factors. Note that the raider can expect to profitably monopolize the industry whenever $\alpha \geq 0.5$.

As was mentioned earlier, for reasonable values of real interest rate, α will exceed 0.8. When α=0.8 (the real interest rate is about 25 per cent), the raider can expect to earn not more than one half of 1 per cent of his firm value. With α=0.95 (the real interest rate is about 5 per cent), a raider's expected profit is about one third of 1 per cent of the initial firm value. For example, if the initial value of a firm in the industry is \$1 billion, the expected profit from attempting monopolization through acquisition is \$3.3 million. An analysis of the probabilities of selling their firms by the targets' owners shows that they are extremely low, and do not exceed 0.04 for any values of α. Such a low probability of selling puts the success of a monopolization process under a serious doubt.

In the static game, a target owner stands to lose a lot by not selling his firm. If the other target owner does not sell his firm either, both of them have lost any opportunity of selling their firms at a premium. This creates a strong incentive to sell on the part of the targets' owners and results in higher probabilities of selling, as well as higher raider's expected profits from monopolization. When α=0.95, the probability of a target owner selling is about 0.209 and the raider's expected profit is 4.2 per cent of his firm initial value. However, when the takeover bid is not a one-time affair, the downside to not selling today is lessened. Even if the purchase offer is not initially successful, it may succeed in the future. This makes the targets' owners much less anxious to sell their firms, and results in considerably lower expected profits to the acquirer. When α=0.95, the probability of selling is about 0.017 and the raider's expected profit equals 1/3 of 1 percent of the firm initial value; that is 12 times less than in the static game. It follows that if a raider could commit, he would like to make a one-time purchase offer to acquire his rivals, and come back to the market only when at least one of them sold his firm.

Assuming there are some fixed costs associated with either attempting or consummating an acquisition, a dynamic theory predicts that the monopolization of even the three-firm industry is rather not profitable and quite unlikely; and it is certainly much less profitable and less successful than predicted by a static theory.

Table 2

Symmetric Markov perfect equilibrium: effect of the discount factor

α	r^*	p^*	V^*	$\pi(3)/(1-\alpha)$	$V^*/ (3)/(1-\alpha)$
.5	.125	0	.1250	.1250	1.0000
.6	.164	.026	.1564	.1563	1.0006
.7	.227	.038	.2089	.2083	1.0029
.8	.354	.039	.3140	.3125	1.0048
.85	.480	.035	.4188	.4167	1.0050
.9	.734	.028	.6279	.6250	1.0046
.95	1.496	.017	1.2542	1.250	1.0034
.99	7.606	.004	6.2552	6.250	1.0008

$\alpha \equiv$ discount factor
$r^* \equiv$ equilibrium tender offer
$p^* \equiv$ equilibrium probability of a target owner selling his firm
$V^* \equiv$ raider's equilibrium payoff
$\pi(3) \equiv$ company profit in triopoly

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Concluding Remarks

In this paper we have analysed the possibility of monopolizing a three-company industry through acquisition of rivals in the absence of regulatory restrictions. The problem has been formulated as a noncooperative game with firm owners as players. The analysis has been conducted in two different models: static and dynamic. In each of them a single bidder considers the possibility of monopolizing an industry through acquisition of rivals. Unlike the models available in the literature to date, beside pure strategies we have also included mixed strategies in the set of strategies available for company owners.

The static model led us to the conclusion that an attempt to monopolize an industry through enterprise acquisition could be a profitable undertaking. However, the dynamic formulation of the process suggests that the expected profit from such an attempt is much lower and might be insufficient to cover any acquisition-related costs. Moreover, the probability of selling a company by its owner is close to zero, which makes the whole process highly improbable. It means that the free-rider problem among the owners of companies makes an attempt to monopolize an industry not very profitable, even in a three-firm industry.

These results have very important implications for regulatory measures aimed at limiting the acquisitions leading to monopolization of an industry; namely, the market itself will prevent a single bidder to take over both rivals in a three-firm industry. Our conclusions supplement the results of [Kamien and Zang, 1990 and 1993}who showed that a single bidder was not able to monopolize at a profit an industry with at least four companies. In this paper we extended that result to a three-firm industry.

[Kamien and Zang,1993] conclude that "It is at low market rates of interest that the anti-trust authorities may seek to discourage mergers …". Our results for three-firm industry lead to the conclusion that monopolization through acquisition is profitable when interest rates are low but only if a bidder is able to persuade everyone that he is launching a one-off bid and he returns to the market only after the selling of an enterprise by one of the owners. However, an attempt to monopolize has very slim chance of success, and the expected bidder's payoff is low (if positive at all after taking into account transaction costs) when a bidder has a very faint possibility to make a reliable pledge not to put additional bids.

The numerical analysis based on the dynamic model of monopolization showed that for any values of real interest rates, the expected profit for a bidder and the probability of selling a target are small and close to zero in the case of low interest rates. That is why anti-trust agencies do not have to become more active, even with decreasing interest rates.

Clearly, further research into the dynamics of the monopolization process is necessary. A natural issue to be raised is the analysis of the acquisitions of companies by more than one bidder. [Kamien and Zang,1993] proved that a market with a few bidders who take over rivals in turn allows reduction of an individual burden of the free-riding problem and offers better chances of monopolization. For example, if the demand is linear, an industry with four companies can be monopolized by two bidders. Yet, the final answer to the question about the reality of monopolization by a few bidders depends on the precise estimation of gains.

Another issue to consider is the possibility of making more than one bid in one period. In this study (and also in papers by [Kamien and Zang 1991 and 1993] transactions are concluded during a given production or accounting period. In practice these processes are independent. A possibility of a few bids during one production or accounting period is particularly important when the research into company owners' behaviour is based on mixed strategies. The pursuit of mixed strategies may lead to the owner not being able to sell his company in response to a certain bid but then he will have another opportunity of selling his enterprise very soon. As a result target owners may demand a higher price decreasing in this way the bidder's expected profits from attempted monopolization of the market. These and other aspects of monopolization through acquisition will be the subject of further research in this field.

References

Carlton D.W., Perloff J.M., [2000], *Modern Industrial Organization,* Addison-Wesley.

Church J., Ware R., [2000], *Industrial Organization. A Strategic Approach,* The McGraw-Hill .

Compte O., Jenny F., Rey P., [2002], *Capacity Constraints, Mergers and Collusion,* European Economic Review, 46(1), pp. 1-29.

Fudenberg D., Tirole J., [1992], *Game Theory,* The MIT Press, Cambridge, Massachusetts.

Harris E.G., [1994], *Why One Firm Is the Target and the Other the Bidder in Single-Bidder Synergistic Takeovers,* Journal of Business, 67, pp. 263-80.

Kamien M.I. and Zang I., [1990], *The Limits of Monopolization Through Acquisition,* Quarterly Journal of Economics, 105, pp. 465-99.

Kamien M.I. and Zang I., [1993], *Monopolization Through Sequential Acquisition,* Journal of Law Economics and Organization, 9, pp. 205-29.

Kuhn K.U., Motta M., [1999], *The Economics of Joint Dominance,* mimeo.

Lehto P. and Tombak M.M., [1996], *Consolidation and the Sequence of Acquisitions to Monopoly,* mimeo.

Perry M.K., Porter R., [1985], *Oligopoly and the Incentive for Horizontal Merger,* American Economic Review, 75, pp.219-227.

Samuelson W.F., Marks S.G., [2003], *Managerial Economics,* J. Wiley & Sons.

Tirole J., [1997], *The Theory of Industrial Organization,* The MIT Press, Cambridge, Massachusetts.

Varian H.R., [1999], *Intermediate Microeconomics. A Modern Approach,* W.W. Norton & Co., New York.