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Mergers, Litigation and Efficiency

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Abstract
We consider antitrust enforcement within the adversarial model used by the United States. We show that, under the adversarial system, the Antitrust Authority may try to prohibit mergers also in those cases in which litigation is inefficient. Even if market concentration and technological disadvantages lead to a significant welfare reduction after merger, from society's perspective the agency's lawsuit may be inefficient. We can show that these inefficiencies may be aggravated if the takeover is hostile.

Key words: hostile takeover; litigation contest; merger
JEL classification: D43; K21; L40

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1 Introduction

From society's point of view, a merger should be prohibited if it were accompanied by a welfare loss. However, in the Western World there exist different forms of antitrust enforcement.[1] In the United States (U.S.), an adversarial system is used in which the Antitrust Authority (AA) must explicitly sue the acquiring firm and prove to a district court judge that merging will harm society. Then merging will not happen if and only if the agency wins the litigation contest against the acquiring firm. In the European Union (E.U.), we have a kind of administrative or inquisitorial system. Here, the AA can simply forbid merging without going to court.

This paper focuses on the U.S. or adversarial system and points out that this kind of antitrust enforcement may be problematic because of its costly litigation procedure. In particular, we will show that there are situations in which the AA sues the acquiring firm although this litigation is inefficient from society's perspective because overall resource expenditures in the litigation contest exceed the expected welfare loss following the potential merger (*inefficiency condition*). We can show that even if merging harms society by both market control and technological disadvantages (i.e. ex-post marginal costs of the buyer are higher than ex-ante ones) the agency should not always become active under the adversarial system. Furthermore, in the case of a hostile takeover the problem of inefficient litigation may be aggravated if the top management of the target firm assists the agency in the litigation contest by spending time and resources of its firm.

Note that, in fact, we have two inefficiency problems which represent two sides of the same coin. On the one hand, the AA can always become active if

[1] Baker (2005) gives a clear comparison of both forms of antitrust enforcement. For a general economic comparison of both court methods see Tullock (1975).

post-merger welfare would be smaller than pre-merger welfare (scenario 1). If in this case the agency does not care for future litigation costs, suing the acquiring firm may be inefficient (i.e. the inefficiency condition may hold). On the other hand, the agency may anticipate future litigation costs and will remain inactive if these costs are too high (scenario 2). In other words, the agency will not sue the acquiring firm if the inefficiency condition is satisfied. However, in this scenario there are exactly the same problematic cases as in the scenario before – all those cases that fulfill the inefficiency condition. In these cases, now the AA allows merging (with probability one), since it has to stick to the adversarial procedure, although society clearly suffers from merging because ex-post welfare is smaller than ex-ante welfare. As both scenarios lead to the same problematic cases, we only have to consider one scenario. We will consider the first one.

There is anecdotal evidence that the problem we are discussing in this paper is indeed a highly relevant one.[2] This evidence comes from the lawsuit of the Department of Justice (DOJ) against Oracle which wanted to take over PeopleSoft. Since merging was against the will of PeopleSoft's top management we have a strictly hostile takeover. Both Oracle and PeopleSoft were important corporations operating in the market for computer software.

[2] Besides this case, Baker (2005, p. 5) states: "The powerful incentives for developing and testing evidence created by the adversarial approach of the United States may at times lead to wasted resources. The extensive evidentiary production in the typical second request, supplied by the merging parties at great expense and substantial loss of executive time, is largely chaff and not wheat. Certainly, in retrospect, much appears wasted.....In addition, much of the massive effort involved in trial preparation on both sides of the case has little social value, notwithstanding its litigation benefit to the parties." Similarly, Baumol and Ordover (1985, p. 248), summarize: "One knows that the costs in terms of the time of management, lawyers, economists, and others absorbed in the litigation process itself are enormous."

As the DOJ argued, a takeover would lead to a decline of innovation and would also harm society because of significant market concentration. The Oracle-DOJ trial started just after announcement of the takeover in June 2003 and lasted until September 2004 when a federal judge allowed Oracle to pursue its takeover bid. However, the whole takeover was completed four months later in January 2005 since PeopleSoft's top managers had decided to apply typical defense measures such as poison pills which resulted in additional lawsuits. The Oracle-DOJ case is interesting for different reasons. First, the lawsuit was very time consuming and long lasting. Second, both parties significantly spent resources in the trial. Oracle paid millions of dollars on lawyers fees. According to Oracle's fourth-quarter earnings call 2004, it has spent 54.2 million up to that date.[3] The costs of the DOJ can only be estimated but should be comparable to that of Oracle. Third, since the takeover was hostile, PeopleSoft's top managers massively assisted the DOJ during the trial and spent lots of resources in the takeover battle and the lawsuit. According to PeopleSoft's filings with the Securities and Exchange Commission (SEC) these resources came up to 70 million dollars.[4] Finally, since PeopleSoft's top managers also fought against Oracle's takeover bid independently of the Oracle-DOJ trial by using typical defense activities we have two battles that are partly sequential. All these characteristics can be found in our modelling in the next sections.

As often pointed out in the merger literature (e.g., Baumol and Ordover 1985), society faces a fundamental dilemma. On the one hand, mergers may be welfare enhancing by generating cost advantages or, more generally, syn-

[3] See Boucher Ferguson (2004).

[4] See again Boucher Ferguson (2004). As Pallatto (2004) took it: "The stakes are so high in Oracle's interminable campaign to buy out PeopleSoft that both companies could end up bleeding themselves to exhaustion in this war of attrition."

ergies which are in line with efficiency considerations. On the other hand, mergers may also be anticompetitive and, hence, welfare reducing. There are several papers on antitrust enforcement which are based on this dilemma when deriving the optimal standard for challenging or approving a merger. Besanko and Spulber (1993) assume that merging firms are better informed about potential cost savings from the merger. The AA optimally reacts to this information asymmetry by setting a standard that is stronger than the social welfare criterion. Lagerlöf and Heidhues (2005) also address the asymmetric-information problem. They consider a game between society and two merging firms which have private information about efficiency of the merger which can be used to influence the decision of the AA. While the merging firms' information is helpful for the antitrust decision, processing and gathering information is assumed to be costly. Within this setting, Lagerlöf and Heidhues derive society's optimal antitrust decision rule. In the model by Motta and Vasconcelos (2005), each merger has to be approved by the AA before being executed where the agency is either myopic or forward looking (i.e. it anticipates subsequent merging). The agency's type clearly determines its antitrust decision. There are no efficiency problems concerning a forward looking agency. Finally, Neven and Röller (2005) raise the question whether the AA should apply a consumer surplus standard or a welfare standard when challenging a merger. In their setting, third parties can choose rent-seeking activities in order to influence the AA which is only imperfectly monitored.

Our model departs from these papers by two means. First, we do not address the question of society's optimal antitrust decision rule but focus on the process of the adversarial system which is based on an explicit litigation contest. Second, and related to the first point, we do not face the fundamental dilemma of merging since we assume that the given merger is purely anticompetitive and, therefore, always welfare reducing and may even lead to cost disadvantages.

The paper is organized as follows. In the next section, we will introduce a basic model on the litigation contest between the AA and the acquiring firm. In Section 3, we derive a condition for the contest to be efficient and show that this condition is always satisfied in the linear Cournot model, but always violated under Bertrand competition. Section 4 then focuses on the case of a hostile takeover and introduces the top management of the target firm as third party participating in the contest. In Section 5, we discuss the case in which the purchase price of the acquiring firm is not adjusted to the target management's resource expenditures spent in the litigation contest. Moreover, we analyze the situation of a hostile takeover with two sequential contests in which first litigation between the AA and the acquiring firm happens. Thereafter, if the agency fails, a takeover battle between the raider and the target management will take place. Section 6 will conclude.

2 The Basic Model

We consider a duopoly where firm B (buyer) wants to obtain market control by acquiring firm T (target firm).[5] The pre-merger duopoly profits are π_B for firm B and π_T for firm T. We assume that B has to pay the amount π_T to player T in case of a merger. Then firm T is shut down; hence the only motive for a merger is decreasing competition.[6] The post-merger market

[5] The model can easily be extended to the case of an oligopoly with $N \geq 2$ firms.

[6] This modelling of mergers is also utilized by Salant et al. (1983), Kamien and Zang (1990), Fauli-Oller and Motta (1996), Gonzalez-Maestre and Lopez-Cunat (2001), Ziss (2001). In the case of constant marginal costs, for example, the buyer is indifferent between

profit of B is described by $\hat{\pi}_B$ with $\hat{\pi}_B > \pi_B$ and $\Delta\pi_B := \hat{\pi}_B - \pi_B$. Let consumers' surplus be CS^D under duopoly and CS^M under monopoly after the successful merger. Hence, welfare can be defined as

$$W^D = CS^D + \pi_B + \pi_T \tag{1}$$

under duopoly, and

$$W^M = CS^M + \hat{\pi}_B \tag{2}$$

in the monopoly case. Let $\Delta W := W^D - W^M$.

It is assumed that the AA A has to prohibit the merger according to the Merger Guidelines because of $\Delta W > 0$. In order to be successful, A has to go to court and win the respective litigation contest against B. In the contest, A spends a certain amount of resources $x_A \geq 0$ to influence its winning probability $p(x_A, x_B) \in [0,1]$ where x_B denotes the resources invested by firm B. Naturally, the winning probability of firm B is given by $1 - p(x_A, x_B)$. $p(\cdot,\cdot)$ is a differentiable function, on which we impose the following assumption:[7]

Assumption 1: (i) $p(\cdot,\cdot)$ is symmetric, i.e. $p(x_A, x_B) = 1 - p(x_B, x_A)$, (ii) $p_1 > 0$, $p_{11} < 0$, $p_2 < 0$, $p_{22} > 0$, (iii) $p_{12} > 0 \Leftrightarrow p > 0.5$.

Part (i) is a standard assumption as well as part (ii), which implies that spending resources has positive but diminishing marginal effects on the own probability of winning the contest. Moreover, part (iii) is very intuitive, too. If, initially, the agency A chooses higher expenditures, a marginal increase in x_B makes it more attractive for A to increase x_A as well. This is due to the more intense competition the increase in firm B's expenditures has caused.

shutting down the acquired firms or not.

[7] Here, as well as in all what follows, a subscript accompanying the function $p(\cdot,\cdot)$ denotes a partial derivative.

Similarly, if, initially, $x_A < x_B$, an increase in x_B makes the contest more uneven so that it is beneficial for the agency to invest less. Note that part (iii) together with Young's theorem implies that $p_{21} > 0 \Leftrightarrow p > 0.5$, which can be interpreted analogously. Notice further that part (iii) is fulfilled for the two most frequently used specifications of $p(x_A, x_B)$, the logit-form contest-success function[8] and the probit-form contest-success function[9].

Note that typically we will have an asymmetric contest with $P_A = \Delta W$ denoting the winner prize of A and $P_B = \Delta\pi_B - \pi_T$ that of firm B. We assume $P_B > 0$ to focus on the interesting cases in which a merger is profitable for buyer B. In order to guarantee the existence of interior equilibria at the litigation stage we additionally introduce the following assumption:

Assumption 2: The parameter constellations are such that $P_A p_1(0, x_B) > 1$, $\forall x_B \geq 0$, and $-P_B p_2(x_A, 0) > 1$, $\forall x_A \geq 0$, $\forall P_A, P_B > 0$.

In the next section, we will investigate under which conditions the litigation contest initiated by the AA is efficient. Section 4 then deals with the case of a hostile takeover where the top management of the target firm may assist A to win the contest against B.

3 Litigation Contest between Antitrust Authority and Buyer

In the contest, the agency chooses x_A in order to maximize

$$\Delta W \cdot p\left(x_A, x_B\right) - x_A,$$

[8] The logit-form contest was introduced by Tullock (1980) and is dealt with in more detail in Section 3. For a formal proof that part (iii) of Assumption 1 is fulfilled in both kinds of contest see Dixit (1987).

[9] See, e.g., Lazear and Rosen (1981).

whereas buyer B spends resources to maximize

$$(\Delta\pi_B - \pi_T) \cdot (1 - p(x_A, x_B)) - x_B.$$

Since both objective functions are strictly concave, equilibrium behavior (x_A^*, x_B^*) is characterized by the first-order conditions

$$\Delta W p_1(x_A^*, x_B^*) = 1 = -(\Delta\pi_B - \pi_T) p_2(x_A^*, x_B^*). \tag{3}$$

From the perspective of the society, it will be efficient to start the litigation contest if expected welfare minus overall resource expenditures exceeds welfare under monopoly:

$$W^D \cdot p(x_A^*, x_B^*) + W^M (1 - p(x_A^*, x_B^*)) - x_A^* - x_B^* > W^M.$$

Hence, we obtain our first result:

Proposition 1 *The litigation contest will be efficient if and only if*

$$\Delta W p(x_A^*, x_B^*) > x_A^* + x_B^*. \tag{4}$$

According to Proposition 1 suing firm B will only be desirable from society's perspective if the expected welfare gain from winning the litigation is greater than the sum of expenditures by both parties. However, if the agency's likelihood of winning or the welfare gain are rather small and/or the two parties choose high investments in equilibrium, starting a law suit against B will not pay off for society. In the following, we will investigate whether condition (4) may be violated under standard competition models and typical contest-success functions $p(x_A, x_B)$.

Consider the case of the well-known contest-success function[10]

$$p\left(x_A, x_B\right) = \begin{cases} \frac{x_A}{x_A + x_B} & \text{if } x_A + x_B > 0 \\ 0.5 & \text{otherwise} \end{cases} \tag{5}$$

which has been introduced by Tullock (1980).[11] Here, the first-order conditions (3) yield

$$x_A^* = \frac{P_B P_A^2}{\left(P_B + P_A\right)^2} \quad \text{and} \quad x_B^* = \frac{P_B^2 P_A}{\left(P_B + P_A\right)^2} \tag{6}$$

with $P_A = \Delta W$ and $P_B = \Delta\pi_B - \pi_T$ as defined in Section 2. Then simple calculations show that, under the Tullock contest success function, condition (4) can be written as

$$\Delta W > \Delta\pi_B - \pi_T. \tag{4'}$$

Note that by inserting for ΔW in (4') we obtain $CS^D - CS^M > 2\left(\Delta\pi_B - \pi_T\right)$. Hence, if the reduction of consumers' surplus is sufficiently large and the buyer's profit increase $\Delta\pi_B$ sufficiently small, litigation will be efficient.

As examples, we will now take a look at two standard models of duopolistic competition – Cournot or quantity competition, and Bertrand or price competition.

Example 1: Cournot Competition

Let the inverse demand function be linear: $p\left(Q\right) = a - bQ$ $(a, b > 0)$ with $Q = q_B + q_T$ and q_i denoting quantity chosen by firm i $(i = B, T)$. Costs are

[10] Notice that in the special case, where only one party actively engages in rent-seeking, one of the two assumptions $p_1 > 0$ or $p_2 < 0$ is not fulfilled. In this case, the party engaging in rent-seeking wins the contest with probability 1 and so does not benefit from further increasing its rent-seeking effort. However, as we focus on interior solutions, this entails no problems for the analysis.

[11] See, e.g., Leininger (1993) and Gradstein and Konrad (1999) for an application to rent seeking, and Wärneryd (2000) for an application to litigation contests. For an axiomatization see Skaperdas (1996).

assumed to be linear so that profits of firm i are described by $\pi_i = pq_i - cq_i$ with $c \in (0, a)$ $(i = B, T)$. Hence, in the pre-merger situation of a duopoly, each firm optimally chooses $q^* = (a - c) / (3b)$ and realizes profits $\pi^* = \pi_B = \pi_T = (a - c)^2 / (9b)$. Consumers' surplus is given by

$$CS^D = \int_0^{Q^*} p(Q)\, dQ - p^* \cdot Q^*$$

with $Q^* = 2(a - c) / (3b)$ and $p^* = (a + 2c)/3$. Therefore, we obtain $CS^D = 2(a - c)^2 / (9b)$ so that $W^D = 4(a - c)^2 / (9b)$. In case of a successful merger, the monopolist B chooses $q_B^* = (a - c) / (2b)$ and gets profits $\hat{\pi}_B = (a - c)^2 / (4b)$. Consumers' surplus now amounts to

$$CS^M = \int_0^{q_B^*} p(Q)\, dQ - p(q_B^*) \cdot q_B^* = \frac{(a - c)^2}{8b}$$

and welfare to $W^M = CS^M + \hat{\pi}_B = 3(a - c)^2 / (8b)$. Altogether, we have $\Delta W = 5(a - c)^2 / (72b)$ and $\Delta\pi_B - \pi_T = (a - c)^2 / (36b)$. Therefore, under homogeneous quantity competition with linear demand function and constant marginal costs, the efficiency condition (4') for litigation is always satisfied.

Example 2: Bertrand Competition

We consider the case of a linear demand function $D(p) = 1 - p$ where p denotes product price, and constant marginal costs are again given by $c > 0$ for both firms B and T. As is well-known from the literature, in pre-merger equilibrium the market price is $p = c$, both firms earn zero profits and split market demand. Consumers' surplus is given by

$$CS^D = \int_c^1 (1 - p)\, dp = \frac{(1 - c)^2}{2} = W^D.$$

After a possible merger of B and T, the monopolist B maximizes $\hat{\pi}_B = (p - c)(1 - p)$ by choosing $p^* = (1 + c)/2$ which yields $\hat{\pi}_B(p^*) = (1 - c)^2/4$. Consumers' surplus is

$$CS^M = \int_{p^*}^{1} (1 - p)\, dp = \frac{(1 - c)^2}{8}$$

so that $W^M = 3(1 - c)^2/8$. Since $\Delta\pi_B - \pi_T = \hat{\pi}_B(p^*) = (1 - c)^2/4 > W^D - W^M = (1 - c)^2/8$, efficiency condition (4') is violated for all values of c.

The following corollary summarizes our findings:

Corollary 1 *Let $p(x_A, x_B)$ be described by the Tullock contest-success function (5), market demand be a linear function of price and firms be homogeneous with constant marginal costs. Under Cournot competition litigation is always efficient, but under Bertrand competition litigation is never efficient.*

The results of Corollary 1 point out that the form of market competition is crucial for litigation being socially desirable or not. In particular, merging in the Bertrand model is highly profitable for firm B since $\Delta\pi_B$ is very large. In other words, the buyer's welfare gains from switching to monopoly are so high relative to reduced consumers' surplus that litigation to prohibit monopoly is inefficient.

Interestingly, litigation may even be undesirable if merging results in higher marginal costs ex-post. Consider again the case of the linear Bertrand model (Example 2). Now, let post-merger marginal costs be $\hat{c} \in (c, 1)$. Condition (4') then becomes

$$\frac{(1 - c)^2}{2} > \frac{5(1 - \hat{c})^2}{8}$$

which is still violated as long as $\hat{c} < \left[\sqrt{5} - 2(1-c)\right]/\sqrt{5} \in (c, 1)$. Hence, even if merging is socially undesirable because of both reduced competition and production inefficiency, this situation may not justify litigation activities of the AA.

To sum up, the results of this section have shown that the U.S. practice of suing the buyer within an explicit litigation contest may lead to strict inefficiencies since the contest implies a waste of resources and the probability of the agency being successful is strictly smaller than one. The last example emphasizes that even if merging harms society by both market control and technological inefficiencies the AA should not always become active under the U.S. system.

4 Hostile Takeover and Litigation

As we know from the case of Oracle versus PeopleSoft sketched in the introduction, given a hostile takeover the top management of the target firm may assist the AA during the litigation contest. Like the agency A, the top management M of firm T can spend resources x_M in the contest in order to prevent the takeover. Since in this section we focus on hostile takeovers, top management M will be dismissed if the raider B is successful and wins the contest. In this case, M looses the benefit $B_M > 0$ (e.g., future salaries, reputation, firm-specific knowledge). Resources x_M belong to firm T and, hence, to its shareholders. However, top managers often own shares of the firms they manage. Moreover, top management M has to bear additional costs when spending resources x_M in the contest. For example, the managers have to invest time in the law suit which then cannot be used for alternative purposes (e.g., for increasing firm sales which would increase their remuneration). Therefore, we assume that investing x_M in the litigation is not free for M but leads to costs $\alpha \cdot x_M$ with $\alpha \in (0,1]$.[12] Note that the value of firm T decreases in x_M. We assume that all parties are aware of these costs. Accordingly, the price to be paid by the raider B for acquiring firm T is reduced to $\pi_T - x_M$. This leaves the raider's benefit from winning the contest unchanged at $\Delta\pi_B - \pi_T$ compared to Section 3.

To summarize, the contest game considered in this section has three players, M, A and B, with top management M maximizing

$$B_M \cdot p\left(x_A + x_M, x_B\right) - \alpha \cdot x_M \tag{7}$$

where the winning probability $p(.,.)$ is defined as in Section 2. Similarly, the Antitrust Authority A wants to maximize

$$\Delta W \cdot p\left(x_A + x_M, x_B\right) - x_A. \tag{8}$$

Finally, the raider B now suffers from facing two opponents in the contest and his objective function is given by

$$\left(\Delta\pi_B - \pi_T\right) \cdot \left(1 - p\left(x_A + x_M, x_B\right)\right) - x_B. \tag{9}$$

We obtain the following results for the equilibrium $(x^*_{Mh}, x^*_{Ah}, x^*_{Bh})$:[13]

Proposition 2 *(i) If* $\Delta W > \frac{B_M}{\alpha}$*, then* $x^*_{Mh} = 0$ *and* $x^*_{Ah}, x^*_{Bh} > 0$ *being described by (3). (ii) If* $\Delta W < \frac{B_M}{\alpha}$*, then* $x^*_{Ah} = 0$ *and* $x^*_{Mh}, x^*_{Bh} > 0$ *with*

$$\frac{B_M}{\alpha} p_1\left(x^*_{Mh}, x^*_{Bh}\right) = 1 = -\left(\Delta\pi_B - \pi_T\right) p_2\left(x^*_{Mh}, x^*_{Bh}\right).$$

(iii) If $\Delta W = \frac{B_M}{\alpha}$*, then* $x^*_{Mh}, x^*_{Ah} \geq 0$ *and* $x^*_{Bh} > 0$ *with*

$$\begin{aligned} \Delta W p_1\left(x^*_{Ah} + x^*_{Mh}, x^*_{Bh}\right) = \frac{B_M}{\alpha} p_1\left(x^*_{Ah} + x^*_{Mh}, x^*_{Bh}\right) &= \\ -\left(\Delta\pi_B - \pi_T\right) p_2\left(x^*_{Ah} + x^*_{Mh}, x^*_{Bh}\right) &= 1. \end{aligned}$$

[12] Otherwise, M would invest maximum resources in the given setting which is not realistic.

[13] The subscript "h" indicates that here we consider the case of a hostile takeover.

Proof. See Appendix. ■

The results of Proposition 2 point out that there is a fundamental free-rider problem between players A and M. If the winner prize of the AA is larger than that of the top management (in relation to marginal costs, i.e. $\Delta W > B_M/\alpha$), A has strong incentives and spends significant resources while M acts as a perfect free rider ($x_{Mh}^* = 0$). This result replicates the outcome of the two-person contest in Section 3. However, if $\Delta W < B_M/\alpha$, then we have just the opposite result with player A free riding on M's expenditures by choosing $x_{Ah}^* = 0$. Finally, there is the special case in which A and M have exactly the same relative winner prize. Then we have a continuum of equilibria in which only the collective amount of resources $x_{Ah}^* + x_{Mh}^*$ is determinate.

In the preceding section, we have seen that, under the U.S. system, the AA also becomes active and start a litigation contest in those situations where it should remain passive from the society's point of view. What we will do next is to analyze whether or not this inefficiency will be aggravated, if a takeover is hostile. For this purpose, we first determine, how the expenditures in the contest change compared to the situation in Section 3. First note that the efficiency problem is exactly the same as in Section 3 if $\Delta W \geq \frac{B_M}{\alpha}$, i.e. in cases (i) and (iii) described in Proposition 2 we have $x_{Ah}^* + x_{Mh}^* \equiv x_A^*$ and $x_{Bh}^* \equiv x_B^*$. In what follows, we therefore restrict attention to the case of Proposition 2(ii) in which $\Delta W < \frac{B_M}{\alpha}$. Before we proceed, notice further that in both, the model in Section 3 as well as in the current model, equilibrium outlays are characterized by two conditions of the form

$$P_y p_1 (y^*, z^*) - 1 = 0 \tag{10}$$

$$-P_z p_2 (y^*, z^*) - 1 = 0, \tag{11}$$

in case they are (strictly) positive. Here, P_y denotes the winner prize (in relation to marginal outlays) of the agency and/or the top management and y^* the respective optimal resource expenditure. Analogous definitions (i.e. P_z and z^*) hold for the buyer. Bearing this in mind, we can derive the following proposition, which compares the resource expenditures in the case of Proposition 2(ii) with the optimal outlays from Section 3:

Proposition 3 *Let $\Delta W < \frac{B_M}{\alpha}$. (a) Then, for all parameter constellations, we have $x^*_{Mh} > x^*_A$. (b) Further, if $\Delta\pi_B - \pi_T \leq \Delta W$, then $x^*_B > x^*_{Bh}$. (c) If $\Delta\pi_B - \pi_T \geq \frac{B_M}{\alpha}$, then $x^*_B < x^*_{Bh}$. (d) Finally, if $\Delta W < \Delta\pi_B - \pi_T < \frac{B_M}{\alpha}$, either we have always $x^*_B < x^*_{Bh}$ or there exists a cut-off value $\tilde{Z} > \Delta\pi_B - \pi_T$ such that $x^*_B < x^*_{Bh}$ if and only if $\frac{B_M}{\alpha} \leq \tilde{Z}$.*

Proof. See Appendix. ■

Obviously, if the top management values winning the contest relatively higher than the AA, it will spend more resources, i.e. $x^*_{Mh} > x^*_A$. However, the reaction of the buyer depends on whether replacement of the agency with the top management makes the contest more or less intense. If $\Delta\pi_B - \pi_T \leq \Delta W < \frac{B_M}{\alpha}$ ($\Delta\pi_B - \pi_T \geq \frac{B_M}{\alpha} > \Delta W$), the contest becomes less (more) intense since the difference of the players' winner prizes increases (decreases), and the buyer chooses a smaller (larger) amount of expenditures. Furthermore, in the case, where $\Delta W < \Delta\pi_B - \pi_T < \frac{B_M}{\alpha}$, the switch from the AA to the top management changes the role of the buyer. Initially, he was in a superior position, which means that he was more likely to win the contest than the agency. However, after the top management has replaced the AA as the party actively engaging in litigation, the buyer loses his superior position and wins the contest with probability less than 0.5. Depending on whether this switch in roles makes the contest more or less intense, the buyer chooses a larger or a smaller resource level. Hence, if $\frac{B_M}{\alpha}$ lies only slightly above $\Delta\pi_B - \pi_T$, expenditures x_{Bh}^* will exceed x_B^*, otherwise, the relationship may well be the other way round.

To sum up, it is possible that, under a hostile takeover aggregate litigation expenditures are even higher than under a friendly takeover. This would make the U.S. system even more inefficient. Yet, in order to give clear welfare implications, it is important to consider the changes in the winning probabilities, too. Making it more likely to prevent an inefficient takeover may in principle outweigh the problem of higher litigation expenditures. This is what we analyze next.

Proposition 4 *Let (y^*, z^*) describe the solution to (10) and (11), and let $\Delta W < \frac{B_M}{\alpha}$. Further, suppose that $P_z > -\frac{p_{21}(y^*,z^*)}{p_{22}(y^*,z^*)} P_y$ with $P_z = P_B$ and $P_y \in \left(\Delta W, \frac{B_M}{\alpha}\right]$. Then $p\left(x_{Mh}^*, x_{Bh}^*\right) > p\left(x_A^*, x_B^*\right)$.*

Proof. See Appendix. ■

Proposition 4 states that, under a certain condition, replacement of the agency with the top management makes it more likely that the inefficient takeover is prevented. The condition ensures that the buyer does not react to strongly to changes in his opponent's expenditures. Formally, $|p_{21}(y^*, z^*)|$ must not be too large. Then, the increase in the top management's outlays (compared to the agency) increases the winning probability more than the potential increase in the buyer's expenditures decreases it. Hence, the management is more likely to win the contest than the agency initially was. Note that the condition in Proposition 4 is always fulfilled for the contest-success function (5), that is, under a Tullock contest the likelihood of prohibiting the takeover will unambiguously increase if the agency is substituted by a more aggressively acting target management.

Summarizing we see that the replacement of the AA with the top management in the contest can have countervailing welfare effects. On the one hand, overall waste of resources in form of litigation expenditures may increase; at least the outlays of the buyer's opponent will rise. On the other hand, the inefficient takeover may less likely take place.

Whereas in general it is not possible to state which effect dominates, the case of a Tullock litigation contest as given by (5) yields a clear-cut result. In case of a friendly takeover, we have already seen that litigation outlays are given by (6), from which it follows that $x_A^* + x_B^* = \frac{P_A P_B}{P_A + P_B}$ and $p(x_A^*, x_B^*) = \frac{P_A}{P_A + P_B}$. Similarly, if, in the case of a hostile takeover, the agency is replaced by the top management we obtain $x_{Mh}^* + x_{Bh}^* = \frac{P_M P_B}{P_M + P_B}$ and $p(x_{Mh}^*, x_{Bh}^*) = \frac{P_M}{P_M + P_B}$, with $P_M := \frac{B_M}{\alpha}$. Therefore, expected welfare under a friendly takeover is higher than expected welfare under a hostile one if and only if

$$W^M + \frac{P_A}{P_A + P_B}\Delta W - \frac{P_A P_B}{P_A + P_B} > W^M + \frac{P_M}{P_M + P_B}\Delta W - \frac{P_M P_B}{P_M + P_B} \quad (12)$$

Simplification of the condition leads to the following corollary:

Corollary 2 *Let $\Delta W < \frac{B_M}{\alpha}$ and the contest-success function given by (5). Then, expected welfare under a hostile takeover is lower than expected welfare under a friendly takeover, if and only if $\Delta W < \Delta\pi_B - \pi_T$.*

Under the Tullock contest-success function, welfare implications crucially depend on the relationship between the welfare spread, ΔW, and the buyer's net profit increase due to merging, $\Delta\pi_B - \pi_T$. From the discussion following Proposition 4 we know that, given (5), the probability of preventing the merger is always larger under a hostile takeover with a strong top management. However, if $\Delta W < \Delta\pi_B - \pi_T$ the contest becomes more intense after the replacement of A by the top management (see Proposition 3). Then, the negative effect due to higher resource expenditures dominates the positive effect of a higher success probability and welfare further decreases compared to the situation in Section 3. Recall that the litigation contest will be inefficient under a friendly takeover if $\Delta W < \Delta\pi_B - \pi_T$ (see condition (4')). Interestingly, according to Corollary 2, exactly in this situation things become even worse, if the takeover is hostile. One the other hand, if $\Delta W > \Delta\pi_B - \pi_T$, the contest becomes less intense. Then, the effect due to the higher winning probability of the top management is dominant and welfare increases.

5 Discussion

In this section, two aspects will be discussed which have not been considered so far. First, we will investigate how the equilibrium outcome of the litigation contest will change if the buyer does not bear in mind the target management's resource expenditures, x_M, when calculating a purchase price for firm T. On the one hand, we can think of a myopic buyer who does not anticipate that the future value of the target firm will decrease by the amount x_M which is going to be invested by a rationally acting management M in the litigation contest. On the other hand, in practice it may be difficult for the buyer to convince the shareholders of the target firm T that it is worth less than actual profit π_T. Hence, in this section we consider an alternative scenario of the hostile-takeover case in which the buyer pays π_T instead of $\pi_T - x_M$ when acquiring firm T. Now spending resources x_M by the top management has two effects – it enhances the agency's winning probability in the litigation contest, and it decreases the value of firm T. The last effect will discourage buyer B as his prize of winning the contest is now given by $P_B = \Delta\pi_B - \pi_T - x_M$. All other assumptions of Section 4 remain unchanged.

Again, management M maximizes

$$B_M \cdot p\left(x_A + x_M, x_B\right) - \alpha \cdot x_M$$

and the Antitrust Authority A

$$\Delta W \cdot p\left(x_A + x_M, x_B\right) - x_A.$$

However, raider B now has a reduced winner prize so that his objective function changes to

$$\left(\Delta\pi_B - \pi_T - x_M\right) \cdot \left(1 - p\left(x_A + x_M, x_B\right)\right) - x_B.$$

The modified game has the following equilibria $\left(\hat{x}_{Mh}^*, \hat{x}_{Ah}^*, \hat{x}_{Bh}^*\right)$:

Proposition 5 *(i) If* $\Delta W > \frac{B_M}{\alpha}$*, then* $\hat{x}_{Mh}^* = 0$ *and* $\hat{x}_{Ah}^*, \hat{x}_{Bh}^* > 0$ *being described by (3). (ii) If* $\Delta W < \frac{B_M}{\alpha}$*, then* $\hat{x}_{Ah}^* = 0$ *and either* $\hat{x}_{Mh}^* < \Delta\pi_B - \pi_T$ *and* $\hat{x}_{Mh}^*, \hat{x}_{Bh}^* > 0$ *with*

$$\frac{B_M}{\alpha} p_1\left(\hat{x}_{Mh}^*, \hat{x}_{Bh}^*\right) = 1 = -\left(\Delta\pi_B - \pi_T - \hat{x}_{Mh}^*\right) p_2\left(\hat{x}_{Mh}^*, \hat{x}_{Bh}^*\right),$$

or $\hat{x}_{Mh}^* \geq \Delta\pi_B - \pi_T$ *and* $\hat{x}_{Bh}^* = 0$ *with* $\frac{B_M}{\alpha} p_1\left(\hat{x}_{Mh}^*, 0\right) = 1$*. (iii) If* $\Delta W = \frac{B_M}{\alpha}$*, then either* $\hat{x}_{Mh}^* < \Delta\pi_B - \pi_T$ *and* $\hat{x}_{Mh}^*, \hat{x}_{Ah}^* \geq 0$*,* $\hat{x}_{Bh}^* > 0$ *with*

$$\begin{aligned} \Delta W p_1\left(\hat{x}_{Ah}^* + \hat{x}_{Mh}^*, \hat{x}_{Bh}^*\right) = \frac{B_M}{\alpha} p_1\left(\hat{x}_{Ah}^* + \hat{x}_{Mh}^*, \hat{x}_{Bh}^*\right) &= \\ -\left(\Delta\pi_B - \pi_T - \hat{x}_{Mh}^*\right) p_2\left(\hat{x}_{Ah}^* + \hat{x}_{Mh}^*, \hat{x}_{Bh}^*\right) &= 1, \end{aligned}$$

or $\hat{x}_{Mh}^* \geq \Delta\pi_B - \pi_T$ *and* $\hat{x}_{Bh}^* = 0$ *and* $\hat{x}_{Mh}^*, \hat{x}_{Ah}^* \geq 0$ *with* $\Delta W p_1\left(\hat{x}_{Ah}^* + \hat{x}_{Mh}^*, 0\right) = 1$*.*

Proof. See Appendix ■

When we compare Propositions 2 and 5 we can see one important difference. In Proposition 5, two things may happen if $\Delta W \leq \frac{B_M}{\alpha}$. On the one hand, player M's optimal expenditures $\hat{x}_{Mh}^*$ can be rather moderate so that both M and B remain active in the contest. On the other hand, the management of the target firm may choose a preemptively high amount

$\hat{x}^*_{Mh} \geq \Delta\pi_B - \pi_T$ which entirely discourages B who then drops out of the contest. In this situation, the target management excessively invests in the litigation. Such waste of firm T's resources makes a takeover completely unattractive for the raider. This outcome of the game will happen if the management's loss from being dismissed, B_M, is quite large but its costs from using firm T's resources in the contest (i.e. α) are rather small. However, such preemption never happens in Section 4 because of the buyer's adjusted purchase price.

Preemptive behavior in the litigation contest might aggravate the existing inefficiencies. In order to compare expected welfare under a friendly takeover as discussed in Section 3 and a hostile takeover with preemption as in Proposition 5, we have to consider a parameterized contest-success function. Once again, the well-known Tullock contest described by (5) is considered. Here, in the preemption case player M exactly chooses $\hat{x}^*_{Mh} = \Delta\pi_B - \pi_T$ since this strategy leads to a winning probability of one while investing the minimum amount of resources necessary for preemption. For the scenario of a friendly takeover, we know from (12) that expected welfare amounts to

$$W^M + \frac{P_A}{P_A + P_B}\Delta W - \frac{P_A P_B}{P_A + P_B} = W^M + \frac{P_A}{P_A + P_B}(P_A - P_B). \tag{13}$$

In the case of a hostile takeover with preemption, duopoly welfare is ensured at total costs $\Delta\pi_B - \pi_T$ so that expected welfare is given by

$$W^D - (\Delta\pi_B - \pi_T) = W^M + P_A - P_B. \tag{14}$$

Since in the latter case efficient litigation requires $W^D - (\Delta\pi_B - \pi_T) > W^M \Leftrightarrow \Delta W > \Delta\pi_B - \pi_T$ to hold which is identical to condition (4'), comparison of (13) and (14) yields the following result:

Corollary 3 *Let the contest-success function be described by (5). If litigation is efficient under the friendly takeover, then this will also be the case* *under the hostile takeover with preemption. Moreover, in this case expected welfare is always larger under the hostile takeover with preemption than under the friendly takeover.*

The preemption case introduces a new trade-off. On the one hand, one party – top management M – spends a very high amount of resources. On the other hand, the welfare reducing takeover is prevented with probability one, and the other party spends no resources in the contest. Whereas in general, depending on the given parameter values and the type of contest-success function either effect can dominate, in the case of a Tullock litigation contest the positive effects of preemption prevail.

The second aspect which has not been discussed so far is the scenario of two consecutive contests under a hostile takeover. It is possible that the AA and the top management act sequentially instead of simultaneously. That is, in a first stage, we have a *litigation contest* between the agency and the buyer. If the agency is successful, the merger is prevented and the game ends. If, on the other hand, the buyer is successful, there will be a *takeover contest* at the second stage where the top management of the target firm spends further resources to defend its firm against raider B.[14] Note that there are parallels between this scenario and the above mentioned case of Oracle versus PeopleSoft in which a lawsuit on a poison pill follows the antitrust decision. Under two consecutive contests, results (and conclusions to be drawn from these results) may well be different from those presented in Section 4. Therefore, in the following we will consider the case of two sequential contests.

Suppose that the agency has lost the litigation contest. Then, with a similar argumentation as in the previous analysis, the parties choose their second-stage resource expenditures in order to maximize (15) and (16), re-

[14] For simplicity, we use the same contest success function in both contests.

spectively.

$$B_M \cdot p\left(x_M, x_B\right) - \alpha \cdot x_M \tag{15}$$

$$\left(\Delta\pi_B - \pi_T\right) \cdot \left(1 - p\left(x_M, x_B\right)\right) - x_B. \tag{16}$$

Denote the equilibrium solution to these maximization problems by $(x^{**}_{Mh}, x^{**}_{Bh2})$. This solution has similar properties as the solutions to the contests in Sections 3 and 4 since all decisions from stage 1 are sunk at this stage. We therefore directly turn to the first stage, where the agency maximizes

$$\Delta W p(x^{**}_{Mh}, x^{**}_{Bh2}) + [\Delta W(1 - p(x^{**}_{Mh}, x^{**}_{Bh2}))] \cdot p\left(x_A, x_B\right) - x_A \tag{17}$$

while B's objective function is given by

$$\left[\left(\Delta\pi_B - \pi_T\right)\left(1 - p(x^{**}_{Mh}, x^{**}_{Bh2})\right) - x^{**}_{Bh2}\right] \cdot \left(1 - p\left(x_A, x_B\right)\right) - x_B. \tag{18}$$

Under a sequential structure, the introduction of a top management fighting against a takeover affects the litigation contest by reducing the *expected winner prizes conditional on winning* of both the agency and the raider.[15] For the agency, it becomes less problematic to lose the litigation, because there is still a chance that the takeover is prevented by the management. Hence, it suffers less from losing or, in other words, gains less from winning the litigation contest. The raider values winning the litigation less, as he still cannot be certain that the takeover will take place and additionally must spend resources in a second contest.

As both parties gain less from winning the contest, it is likely that they reduce their resource expenditures. In fact, if $|p_{12}|$ is not too large, this can be formally shown.[16] This means that the possibility of a second party trying to prevent a takeover, M, discourages the agency as well as the buyer

[15] The expected winner prizes conditional on winning are $\Delta W(1 - p(x^{**}_{Mh}, x^{**}_{Bh2}))$ for the agency, and $\left(\Delta\pi_B - \pi_T\right)\left(1 - p(x^{**}_{Mh}, x^{**}_{Bh2})\right) - x^{**}_{Bh2}$ for the buyer.

[16] One can show that the party who initially valued winning higher always reduces its

and leads to a welfare improvement in terms of lower expenditures spent in the litigation contest. This welfare improvement, however, comes at the cost of a possible second contest, in which further resources are wasted. Hence, compared to the case where the takeover is friendly, aggregate resource expenditures may become higher or lower.

As before, expected welfare also changes with the probability that the takeover is prevented. In this context, the introduction of a top management at the second stage of the model has two effects: First, there is an extra chance that the merger is prevented, which leads to an increase in welfare. Second, the winning probability of the agency in the litigation contest may be affected, too. This is a consequence of the reduction in winner prizes of both parties taking part in the first-stage contest and the corresponding change in the parties' resource expenditures. As the raider's winner prize decreases relatively more,[17] it is likely that the agency's winning probability increases compared to the situation of a friendly takeover. This is beneficial, because the inefficient takeover is more likely to be prevented. Moreover, it has the further advantage that a possible second contest with additional waste of resources does not take place.

To conclude, we revisit our special example and assume the contest-success function to be given by (5). Recall that, in this case, expected welfare

expenditures. This may make the contest more even and, hence, more intense. In this case, the other party's change in expenditures is determined by two countervailing effects. In order to make sure that the party also invests less in the litigation contest, we have to constrain the absolute value of the cross derivative, $|p_{12}|$.

[17] Recall that the raider's winner prize decreases through two channels, through the chance of being defeated in the second-period contest and through the resources he must additionally invest.

under a friendly takeover is

$$\hat{W} = W^D \cdot \left(1 - \frac{P_B}{P_A + P_B}\right) + W^M \cdot \frac{P_B}{P_A + P_B} - \frac{P_A P_B}{P_A + P_B}. \tag{19}$$

In contrast, expected welfare under a hostile takeover with two consecutive contests is

$$\tilde{W} = W^D \cdot \left(1 - \frac{\tilde{P}_B}{\tilde{P}_A + \tilde{P}_B} \frac{P_B}{P_M + P_B}\right) + W^M \frac{\tilde{P}_B}{\tilde{P}_A + \tilde{P}_B} \frac{P_B}{P_M + P_B} \tag{20}$$
$$- \frac{\tilde{P}_A \tilde{P}_B}{\tilde{P}_A + \tilde{P}_B} - \frac{\tilde{P}_B}{\tilde{P}_A + \tilde{P}_B} \frac{P_M P_B}{P_M + P_B}$$

where $\tilde{P}_A := \Delta W(1 - p(x^{**}_{Mh}, x^{**}_{Bh2})) = \frac{P_B}{P_M + P_B} P_A$ and $\tilde{P}_B := (\Delta\pi_B - \pi_T)(1 - p(x^{**}_{Mh}, x^{**}_{Bh2})) - x^{**}_{Bh2} = \frac{P_B}{P_M + P_B} P_B - \frac{P_M P_B^2}{(P_M + P_B)^2}$. Comparing $\hat{W}$ and $\tilde{W}$, we can derive the following result:

Corollary 4 *Let the contest success function be given by (5) and suppose that $2P_M < P_B + 7P_A$. Then, there exists a cut-off value $\hat{Z}$ such that $\hat{W}$ is higher than $\tilde{W}$, if and only if $\Delta\pi_B - \pi_T > \hat{Z}$.*

Proof. See Appendix. ■

Corollary 4 states that under a relatively weak condition on P_M, we have $\tilde{W} > \hat{W}$ unless $\Delta\pi_B - \pi_T$ becomes too large. If $\Delta\pi_B - \pi_T$ gets large, the merger is likely to take place in either scenario, as the buyer invests heavily to affect the contest outcomes. The difference between the scenarios is that the buyer needs to succeed in two contests under the sequential structure, but in only one in the case of a friendly takeover. Therefore, more resources are wasted in the former case and welfare is higher in the latter. Finally, note that $2P_M < P_B + 7P_A$ is a sufficient condition, which is usually excessively strong.

6 Conclusion

This paper wants to highlight the potential perils of the U.S. antitrust system which focuses on a formal litigation contest between the buyer and the AA. The results show that this contest may be so expensive that the gross welfare gains from prohibiting a merger might be completely offset by the huge amounts of litigation expenditures. The lawsuit of the DOJ against Oracle trying to take over PeopleSoft as sketched in the introduction indicates that this problem is indeed relevant in practice.

Note that we do not compare the antitrust enforcement in the U.S. with that in the E.U.. In the given setting, where the agency knows for sure that merging only serves to obtain market control and reduces welfare, such comparison would be rather unfair and trivial: the U.S. or adversarial system with positive litigation costs and a success probability strictly smaller than one is always dominated by the E.U. or inquisitorial system. A serious comparison has to include further aspects such as the opportunity costs of time and the quality of the antitrust decision, for example. Whereas the opportunity costs of time should be considerably high under the U.S. system due to the time consuming litigation process, the quality of the antitrust decision might be better under the U.S. than under the E.U. system since the adversarial system consults further experts and their valuable knowledge. However, the litigation might be used by either party – the raider and the management of the target firm in case of a hostile takeover – rather for influence activities than for searching for an efficient decision.

Future research should combine the litigation problem with the literature on corporate governance. Typically, the public corporation consists of different parties with heterogeneous interests. In particular, we have to differentiate between the owners or shareholders of the corporation and its top management. There exist several situations in which the interests of these two parties fall apart, including the threat of a hostile takeover given an inefficient top management. The litigation contest should then be discussed together with questions regarding management compensation. For example, it might be rational for the shareholders of the target firm to give golden parachutes to its top management in order to prevent the waste of firm resources within the litigation contest. Another possibility would be to combine the litigation process with the aspect of strategic delegation to managers. As we know from the literature on strategic delegation (e.g. Fershtman and Judd 1987, Sklivas 1987), compensation of managers can be used to make them behave more or less aggressively in the market compared to a situation without strategic delegation. Since strategic management compensation influences firm profits and welfare, it will also have an impact on the strategic interaction during the litigation contest.

Appendix

Proof of Proposition 2:

It is easy to see that the optimality conditions are given by

$$\begin{aligned}
\Delta W p_1\left(x_{Ah}^* + x_{Mh}^*, x_{Bh}^*\right) - 1 &\leq 0 \quad (= 0 \text{ if } x_{Ah}^* > 0) \quad \text{(A1)}\\
\frac{B_M}{\alpha} p_1\left(x_{Ah}^* + x_{Mh}^*, x_{Bh}^*\right) - 1 &\leq 0 \quad (= 0 \text{ if } x_{Mh}^* > 0) \quad \text{(A2)}\\
-\left(\Delta\pi_B - \pi_T\right) p_2\left(x_{Ah}^* + x_{Mh}^*, x_{Bh}^*\right) - 1 &\leq 0 \quad (= 0 \text{ if } x_{Bh}^* > 0). \quad \text{(A3)}
\end{aligned}$$

(i) Let $\Delta W > \frac{B_M}{\alpha}$. Then the left-hand side (LHS) of (A2) is always smaller than the LHS of (A1). Hence, it must be that $\Delta W p_1\left(x_{Ah}^* + x_{Mh}^*, x_{Bh}^*\right) - 1 = 0$ and $\frac{B_M}{\alpha} p_1\left(x_{Ah}^* + x_{Mh}^*, x_{Bh}^*\right) - 1 < 0$ so that $x_{Ah}^* > 0$ and $x_{Mh}^* = 0$. It follows that we obtain exactly the same results as in Section 3.

(ii) Now consider $\Delta W < \frac{B_M}{\alpha}$ which (in analogy to case (i)) implies that the LHS of (A2) is zero and the LHS of (A1) is negative with $x_{Mh}^* > 0$ and $x_{Ah}^* = 0$. The characterization of the equilibrium is completed by $-\left(\Delta\pi_B - \pi_T\right) p_2(x_{Mh}^*, x_{Bh}^*) = 1$, i.e. the binding version of (A3).

(iii) $\Delta W = \frac{B_M}{\alpha}$ yields a continuum of equilibria in which A and M may both choose an interior solution so that $x_{Ah}^* + x_{Mh}^*$ makes (A1) (and (A2)) hold with equality. For B, the optimality condition is given by $-\left(\Delta\pi_B - \pi_T\right) p_2(x_{Ah}^* + x_{Mh}^*, x_{Bh}^*) = 1$.

Proof of Proposition 3:

Differentiating (10) and (11) with respect to P_y yields (for simplicity we write y^* instead of $y^*(P_y, P_z)$ and z^* instead of $z^*(P_y, P_z)$)

$$\begin{aligned}
p_1\left(y^*, z^*\right) + P_y\left(p_{11}\left(y^*, z^*\right)\right)\frac{\partial y^*}{\partial P_y} + p_{12}\left(y^*, z^*\right)\frac{\partial z^*}{\partial P_y}\Bigg) &= 0 \quad \text{(A4)}\\
-P_z\left(p_{21}\left(y^*, z^*\right)\frac{\partial y^*}{\partial P_y} + p_{22}\left(y^*, z^*\right)\frac{\partial z^*}{\partial P_y}\right) &= 0. \quad \text{(A5)}
\end{aligned}$$

Note that $p_{21}\left(y^*, z^*\right) = p_{12}\left(y^*, z^*\right)$. Simultaneous solution of (A4) and (A5) leads to

$$\frac{\partial y^*}{\partial P_y} = -\frac{p_{22}(y^*, z^*)\, p_1(y^*, z^*)}{P_y \left[p_{11}(y^*, z^*)\, p_{22}(y^*, z^*) - (p_{12}(y^*, z^*))^2\right]} \tag{A6}$$

$$\frac{\partial z^*}{\partial P_y} = \frac{p_1(y^*, z^*)\, p_{12}(y^*, z^*)}{P_y \left[p_{11}(y^*, z^*)\, p_{22}(y^*, z^*) - (p_{12}(y^*, z^*))^2\right]} \tag{A7}$$

with $p_{11}(y^*, z^*)\, p_{22}(y^*, z^*) - (p_{12}(y^*, z^*))^2 < 0$. Hence, $\frac{\partial y^*}{\partial P_y}$ is always positive which directly proves part (a) of the proposition (i.e. $x^*_{Mh} > x^*_A$) as $\Delta W < \frac{B_M}{\alpha}$.

(b) Notice that $x^*_{Bh} - x^*_B = \int_{\Delta W}^{\frac{B_M}{\alpha}} \frac{\partial z^*(t, P_B)}{\partial P_y} dt$. Further note, given the symmetry of the contest success function $p(\cdot, \cdot)$, that the player with the higher winner prize always spends more resources in equilibrium. Hence, since $P_B = \Delta\pi_B - \pi_T \leq \Delta W = P_A < \frac{B_M}{\alpha}$ we have $x^*_A \geq x^*_B$ and $x^*_{Mh} > x^*_{Bh}$. According to (A7), $\frac{\partial z^*}{\partial P_y}$ is negative if and only if $p_{12}(y^*, z^*) > 0$ or – by Assumption 1(iii) – $y^* > z^*$. Therefore $\frac{\partial z^*(t, P_B)}{\partial P_y}|_{t=\Delta W} \leq 0$ due to $x^*_A \geq x^*_B$. Moreover, $\frac{\partial z^*(t, P_B)}{\partial P_y}$ is never positive and strictly negative for $t = \frac{B_M}{\alpha}$. It follows that $x^*_{Bh} - x^*_B = \int_{\Delta W}^{\frac{B_M}{\alpha}} \frac{\partial z^*(t, P_B)}{\partial P_y} dt < 0 \Leftrightarrow x^*_{Bh} < x^*_B$.

In case (c), we have $\Delta\pi_B - \pi_T \geq \frac{B_M}{\alpha} > \Delta W$ and, accordingly, $x^*_A < x^*_B$ and $x^*_{Mh} \leq x^*_{Bh}$. From (A7) we know that $\frac{\partial z^*}{\partial P_y}$ is positive if and only if $p_{12}(y^*, z^*) < 0$ or $y^* < z^*$. Therefore, $\frac{\partial z^*(t, P_B)}{\partial P_y}$ is never negative and strictly positive for $t = \Delta W$, which implies that $x^*_{Bh} - x^*_B = \int_{\Delta W}^{\frac{B_M}{\alpha}} \frac{\partial z^*(t, P_B)}{\partial P_y} dt > 0 \Leftrightarrow x^*_{Bh} > x^*_B$.

Finally, in case (d), we have $\Delta W < \Delta\pi_B - \pi_T < \frac{B_M}{\alpha}$. Then, we can rewrite

$$x^*_{Bh} - x^*_B = \int_{\Delta W}^{\Delta\pi_B - \pi_T} \frac{\partial z^*(t, P_B)}{\partial P_y} dt + \int_{\Delta\pi_B - \pi_T}^{\frac{B_M}{\alpha}} \frac{\partial z^*(t, P_B)}{\partial P_y} dt. \tag{A8}$$

The first term on the RHS of (A8) is strictly positive, the second term strictly negative. Moreover, the second term is strictly decreasing in $\frac{B_M}{\alpha}$. If $\frac{B_M}{\alpha} \rightarrow$

$\Delta\pi_B - \pi_T$, $\int_{\Delta\pi_B - \pi_T}^{\frac{B_M}{\alpha}} \frac{\partial z^*(t,P_z)}{\partial P_y} dt \to 0$ and $x^*_{Bh} > x^*_B$. Furthermore, if

$$\int_{\Delta W}^{\Delta\pi_B - \pi_T} \frac{\partial z^*(t,P_B)}{\partial P_y} dt + \int_{\Delta\pi_B - \pi_T}^{+\infty} \frac{\partial z^*(t,P_B)}{\partial P_y} dt > 0$$

it must always be that $x^*_{Bh} > x^*_B$. However, if

$$\int_{\Delta W}^{\Delta\pi_B - \pi_T} \frac{\partial z^*(t,P_B)}{\partial P_y} dt + \int_{\Delta\pi_B - \pi_T}^{+\infty} \frac{\partial z^*(t,P_B)}{\partial P_y} dt < 0$$

there must be some cut-off $\tilde{Z}$, with $\Delta\pi_B - \pi_T < \tilde{Z} < \infty$, where the sign of $x^*_{Bh} - x^*_B$ changes.

Proof of Proposition 4:

The probability that the takeover can be prevented is given by

$$p(y^*(P_y, P_z), z^*(P_y, P_z)) \tag{A9}$$

Totally differentiating with respect to P_y yields

$$\begin{aligned} \frac{dp}{dP_y} &= p_1(y^*(P_y, P_z), z^*(P_y, P_z)) \cdot \frac{\partial y^*}{\partial P_y} \\ &\quad + p_2(y^*(P_y, P_z), z^*(P_y, P_z)) \cdot \frac{\partial z^*}{\partial P_y}. \end{aligned} \tag{A10}$$

From the optimality conditions (10) and (11) we know that $p_1(y^*(P_y, P_z), z^*(P_y, P_z)) = \frac{1}{P_y}$ and $p_2(y^*(P_y, P_z), z^*(P_y, P_z)) = -\frac{1}{P_z}$. Further, (A5) states that $\frac{\partial z^*}{\partial P_y} = -\frac{p_{21}(y^*,z^*)\frac{\partial y^*}{\partial P_y}}{p_{22}(y^*,z^*)}$. Inserting these three conditions into (A10), we can rewrite $\frac{dp}{dP_y} > 0$ as

$$\frac{1}{P_y} \cdot \frac{\partial y^*}{\partial P_y} + \frac{1}{P_z} \cdot \frac{p_{21}(y^*, z^*)\frac{\partial y^*}{\partial P_y}}{p_{22}(y^*, z^*)} > 0 \Leftrightarrow P_z > -\frac{p_{21}(y^*, z^*)}{p_{22}(y^*, z^*)} \cdot P_y. \tag{A11}$$

Hence, if $P_z > -\frac{p_{21}(y^*,z^*)}{p_{22}(y^*,z^*)} \cdot P_y$, we will have that $\frac{dp}{dP_y}$ is always strictly positive. As $\Delta W < \frac{B_M}{\alpha}$, this implies that $p(x^*_{Mh}, x^*_{Bh}) > p(x^*_A, x^*_B)$ with $P_z = P_B$ and $P_y \in \left(\Delta W, \frac{B_M}{\alpha}\right]$.

Proof of Proposition 5:

In the optimum, we must have that

$$\Delta W p_1\left(\hat{x}_{Ah}^* + \hat{x}_{Mh}^*, \hat{x}_{Bh}^*\right) - 1 \leq 0 \tag{A12}$$

$$\frac{B_M}{\alpha} p_1\left(\hat{x}_{Ah}^* + \hat{x}_{Mh}^*, \hat{x}_{Bh}^*\right) - 1 \leq 0 \tag{A13}$$

$$-\left(\Delta\pi_B - \pi_T - x_M^*\right) p_2\left(\hat{x}_{Ah}^* + \hat{x}_{Mh}^*, \hat{x}_{Bh}^*\right) - 1 \leq 0. \tag{A14}$$

Case (i) is identical with Proposition 2(i).

(ii) $\Delta W < \frac{B_M}{\alpha}$ implies that the LHS of (A13) is zero and the LHS of (A12) is negative with $\hat{x}_{Mh}^* > 0$ and $\hat{x}_{Ah}^* = 0$. In case of $\hat{x}_{Mh}^* < \Delta\pi_B - \pi_T$, the LHS of (A14) is zero so that $\hat{x}_{Mh}^*, \hat{x}_{Bh}^* > 0$ are described by (A13) and (A14) which must hold with equality. In case of $\hat{x}_{Mh}^* \geq \Delta\pi_B - \pi_T$, the LHS of (A14) is negative which implies a corner solution for player B, too: $\hat{x}_{Bh}^* = 0$. We have $\hat{x}_{Mh}^* > 0$ being characterized by (A13) which holds with equality with $\hat{x}_{Ah}^* = \hat{x}_{Bh}^* = 0$.

(iii) $\Delta W = \frac{B_M}{\alpha}$ leads to a continuum of equilibria with $\hat{x}_{Ah}^* + \hat{x}_{Mh}^*$ making (A12) (or (A13)) hold with equality. For B, we have either an interior solution (if $\hat{x}_{Mh}^* < \Delta\pi_B - \pi_T$) or a corner solution (if $\hat{x}_{Mh}^* \geq \Delta\pi_B - \pi_T$).

Proof of Corollary 4:

Note that

$$\frac{\tilde{P}_B}{\tilde{P}_A + \tilde{P}_B} = \frac{P_B^2}{P_B^2 + \left(P_M + P_B\right) P_A}.$$

From (19) and (20) we then see that $\hat{W} > \tilde{W}$ is equivalent to

$$W^D \cdot \left(1 - \frac{P_B}{P_A + P_B}\right) + W^M \frac{P_B}{P_A + P_B} - \frac{P_A P_B}{P_A + P_B} >$$
$$W^D \cdot \left(1 - \frac{P_B^2}{P_B^2 + (P_M + P_B) P_A} \frac{P_B}{P_M + P_B}\right) + W^M \frac{P_B^2}{P_B^2 + (P_M + P_B) P_A} \frac{P_B}{P_M + P_B}$$
$$- \frac{P_A P_B^3}{(P_M + P_B) P_B^2 + (P_M + P_B)^2 P_A} - \frac{P_B^2}{P_B^2 + (P_M + P_B) P_A} \frac{P_M P_B}{P_M + P_B}.$$

This condition can be simplified to

$$\left(W^D - W^M\right) \cdot \left(\frac{P_B^2}{P_B^2 + (P_M + P_B) P_A} \frac{P_B}{P_M + P_B} - \frac{P_B}{P_A + P_B}\right) - \frac{P_A P_B}{P_A + P_B}$$
$$+ \frac{P_A P_B^3}{(P_M + P_B) P_B^2 + (P_M + P_B)^2 P_A} + \frac{P_B^2}{P_B^2 + (P_M + P_B) P_A} \frac{P_M P_B}{P_M + P_B} > 0,$$

which can be further transformed into

$$\begin{aligned} &(W^D - W^M) \cdot ((P_A + P_B) P_B^2 - (P_M + P_B) P_B^2 - (P_M + P_B)^2 P_A) \\ &- P_A \left((P_M + P_B) P_B^2 + (P_M + P_B)^2 P_A\right) + (P_A + P_M) P_B^2 (P_A + P_B) > 0 \\ &\Leftrightarrow (W^D - W^M) \cdot (-P_B^2 - P_A P_M - 2 P_B P_A) \\ &-2 P_A^2 P_B - P_M P_A^2 + P_B^3 > 0. \end{aligned}$$

Finally, noting that $P_A = W^D - W^M$, one can rewrite the condition as

$$Y := -P_A P_B^2 - 2 P_A^2 P_M - 4 P_B P_A^2 + P_B^3 > 0.$$

Recall that $P_A = CS^D - CS^M - (\Delta\pi_B - \pi_T)$ and $P_B = \Delta\pi_B - \pi_T$. It directly follows that, for $\Delta\pi_B - \pi_T = 0$, $Y < 0$ and, accordingly, $\hat{W} < \tilde{W}$. On the other hand, if $\Delta\pi_B - \pi_T \to CS^D - CS^M$, it is easy to see that $P_A \to 0$ and so $Y > 0$. Further, it is straightforward to show that $\frac{\partial P_A}{\partial(\Delta\pi_B - \pi_T)} = -1$ and $\frac{\partial P_B}{\partial(\Delta\pi_B - \pi_T)} = 1$. Hence, we have

$$\begin{aligned} \frac{\partial Y}{\partial(\Delta\pi_B - \pi_T)} &= P_B^2 - 2 P_A P_B + 4 P_A P_M - 4 P_A^2 + 8 P_A P_B + 3 P_B^2 \\ &= 4 P_B^2 + 4 P_A P_M - 4 P_A^2 + 6 P_A P_B \end{aligned}$$

and

$$\frac{\partial Y^2}{\partial^2(\Delta\pi_B - \pi_T)} = 8P_B - 4P_M + 8P_A - 6P_B + 6P_A = 2P_B - 4P_M + 14P_A.$$

If $2P_M < P_B + 7P_A$, we see that $\frac{\partial Y^2}{\partial^2(\Delta\pi_B - \pi_T)} > 0$. This implies that $\frac{\partial Y}{\partial(\Delta\pi_B - \pi_T)}$ is either always positive, or negative for small values of $\Delta\pi_B - \pi_T$ and positive for larger values of $\Delta\pi_B - \pi_T$. Thus, there must be a unique value for $\Delta\pi_B - \pi_T$, denoted as $\hat{Z}$, where Y becomes positive. This completes the proof of Corollary 4.

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