RESEARCH INSTITUTE OF
INDUSTRIAL ECONOMICS

IFN Working Paper No. 694, 2007

Anti- versus Pro-Competitive Mergers

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January 23, 2007

Abstract

In a framework where mergers are mutually excluding, I show that firms pursue anti- rather than (alternative) pro-competitive mergers. Potential outsiders to anti-competitive mergers refrain from pursuing pro-competitive mergers if the positive externalities from anti-competitive mergers are strong enough. Potential outsiders to pro-competitive mergers pursue anti-competitive mergers if the negative externalities from the pro-competitive mergers are strong enough. Potential participants in anti-competitive mergers are cheap targets due to the risk of becoming outsiders to pro-competitive mergers. Firms may even pursue an unprofitable and anti-competitive merger, when alternative mergers are profitable and pro-competitive.

Key Words: anti- and pro-competitive mergers, consumers' welfare, coalition formation, endogenous split of surplus.
JEL-codes: L12, L13, L41

*This work has been significantly improved through numerous discussions with Johan Stennek. Comments from Jonas Björnestedt, Helen Jakobsson, Lars Persson, Giancarlo Spagnolo and Andreas Westermark, as well as from seminar participants at the Stockholm University, the Research Institute of Industrial Economics, EARIE 2004 in Berlin and IIOC 2006 in Boston are also gratefully acknowledged. The author thanks Konkurrensverket for financial support. Postal address: Research Institute of Industrial Economics, Box 55665, 102 15 Stockholm, Sweden.

1 Introduction

Mergers and acquisitions (M&As) are often legitimate responses to changing business conditions such as global competition, deregulation, and over capacity (Mitchell and Mulherin, 1996). Nevertheless, in the merger wave during the 90's, a larger share than in the past involved direct competitors (Pitofsky, Chairman of the FTC, 1997). As a result, it may legitimately be feared that several mergers increased firms' market power and thereby reduced consumers' welfare.

This concern has been the main motivation for ruling some horizontal mergers illegal. For example, the European Commission recently blocked a merger between the two Swedish truck manufacturers Volvo and Scania on the ground that the merger would nearly eliminate all competition in the Scandinavian market while reducing it significantly in Irland and the United Kingdom (European Commission, 2000a). Interestingly, the prohibition of this merger induced Volvo to acquire Renault Véhicules Industriels (RVI).[1] Unlike the attempted merger between Volvo and Scania, the latter merger was not blocked by the Commission (European Commission, 2000b). According to the Commission, this merger would not increase market concentration significantly in any geographical market and consequently should not hurt the consumers. It may even be hypothesized that the Volvo-RVI merger benefited consumers; if a merger does not reduce competition and its only impact is to save on costs, some of the associated benefits should spill over to consumers.

These events raise the concern that mergers that are harmful to consumers, that is anti-competitive mergers, may preempt pro-competitive merg-

[1] Similarly, Volkswagen purchased a large minority stake in Scania. However, this purchase was not investigated by the Commission, since it was not classified as a merger.

ers that are beneficial to this category. The main finding of this paper is that this is a legitimate concern. While the market sometimes selects the most desirable merger from the consumers' point of view, the subsequent analysis highlights several mechanisms leading firms to pursue anti- rather than pro-competitive mergers.

The starting point of this analysis is a robust finding in the theoretical literature on mergers, that the "competitive" nature of mergers is linked to their impact on the profitability of outsiders (competitors). While anti-competitive mergers typically benefit outsiders, the opposite is true for pro-competitive mergers.[2] In turn, the signs and magnitudes of these external effects on outsiders favor anti- rather than pro-competitive mergers.

To be more precise, external effects have a direct influence on the firms' merger decisions which, depending on their sign, materialize into different incentives for potential outsiders. First, consider anti-competitive mergers. Potential outsiders to such mergers refrain from pursuing pro-competitive mergers if the positive external effect from the anti-competitive merger is large enough. This lack of incentives for merging is referred to as the "inducement mechanism." Second, consider pro-competitive mergers with negative external effects. Potential outsiders to such mergers pursue anti-competitive mergers to preempt the pro-competitive merger that would hurt them. This incentive for merging is referred to as the "preemption mechanism."

Furthermore, external effects also have an indirect influence on firms' merger decisions. Since firms' pre-merger values incorporate the risk of be-

[2] Intuitively, merging firms in an anti-competitive merger restrict their output relative to their combined pre-merger output in order to increase the equilibrium price. As a result, the external effect of the merger is positive, since the outsider benefits from the higher price without bearing the cost of reducing its own output (Salant, Switzer and Reynolds, 1983; Perry and Porter, 1985; Farrell and Shapiro, 1990). Throughout the paper, I use the sign of the external effects in order to identify whether a merger is anti- or pro-competitive.

coming an outsider, potential outsiders to anti-competitive mergers with positive external effects have high pre-merger values. As a result, the acquisition of such firms tend to be expensive. Conversely, potential outsiders to pro-competitive mergers tend to be cheap. In turn, other firms, including potential participants in pro-competitive mergers, tend to find it profitable to buy potential outsiders to pro-competitive mergers. Thereby, they preempt the pro-competitive merger and instead induce an anti-competitive one. This incentive for buying firms that will lose as outsiders is referred to as the "valuation mechanism."

To illustrate these mechanisms, I extend the model in Fridolfsson and Stennek (2005a and 2005b) to asymmetric firms. Unlike other models of endogenous merger formation, this model predicts how the merging firms split the surplus. In the present context, such a prediction is crucial. Due to the valuation mechanism, firms pursue anti- rather than pro-competitive mergers, since the split of the surplus in the former type of merger is more favorable to bidding firms.

Previous merger analyses, starting with Stigler (1950), have mainly focused on the question of whether the process of merger formation leads to the most desirable level of concentration.[3] In contrast, the present paper asks the question whether the process of merger formation induces the most desirable merger for a given level of concentration. This issue was first addressed in a full-fledged model of endogenous merger formation by Horn and Persson (2001b).[4] They propose a cooperative model of endogenous merger forma-

[3]More recent contributions along these lines are Kamien and Zang (1990), (1991), (1993), Gowrisankaran and Holmes (2004), Fridolfsson and Stennek (2005a), (2005b) and Nocke (2000).

[4]A number of other papers treat related questions. Barros (1998) studies whether the merger formation process eliminates inefficient rather than efficient firms. Horn and Persson (2001a) analyze whether firms pursue national rather than cross border mergers.Persson (2005) formalizes the failing firm defense as an auction and finds that the

tion which captures the inducement and preemption mechanisms. However their model does not endogenously predict the split of the surplus among the merging firms and is therefore not suitable for identifying the valuation mechanism. Moreover, they do not explicitly analyze cases with pro-competitive mergers.

The paper is organized as follows. Section 2 introduces the model. To focus on the competitive nature of mergers, Section 3 considers cases where the profitability of mergers (their internal effects) is small relative to their external effects. As a result, merger incentives are, to a large extent, determined by the external effects of mergers. If one merger is anti-competitive (has a positive external effect) while an alternative merger is pro-competitive (has a negative external effect), the firms tend to pursue the former merger. Furthermore, the market may fail to select the most desirable merger, also when all mergers benefit the consumers (are pro-competitive). Section 4 briefly discusses cases when internal effects are larger than external effects. Section 5 shows that the signs and magnitudes of external effects may be crucial for predicting the likelihood of specific mergers, even though profitability considerations clearly favor specific mergers. Indeed, firms may pursue an unprofitable and anti-competitive merger, even though other mergers are profitable and pro-competitive. The welfare effects may also be perverse; firms may pursue an unprofitable merger reducing both the consumers' and producers' surpluses, even though an alternative and profitable merger increases these surpluses. The Concluding Remarks discuss policy implications of the finding that more anti-competitive mergers preempt less anti-competitive ones.

worst buyer, from the consumers' point of view, often acquires the failing firm.

2 The Model

Time is infinite and continuous but divided into short periods of length Δ. Each period is divided into two phases. In the first phase, there is an acquisition game where nature, with equal probability, selects a firm as the bidder. The selected firm then chooses whether to bid, the identity of the target firm and the size of the bid. A firm receiving a bid can only accept or reject it; if it rejects, it can give a (counter) offer in some future period when selected by nature. No time is assumed to elapse during the acquisition game, although it is described as a sequential game.

I consider an industry which initially consists of three firms: two identical firms, labelled x_1 and x_2, and one other firm, labelled y. Mergers to monopoly are not allowed, that is such mergers are implicitly assumed to be blocked by competition authorities. Consequently, firms can only submit bids for one other firm at a time.

In the second phase, there is a market game. Rather than specifying an explicit oligopoly model, I take the profit levels of each firm in each market structure as exogenous. In the triopoly, a firm x_i earns profit flow $\pi_x(3)$ and firm y earns profit flow $\pi_y(3)$. After the xx-merger, that is the merger between firms x_1 and x_2, the merged firm earns profit flow $\pi_{xx}(2)$, and the outsider (i.e. firm y) earns $\pi_y(2)$. Similarly, after an xy-merger, that is a merger between say firm x_i and firm y, the merged firm earns profit flow $\pi_{xy}(2)$, and the outsider (i.e. firm x_j) earns $\pi_x(2)$.

A firm's strategy describes the firm's behavior in the acquisition game: whether to bid (if selected by nature), the identity of the target firm, how much to bid, and a reservation price at which to accept an offer. The strategy specifies the behavior for all periods, and for all possible histories. I restrict the attention to Markov strategies and symmetric equilibria. In the present context, symmetry means that firm y treats firms x_1 and x_2 identically, and that firms x_1 and x_2 behave identically. With a slight abuse of notation, let subscripts yx, xx and xy denote the events that firm y submits a bid to firm x_1 or x_2, firm x_i submits a bid to firm x_j and firm x_i submits a bid to firm y. Firm y's strategy consists of the triple (p_{yx}, b_{yx}, a_y), where $p_{yx} \in [0, 1/2]$ denotes the probability that firm y bids for a specific firm x_i in a given period, b_{yx} denotes the size of this bid and a_y denotes the lowest bid that firm y accepts. Firm x_i's strategy consists of the quintuple $(p_{xx}, b_{xx}, p_{xy}, b_{xy}, a_x)$, where $(p_{xx}, p_{xy}) \in \left\{[0,1]^2 : p_{xx} + p_{xy} \in [0,1]\right\}$, p_{xx} (p_{xy}) denotes the probability that firm x_i bids for firm x_j (y) in a given period, b_{xx} (b_{xy}) denotes the size of this bid and a_x denotes the lowest bid that firm x_i accepts. For simplicity, I also restrict the attention to sharp bids, that is bids accepted in equilibrium. Formally, it implies that $b_{xy} \geq a_y$ and $b_{xx}, b_{yx} \geq a_x$.[5]

Next, I define the continuation values after a merger, at the date of a merger, and before a merger. After the xy- (xx-) merger has occurred, the values of the merged firm xy (xx) and the outsider x (y) are given by

$$W_i(2) = \frac{\pi_i(2)}{r}, \tag{1}$$

for $i \in \{xy, x, xx, y\}$, where r is the common discount rate, and $\pi_i(2)/r$ is the discounted value of all future profits. At the points in time when firm y buys firm x_i (event yx), firm x_i buys firm x_j (event xx) and firm x_i buys firm y (event xy), the values of the buying and the selling firms are given by

$$V_i^{buy} = W_i(2) - b_i, \tag{2}$$

$$V_i^{sell} = b_i, \tag{3}$$

for $i \in \{yx, xx, xy\}$. Furthermore, at the time of a merger, the value of the

[5] This is assumed without loss of generality, since a firm making a non-sharp bid can achieve the same outcome by not bidding.

outsider is given by

$$V_i^{out} = W_i(2), \tag{4}$$

for $i \in \{y, x\}$. Finally, firm y's pre-merger value, that is its expected value in the triopoly, is given by

$$\begin{aligned} W_y(3) = \frac{\pi_y(3)}{r}\left(1 - e^{-r\Delta}\right) + e^{-r\Delta}\Big[&\tfrac{2}{3}p_{yx}V_{yx}^{buy} + \tfrac{2}{3}p_{xy}V_{xy}^{sell} + \tfrac{2}{3}p_{xx}V_y^{out} \\ &+ \left(1 - \tfrac{2}{3}(p_{yx} + p_{xy} + p_{xx})\right)W_y(3)\Big]. \end{aligned} \tag{5}$$

The first term is the value generated by firm y in the current period. The second term is the discounted expected value of all future profits, that is the values for firm y of being a buyer, seller, outsider and triopolist in the next period, multiplied by the respective probabilities of becoming a buyer, seller, outsider and triopolist. For example, the probability of firm y being a buyer in the next period is $\frac{2}{3}p_{yx}$, since firm y is selected by nature with probability $\frac{1}{3}$ and then buys each x-firm with probability p_{yx}. Moreover, given the probabilities of firm y being a buyer, a seller and an outsider in the next period, the probability of remaining in the triopoly is $1 - \frac{2}{3}(p_{yx} + p_{xy} + p_{xx})$. In particular, note that firm y's pre-merger value incorporates the risk of becoming an outsider in the next period, that is $\frac{2}{3}p_{xx}V_y^{out}$. Similarly, a firm x_i's pre-merger value, that is its expected value in the triopoly, is given by

$$\begin{aligned} W_x(3) = \frac{\pi_x(3)}{r}&\left(1 - e^{-r\Delta}\right) \\ &+e^{-r\Delta}\Big[\tfrac{1}{3}\left(p_{xx}V_{xx}^{buy} + p_{xy}V_{xy}^{buy}\right) + \tfrac{1}{3}\left(p_{xx}V_{xx}^{sell} + p_{yx}V_{yx}^{sell}\right) \\ &\qquad+\tfrac{1}{3}(p_{xy} + p_{yx})V_x^{out} + \left(1 - \tfrac{2}{3}(p_{yx} + p_{xy} + p_{xx})\right)W_x(3)\Big]. \end{aligned} \tag{6}$$

Three types of equilibrium conditions complete the model. First, by subgame perfection, an offer is accepted if, and only if, the bid is at least as high as the value of the firm, that is, for $i \in \{x, y\}$,

$$a_i = W_i(3). \tag{7}$$

Second, for the bidders to maximize their value, it is necessary that

$$\begin{aligned} b_{xy} &= a_y = W_y(3), \\ b_{xx} &= b_{yx} = a_x = W_x(3). \end{aligned} \tag{8}$$

The third type of equilibrium condition is that firms, when selected by nature, submit a bid if, and only if, it is profitable. Once firm y is selected by nature, it can either buy an x-firm which is worth V_{yx}^{buy}, or remain in the triopoly which is worth $W_y(3)$. Hence, by subgame perfection it is necessary that

$$\begin{cases} p_{yx} = 0 & \text{only if} \quad V_{yx}^{buy} \leq W_y(3), \\ p_{yx} = \frac{1}{2} & \text{only if} \quad V_{yx}^{buy} \geq W_y(3), \\ p_{yx} \in \left(0, \frac{1}{2}\right) & \text{only if} \quad V_{yx}^{buy} = W_y(3). \end{cases} \tag{9}$$

Similarly, firm x_i can choose between remaining triopolist and buying firm x_j or firm y. Hence, by subgame perfection it is necessary that

$$\begin{cases} (p_{xx}, p_{xy}) = (0,0) & \text{only if} \quad V_{xx}^{buy}, V_{xy}^{buy} \leq W_x(3) \\ (p_{xx}, p_{xy}) = (1,0) & \text{only if} \quad V_{xx}^{buy} \geq V_{xy}^{buy}, W_x(3) \\ (p_{xx}, p_{xy}) = (0,1) & \text{only if} \quad V_{xy}^{buy} \geq V_{xx}^{buy}, W_x(3) \\ (p_{xx}, p_{xy}) \in \left\{(0,1)^2 : p_{xx} + p_{xy} = 1\right\} & \text{only if} \quad V_{xx}^{buy} = V_{xy}^{buy} \geq W_x(3) \\ p_{xx} \in (0,1), \, p_{xy} = 0 & \text{only if} \quad V_{xx}^{buy} = W_x(3) \geq V_{xy}^{buy} \\ p_{xx} = 0, \, p_{xy} \in (0,1) & \text{only if} \quad V_{xy}^{buy} = W_x(3) \geq V_{xx}^{buy} \\ (p_{xx}, p_{xy}) \in \left\{(0,1)^2 : p_{xx} + p_{xy} \in (0,1)\right\} & \text{only if} \quad V_{xx}^{buy} = V_{xy}^{buy} = W_x(3). \end{cases} \tag{10}$$

Combining firm y's three types of equilibrium conditions in (9) with the x-firms' seven types of equilibrium conditions in (10) potentially yields 21 types of symmetric Markov perfect equilibria. These different types of equilibria are partitioned into three different categories: no-merger equilibria (NME), immediate-merger equilibria (IME) and delayed-merger equilibria (DME). In a NME, no firm submits bids, that is $p_{yx} = 0$ and $(p_{xx}, p_{xy}) = (0, 0)$. In an IME, at least one firm submits a bid with certainty. For example, $p_{yx} = \frac{1}{2}$ and $(p_{xx}, p_{xy}) = (0, 1)$ constitute an IME. In total, there are 13 types of IME.[6] In a DME, no firm bids with certainty and at least one firm bids with strictly positive probability. For example, $p_{yx} \in \left(0, \frac{1}{2}\right)$ and $(p_{xx}, p_{xy}) = (0, 0)$ constitutes a DME. In total, there are 7 types of DME.

Let the internal effects of the xy- and the xx-merger, that is the profitability of these mergers, be denoted

$$I_{xy} \equiv \frac{1}{r}\left[\pi_{xy}(2) - \pi_x(3) - \pi_y(3)\right], \tag{11a}$$

$$I_{xx} \equiv \frac{1}{r}\left[\pi_{xx}(2) - 2\pi_x(3)\right]. \tag{11b}$$

Furthermore, let the the external effects of the xy- and the xx-merger, that is the net gain compared to remaining in the triopoly of becoming an outsider to these mergers, be denoted

$$E_{xy} \equiv \frac{1}{r}\left[\pi_x(2) - \pi_x(3)\right], \tag{12a}$$

$$E_{xx} \equiv \frac{1}{r}\left[\pi_y(2) - \pi_y(3)\right]. \tag{12b}$$

Lemma 1 in the Appendix characterizes the conditions under which the different types of equilibria exist as $\Delta \to 0$. In particular, there exists at least one type of equilibrium for all profit configurations. Henceforth, I restrict the attention to equilibria that exist under generic profit configurations.[7] Moreover, if an equilibrium is said to exist, it is meant to exist generically.

[6] In some IME, a merger occurs after a few periods. For example, consider the IME where $p_{yx} = 0$ and $(p_{xx}, p_{xy}) = (1, 0)$. If firm y is selected as bidder in the first period, then the xx-merger is delayed until firm x_1 or x_2 is selected as bidder. However, the xx-merger occurs almost immediately as the length of the periods become very short and, as $\Delta \to 0$, the delay tends to 0.

[7] Non-generic profit configurations are such that $I_{xx} = 0$, $I_{xx} = E_{xy}$ and so on.

The following types of equilibria exist:

$$
\begin{array}{ll}
NME: & p_{yx}=0 \text{ and } (p_{xx},p_{xy})=(0,0)\,, \\
IME_{xx}: & p_{yx}=0 \text{ and } (p_{xx},p_{xy})=(1,0)\,, \\
IME_{xy,yx}: & p_{yx}=\frac{1}{2} \text{ and } (p_{xx},p_{xy})=(0,1)\,, \\
IME_{xx,yx}: & p_{yx}=\frac{1}{2} \text{ and } (p_{xx},p_{xy})=(1,0)\,, \\
IME_{xx,xy,yx}: & p_{yx}=\frac{1}{2} \text{ and } (p_{xx},p_{xy})\in\left\{(0,1)^2 : p_{xx}+p_{xy}=1\right\}, \\
DME_{xy,yx}: & p_{yx}\in\left(0,\frac{1}{2}\right) \text{ and } p_{xx}=0,\ p_{xy}\in(0,1)\,, \\
DME_{xx,xy,yx}: & p_{yx}\in\left(0,\frac{1}{2}\right) \text{ and } (p_{xx},p_{xy})\in\left\{(0,1)^2 : p_{xx}+p_{xy}\in(0,1)\right\}.
\end{array}
$$

In the IME_{xx}, the xx-merger occurs with certainty since firm y does not bid while the x-firms bid on each other with certainty. Similarly, in the $IME_{xy,yx}$, an xy-merger occurs with certainty while, in contrast, both types of mergers occur with positive probabilities in the $IME_{xx,yx}$ and the $IME_{xx,xy,yx}$. In the $DME_{xy,yx}$, the xy-merger, even though it is delayed, occurs with certainty as in the $IME_{xy,yx}$. Similarly, the $DME_{xx,xy,yx}$ might be related to the $IME_{xx,xy,yx}$.[8]

In the remainder of the paper, I discuss the properties of the above equilibrium structure. In particular, I am concerned with the impact of external effects on the type of merger that the firms select in equilibrium. For instance, do the firms always select the most profitable merger (with the highest internal effect) or do the external effects of mergers also matter? In fact, the conditions under which a specific merger may occur depend in a subtle way on the signs and magnitudes of both internal (I_{xx} and I_{yx}) and external (E_{xx} and E_{yx}) effects. To focus on the role of external effects, Section 3 considers cases where these are larger than internal effects. In turn, Section 4 discusses to which extent the insights found in Section 3 carry over to cases

[8]Actually, other equilibria do exist (see Lemma 1 in the Appendix). However, disregarding these (which is done in order to simplify the exposition below), does not affect any result.

where internal effects are larger than external effects. Section 5 considers a case where internal effects clearly favor one type of merger, namely when one type of merger is profitable while the other is unprofitable.

3 Large External Effects

In this section, my focus is on markets where external effects are important for the process of merger formation. To be more precise, I consider profit configurations such that external effects are large in absolute terms relative to internal effects, that is $|E_{xx}|, |E_{xy}| > \max\{I_{xx}, I_{xy}\}$ where $I_{xx}, I_{xy} > 0$.[9] This assumption does not only have the advantage of highlighting the role of external effects on the endogenous formation of mergers, it also has the advantage of putting the impact of mergers on consumer welfare into focus. Indeed, based on findings in the theoretical literature on mergers, the signs of mergers' external effects can be used to identify whether they are anti- or pro-competitive, that is whether they harm or benefit consumers.[10] Throughout the paper, I assume the following:

Assumption 1 *A merger is anti- [pro-] competitive if its external effect is positive [negative].*

Assumption 1 holds in many oligopoly models. For example, if goods are perfect substitutes and firms compete in quantities, then Assumption 1 holds under standard assumptions about demand and cost functions (Farrell and Shapiro, 1990). Intuitively, merging firms in an anti-competitive merger restrict their output relative to their combined pre-merger output in order to

[9] The assumption that $I_{xy}, I_{xx} > 0$ implies that the firms have incentives to merge.

[10] A leading example of an anti- (pro-) competitive merger is that it increases (decreases) the prices of final goods. Other examples include mergers reducing (increasing) the variety or the quality of final goods.

increase the equilibrium price. As a result, the external effect of the merger is positive, since the outsider benefits from the higher price without bearing the cost of reducing its own output. Similarly, Assumption 1 is usually true if goods are differentiated and the firms compete in prices.[11]

3.1 Anti- versus Pro-competitive Mergers

This subsection focuses on profit configurations such that one type of merger has a positive external effect while the other type has a negative one. Note that such a configuration of external effects can be consistent with both types of mergers being profitable. While the type of merger with a positive external effect may be profitable due to fixed cost savings, the other type may also be profitable and have a negative external effect due to marginal cost savings.

Given that Assumption 1 holds, a natural question is whether the firms pursue anti- rather than pro-competitive mergers. In general, no definite answer can be given to this question, but the following analysis highlights several mechanisms inducing firms to act in this way.

The discussion below makes frequent use of Figure 1 which illustrates the conditions under which the different equilibria exist in the case where $I_{xx} = I_{xy} = \varepsilon > 0$ and ε is close to 0 (to focus on the external effects). The horizontal and vertical axes in Figure 1 indicate the external effects of the xy- and the xx-merger, respectively. An IME_{xx} exists in the areas marked with IME_{xx} and so on. Note that there are profit configurations with multiple equilibria.

In the north-west and south-east quadrants of Figure 1, one type of merger is anti-competitive while the other is pro-competitive. These quadrants are

[11] To see this, consider an anti-competitive merger. Following such a merger, the merging firms increase their prices. As a result, the outsider is better off, since he responds by increasing his own prices and still gains market shares.

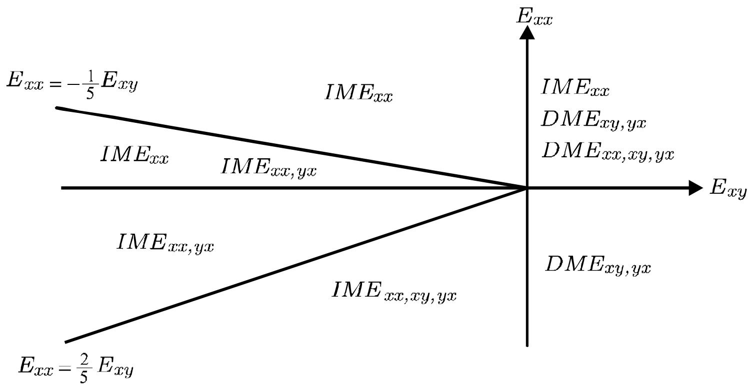

Figure 1: $I_{xx} = I_{xy} = \varepsilon > 0$ where $\varepsilon \to 0$.

characterized by different types of equilibria and are therefore treated sequentially, starting by the north-west quadrant in Figure 1.

Proposition 1 *Consider profit configurations such that the xx-merger is anti-competitive [$E_{xx} > 0$] while the xy-merger is pro-competitive [$E_{xy} < 0$] and assume mergers to be profitable [$I_{xx}, I_{xy} > 0$]. If external effects are large in absolute terms relative to internal effects [$|E_{xx}|, |E_{xy}| > \max\{I_{xx}, I_{xy}\}$], the IME_{xx} is unique or exists simultaneously with the $IME_{xx,yx}$ so that the anti-competitive xx-merger occurs with a lower bound probability of 2/3.*

All proofs are relegated to the Appendix.

Provided that the IME_{xx} is selected when the $IME_{xx,yx}$ also exists, the anti-competitive xx-merger occurs with certainty in the whole north-west quadrant of Figure 1.[12] Since the xx-merger is profitable, the x-firms have incentives to merge. In turn, the positive external effect E_{xx} ensures that firm

[12] If the $IME_{xx,yx}$ is instead selected when it exists, the pro-competitive xy-merger occurs with positive probability. Nevertheless, the anti-competitive xx-merger occurs with higher probability in this case, namely with the lower bound probability of 2/3. This lower bound is precisely 2/3, since the firms are exogenously selected as bidders with equal probabilities.

y has no incentive to block the xx-merger. Hence, firm y refrains from pursuing the pro-competitive xy-merger in order to induce the anti-competitive xx-merger which is of even further benefit to him. This lack of incentive for merging constitutes an example of the inducement mechanism. Note also that firm y's pre-merger value is high, reflecting that in the IME_{xx}, firm y becomes an outsider with certainty. As a result, the x-firms bid on each other rather than on firm y, since each x-firm is cheaper to buy. This incentive for buying other firms than a potential outsider to an anti-competitive merger constitutes an example of the valuation mechanism.

Unlike the positive external effect E_{xx}, the negative one, E_{xy}, plays no role in sustaining the IME_{xx}. Nevertheless, it plays an important role in ruling out equilibria where the pro-competitive xy-merger occurs with certainty. For example, suppose the $IME_{xy,yx}$ is an equilibrium so that the xy-merger occurs with certainty. In such an equilibrium, each x-firm faces a risk of becoming an outsider and as a result its pre-merger value is low (since $E_{xy} < 0$). Therefore each x-firm is better off buying the other x-firm rather than firm y which contradicts the supposition that the $IME_{xy,yx}$ constitutes an equilibrium. This out of equilibrium incentive for buying a potential outsider to a pro-competitive merger constitutes a second example of the valuation mechanism.

The above discussion illustrates the crucial role of an *endogenous* split of the surplus. If instead the surplus in each merger was determined exogenously, it could easily be constructed in such a way that the pro-competitive xy-merger would occur with certainty. It is worth emphasisizing that an endogenous split of the surplus is particularly important for the process of merger formation. In other contexts such as the formation of joint ventures, an exogenous split of the surplus may be less problematic. The reason is that no direct transfer of wealth occurs between firms forming a joint venture.[13]

Next, consider the south-east quadrant in Figure 1.

Proposition 2 *Consider profit configurations such that the xy-merger is anti-competitive [$E_{xy} > 0$], while the xx-merger is pro-competitive [$E_{xx} < 0$] and assume that $I_{xy} > \frac{I_{xx}}{2} > 0$. If external effects are large in absolute terms relative to internal effects [$|E_{xx}|, |E_{xy}| > \max\{I_{xx}, I_{xy}\}$], the $DME_{xy,yx}$ is unique so that the anti-competitive xy-merger occurs with certainty in the long run.*

Once more, the negative external effect, in this case E_{xx}, rules out equilibria such as the IME_{xx}, where the pro-competitive xx-merger occurs with certainty. In such an equilibrium, firm y becomes an outsider with certainty which is detrimental to him, since $E_{xx} < 0$. In turn, firm y has an incentive to block the xx-merger by buying one of the x-firms, which contradicts the presumption that the IME_{xx} constitutes an equilibrium. This out of equilibrium incentive constitutes an example of the preemption mechanism. Note also that the valuation mechanism plays a role in ruling out the IME_{xx}. Indeed, firm y's pre-merger value is low in such an equilibrium, since it becomes an outsider with certainty. As a result, each x-firm is better off buying firm y rather than the other x-firm which again contradicts the assumption that the IME_{xx} constitutes an equilibrium.

At this point, the distinction between the preemption and the valuation mechanisms should be clarified. In the above out of equilibrium example, firm y's motive for merging is to preempt the pro-competitive xx-merger, that is firm y's decision is driven by the preemption mechanism. However, to preempt this merger, firm y cannot choose between different types of

[13]See Bloch (1995) for an application to joint ventures of a coalition formation game with an exogenous split of the surplus.

mergers, since firm y can only participate in the anti-competitive xy-merger. In contrast, the x-firms can choose between the two different types of mergers. Moreover, these firms pursue the anti-competitive merger precisely because firm y is cheaper to buy, that is, their decision is driven by the valuation mechanism.

While the preemption and valuation mechanisms prevent the pro-competitive merger from occurring, the inducement mechanism *delays* rather than favors the anti-competitive xy-merger. Indeed, the $DME_{xy,yx}$ is unique in the south-east quadrant of Figure 1. In such an equilibrium, the x-firms gain from merging, since $I_{xy} > 0$. However, these firms are even better off as outsiders, since $E_{xy} > I_{xy}$. As a result, the x-firms delay their merger proposals, and consequently forego valuable profits, since they hope other firms will merge instead - much like a war of attrition. Moreover, the larger the positive external effect E_{xy}, the larger the incentives to become an outsider. As a result, the expected delay (until the anti-competitive xy-merger occurs) increases with the positive external effect E_{xy}. Hence, the inducement mechanism creates a holdup problem for the firms in the sense that a profitable merger does not occur immediately (see also Fridolfsson and Stennek, 2000a).[14]

Finally, the condition $I_{xy} > \frac{I_{xx}}{2} > 0$ remains to be discussed. In cases where $\frac{I_{xx}}{2} > I_{xy} > 0$ is fulfilled (and external effects are large in absolute terms relative to internal effects), the $DME_{xx,xy,yx}$ is unique if $E_{xy} > 0$ and

[14] The reason for the ambiguous impact of positive external effects is simple. In the north-west quadrant of Figure 1 (Proposition 1), only firm y gains by becoming an outsider while the x-firms lose as outsiders. As a result, there is no conflict of interests between the firms regarding which merger should form. In contrast, in the south-east quadrant of Figure 1 (Proposition 2), both x-firms are better off as outsiders than as insiders due to the positive external effect E_{xy}. As a result, a conflict of interests appears between firms x_1 and x_2 regarding which xy-merger should form. In turn, by delaying its merger proposal, each x-firm tries to induce the merger in which it does not participate.

$E_{xx} < 0$. In such an equilibrium, the xy-merger occurs with strictly positive probability in the long run. However, it also turns out to be impossible to establish a lower bound probability for the anti-competitive xy-merger to occur that is strictly larger than 0 for all pairs of external effects. For this reason, Proposition 2 is stated in terms of the condition $I_{xy} > \frac{I_{xx}}{2} > 0$ only.

3.2 Least versus Most Pro-competitive Mergers

Up to this point, I have only considered cases where one type of merger is anti-competitive and the other pro-competitive. The reason is twofold. First, when both types of mergers are anti-competitive (the positive quadrant in Figure 1), there are multiple equilibria. In fact, both the xx- and the xy-merger may occur with certainty depending on which equilibrium is selected. Intuitively, there is a conflict of interests between all firms regarding which merger should form and this conflict materializes into multiple equilibria. Unfortunately, I am not aware of any method of equilibrium selection that can be straightforwardly applied to the present problem, and therefore, I abstain from making any prediction in this region. Second, it is not straightforward to identify which type of merger is the most anti- or pro-competitive when external effects have the same sign. However, the following assumption is motivated in many contexts.

Assumption 2 *If both types of mergers are anti- [pro-] competitive, then the type of merger with the largest positive [negative] external effect is the most anti- [pro-] competitive.*

Assumption 2 has weaker theoretical support than Assumption 1. Nevertheless, it is easy to construct examples by means of simple oligopoly models that validate this assumption. For example, consider an homogeneous good

Cournot oligopoly where firms have constant marginal costs, where demand is linear and both types of mergers are pro-competitive due to large marginal cost savings. Then, the merger inducing the largest marginal cost savings is the most pro-competitive, that is benefits the consumers the most. Moreover, this merger has the largest negative external effect, as long as the outsider is not driven out of the market.[15]

Proposition 3 *Consider pro-competitive mergers [$E_{xx}, E_{xy} < 0$] and assume mergers to be profitable [$I_{xx}, I_{xy} > 0$]. If Assumption 2 holds and external effects are large in absolute terms relative to internal effects [$|E_{xx}|, |E_{xy}| > \max\{I_{xx}, I_{xy}\}$], the $IME_{xx,yx}$ or the $IME_{xx,xy,yx}$ is unique and the least pro-competitive merger occurs with a lower bound probability approximately equal to 0,16.*

Proposition 3 focuses on the negative quadrant in Figure 1. In this area, the preemption mechanism provides all the firms with incentives to pursue a merger in order to avoid becoming an outsider. This is not main mechanism, however, for inducing the firms to pursue the least pro-competitive merger. Indeed, firm y has an incentive to pursue the xy-merger irrespective of whether it is the most or the least pro-competitive one. Rather it is the valuation mechanism. To see this, consider the behavior of the x-firms which can choose between the two different types of mergers. Since firms' pre-merger values incorporate the risk of becoming outsiders, these firms tend to buy the firm that is the potential outsider to the most pro-competitive merger with the largest negative external effect. Thereby, they preempt this merger and instead induce the least pro-competitive merger.

[15] One may construct examples where Assumption 2 does not hold if the negative external effect of one type of merger drives the outsider out of the market. To see this, note that the triopoly profits of the firm becoming an outsider constitutes an upper bound on the negative external effect. Hence, if these profits are small, then the negative external effect must also be small, even though the merger induced marginal cost savings may be large.

To be more precise, consider the simplest case, namely the area in Figure 1 where the $IME_{xx,yx}$ is unique. In this area, the x-firms lose more as outsiders than does firm y (since $E_{xy} < E_{xx} < 0$) and therefore their pre-merger value is low. In turn, the x-firms bid on each other with certainty and therefore, the xx-merger, that is the least pro-competitive merger, occurs with high probability, namely $2/3$. In the area where the $IME_{xx,xy,yx}$ is unique, each x-firm bids on both other firms with positive probabilities. However, they bid with the highest probability on the firm that is a potential outsider to the most pro-competitive merger (if $I_{xx} = I_{xy}$). In fact, the x-firms bid on firm y almost with certainty as $E_{xy} \to 0$. As a result, the preemption and the valuation mechanisms complement each other so that the least pro-competitive merger, in this case the xy-merger, occurs almost with certainty.

4 Large Internal Effects

The present section discusses briefly cases where internal effects may be large relative to external effects, keeping the assumption that mergers are profitable. In connection to the previous analysis, a natural question is whether profitability considerations reinforce the tendency for firms to pursue anti- rather than pro-competitive mergers. Unsurprisingly, the answer to this question is ambiguous. Assume that the pro-competitive merger is very profitable while the anti-competitive; then the firms tend to pursue the former merger. Conversely, if the anti-competitive merger is sufficiently profitable, the firms tend to pursue that merger. While recognizing that firms, in many markets, pursue the most desirable merger, I proceed by identifying further instances in which the opposite is true.

To test the robustness of Propositions 1, 2 and 3 with respect to large

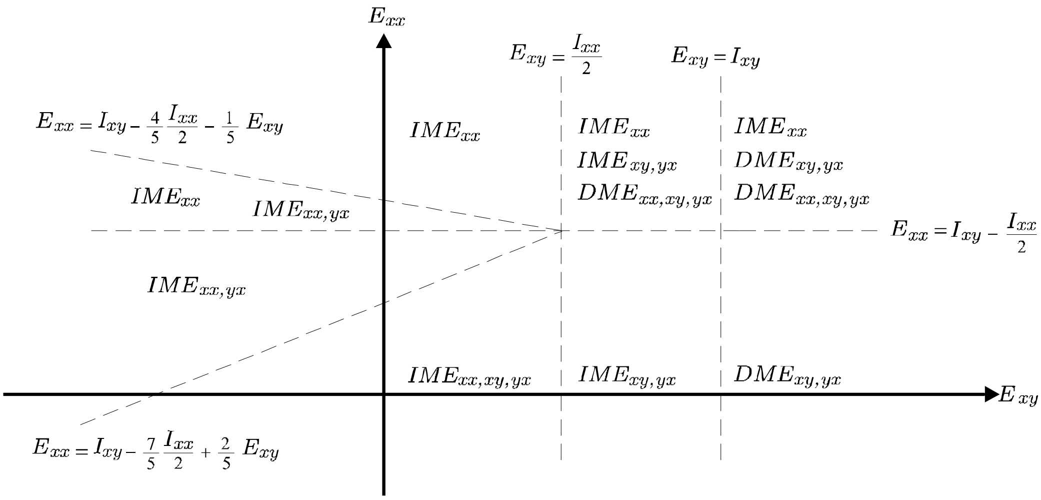

Figure 2: $I_{xy} > \frac{I_{xx}}{2} > 0$.

internal effects, consider profit configurations such that $I_{xy} > \frac{I_{xx}}{2} > 0$. If external effects are equal to 0, the $IME_{xx,yx}$ or the $IME_{xx,xy,yx}$ is unique. Hence, although some merger occurs with certainty, no specific type of merger occurs with certainty.[16] In this sense, the condition $I_{xy} > \frac{I_{xx}}{2} > 0$ implies that profitability considerations do not favor one type of merger too much over the other. In turn, if external effects differ from 0 and from each other, their impacts on firms' merger decisions are similar to the ones discussed in Section 3.

To be more precise, consider Figure 2 that illustrates in the (E_{xy}, E_{xx})-plane the conditions under which the different equilibria exist when $I_{xy} > \frac{I_{xx}}{2} > 0$. The solid lines represent the horizontal and vertical axes and an equilibrium area is delimited by the dashed lines.[17]

First, consider the north-west and south-east quadrants of Figure 2 where one type of merger is anti-competitive, while the other is pro-competitive.

[16]Interestingly, this observation implies that firms may fail to pursue the most profitable merger, even in the absence of external effects.

[17]Note that Figure 1 is obtained by letting the internal effects tend to 0 in Figure 2.

Since the $IME_{xx,yx}$ or the $IME_{xx,xy,yx}$ is unique in these areas if the positive external effect is sufficiently small relative to the internal effect, the anti-competitive type of merger occurs with strictly positive probability in such cases. Furthermore, there are profit configurations in the south-east quadrant of Figure 2 where the $IME_{xy,yx}$ is unique. Unlike the case when internal effects are small, the anti-competitive xy-merger may thus occur, not only with certainty, but also immediately.[18] In these cases, large internal effects thus strengthen Propositions 1 and 2.

Next, consider the negative quadrant in Figure 2, where both types of mergers are pro-competitive. Since the $IME_{xx,yx}$ or the $IME_{xx,xy,yx}$ is unique in the negative quadrant of Figure 2 also when external effects are small in absolute terms, both types of mergers occur with strictly positive probability in this quadrant. In this sense, Proposition 3 is also robust to large internal effects. Finally, note that equilibria are unique in the positive quadrant of Figure 2 if at least one external effect is sufficiently large relative to the internal effects. Therefore, one may conclude that also more anti-competitive mergers in some cases preempt less anti-competitive ones (in particular, if Assumption 2 holds).

The conclusion of this discussion is thus that external effects being large relative to internal effects is a sufficient, but not a necessary condition, for the results in the previous section to hold.

5 The Preemptive Merger Hypothesis

The present section relaxes the assumption that all mergers are profitable. In particular, I will focus on cases where the xy-merger is unprofitable ($I_{xy} < 0$)

[18] Also, the expected delay associated with the $DME_{xy,yx}$ decreases as I_{xy} increases.

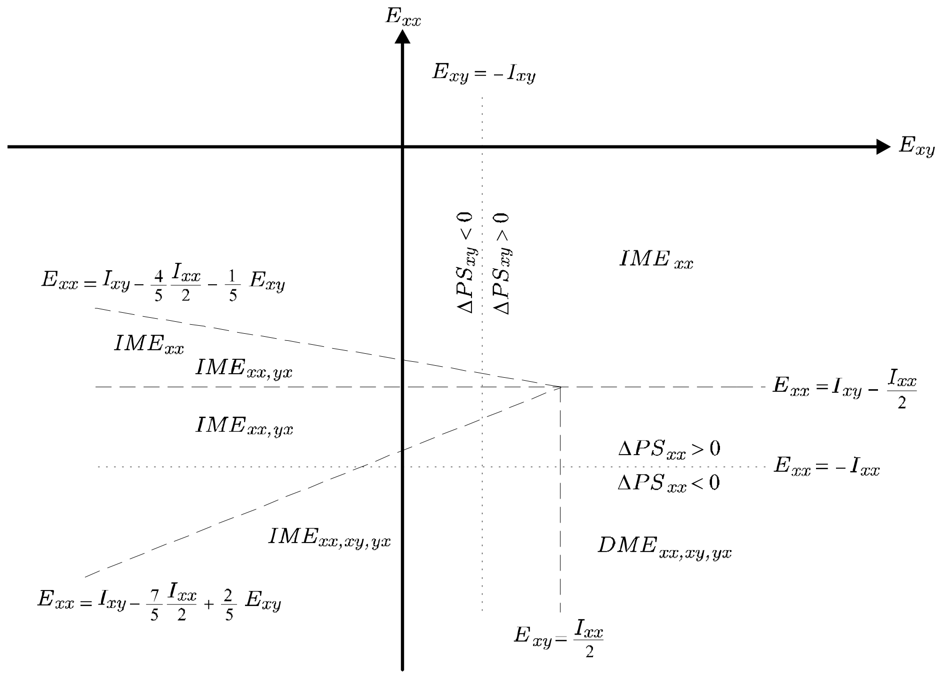

Figure 3: $I_{xx} > 0$ and $\frac{I_{xx}}{2} > I_{xy}$.

while the xx-merger is profitable ($I_{xx} > 0$). Clearly, this assumption favors the xx-merger. Nevertheless, the signs and magnitudes of the external effects may be crucial in order to determine which merger will occur.

To be more precise, consider Figure 3 which illustrates in the (E_{xy}, E_{xx})-plane the conditions under which the different equilibria exist when, $I_{xx} > 0$ and $\frac{I_{xx}}{2} > I_{xy}$ (actually, Figure 3 is drawn such that $I_{xx} > 0$ and $I_{xy} < 0$). The solid lines represent the horizontal and vertical axes and an equilibrium area is delimited by the dashed lines.

Not surprisingly, the xx-merger occurs with certainty for many profit configurations. More interestingly, however, note that the xx-merger does not occur with certainty if $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$. Hence:

Proposition 4 *Assume that the xx-merger is profitable and pro-competitive*

[$I_{xx} > 0$ and $E_{xx} < 0$] while the xy-merger is unprofitable and anti-competitive [$I_{xy} < 0$ and $E_{xy} > 0$]. Then, the unprofitable and anti-competitive xy-merger occurs with strictly positive probability if $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$.[19]

The condition $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$ guarantees that equilibria such as the IME_{xx} where the profitable xx-merger occurs with certainty, do not exist. In such an equilibrium, the x-firms split the surplus equally. In turn, if firm y buys one of the x-firms (which contradicts that the IME_{xx} is an equilibrium), it must compensate the selling x-firm for its foregone share of the surplus in the xx-merger, that is $\frac{I_{xx}}{2}$. Thereby, firm y loses $I_{xy} - \frac{I_{xx}}{2}$ relative to the status quo. But incurring this loss is a best reply if firm y is even worse off as an outsider, that is $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$. Hence, firm y's decision is driven by the preemption mechanism discussed previously. Note also that the valuation mechanism plays a role in ruling out the IME_{xx}, since firm y becomes an outsider with certainty in such an equilibrium. As a result, the x-firms are better off pursuing the unprofitable xy-merger rather than the profitable xx-merger, since firm y's pre-merger value is very low. Finally, note that firm y bears more than the whole cost associated with the xy-merger. Otherwise, it could not be a best-reply for the x-firms to bid on firm y with positive probability, as they do in the $IME_{xx,xy,yx}$ and the $DME_{xx,xy,yx}$.[20]

The preemptive motive for unprofitable mergers has already been studied by Fridolfsson and Stennek (2005b). In a setting with three symmetric firms, they show that unprofitable mergers may occur in equilibrium, if being an

[19]It can be shown that the unprofitable xy-merger may be very likely. For instance, the probability with which the unprofitable xy-merger occurs, tends to 1 as $E_{xy} \to \frac{I_{xx}}{2}$ (given that $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$). Note also that there are profit configurations such that an unprofitable and anti-competitive xx-merger occurs with strictly positive probability even though the xy-merger is profitable and pro-competitive.

[20]Hence, assuming an exogenous split of the surplus could, once more, be troublesome. In particular, if both merging firms in the unprofitable merger were exogneously assigned to bear a share of the cost associated with the merger, then the unprofitable merger would not occur.

outsider is even more disadvantageous. The value added of the present paper is thus to extend their analysis to asymmetric firms. Thereby, Proposition 4 shows that the preemptive motive may be so strong that unprofitable mergers occur, even though other mergers are profitable. In addition, the present analysis strengthens their results by showing that some equilibria entailing unprofitable mergers are unique. In Fridolfsson and Stennek (1999), unprofitable mergers only occur when all mergers are unprofitable (due to symmetry). In that case, a NME exists as well. In contrast, a NME does not exist in Figure 3, since the xx-merger is profitable.[21]

Proposition 4 deserves a few more remarks. First, restricting the attention to *symmetric* Markov perfect equilibria is not crucial for that result. While *asymmetric* equilibria may exist for the profit configurations indicated in Proposition 4, they must entail that the unprofitable merger occurs with positive probability. Indeed, the condition $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$ reflects that equilibria such that the profitable xx-merger occurs with certainty, do not exist *even* if the analysis is extended to asymmetric equilibria.

Second, one can easily generate examples by means of simple oligopoly models such that one type of merger is anti-competitive and unprofitable while the other is pro-competitive and profitable. For instance, it is well known that anti-competitive mergers are often unprofitable (Salant, Switzer and Reynolds, 1983; Perry and Porter, 1985). Moreover, substantial average cost savings are necessary for a merger to reduce the equilibrium price (Farrell and Shapiro, 1990) and, thereby, pro-competitive mergers tend to be profitable.

Third, preemptive mergers may be relevant for vertical mergers aiming at

[21]Note also in Figure 3 that one merger being anti-competitive while the other is pro-competitive, is not a necessary condition for an unprofitable merger to occur with positive probability. Indeed, the $IME_{xx,yx}$ and the $IME_{xx,xy,yx}$ also exist (and are unique) if $E_{xx}, E_{xy} < 0$ (that is, both mergers are pro-competitive), $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$ and $I_{xx} > 0$.

raising the rivals' costs. A downstream firm may buy a supplier to foreclose other downstream firms' access to the input market (Ordover, Saloner and Salop, 1990). Note that the reason for such a merger is closely related to its negative externality on the competitor. The present analysis suggests that downstream firms may buy the supplier even if vertical integration is inefficient in itself, and even if the gains from foreclosure are dominated by reduced internal efficiency. The reason is that the relevant alternative is that a rival integrates with the supplier. Hence, by allowing for bidding-competition, this work extends and strengthens the previous analysis of foreclosure.

Fourth, the welfare effects of mergers may be quite perverse. To see this, note that the change in the producer surplus relative to the initial market structure is given by $\Delta PS_{xx} \equiv I_{xx} + E_{xx}$ and $\Delta PS_{xy} \equiv I_{xy} + E_{xy}$ for the xx- and the xy-merger, respectively. The two dotted lines in Figure 3 separate the areas where $\Delta PS_{xx} > 0$ ($\Delta PS_{xy} > 0$) and $\Delta PS_{xx} < 0$ ($\Delta PS_{xy} < 0$). In particular, consider the area to the left of the vertical dotted line (so that $\Delta PS_{xy} < 0$) and above the horizontal dotted line (so that $\Delta PS_{xx} > 0$). In this area, there are profit configurations such that the xx-merger is profitable ($I_{xx} > 0$) and pro-competitive ($E_{xx} < 0$) while the xy-merger is unprofitable ($I_{xy} < 0$) and anti-competitive ($E_{xy} > 0$). Hence, in this area, the profitable xx-merger increases both the producer and consumer surpluses. In contrast, the unprofitable xy-merger reduces both these surpluses. Nevertheless, the xy-merger occurs with strictly positive probability if $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$.[22]

[22] In such cases, the profitable and pro-competitive xx-merger occurs with the highest probability. Nevertheless, the unprofitable and anti-competitive xy-merger occurs with a lower bound probability of $\frac{1}{3}$.

6 Concluding Remarks

In a framework where mergers are mutually excluding, I find that firms pursue an anti-competitive merger when alternative mergers are pro-competitive. This result is driven by three distinct mechanisms related to the signs and magnitudes of mergers' external effects.

The finding that the relevant alternative to a merger may be another merger rather than the original market structure, has some policy implications. Current policies mainly evaluate the impact of mergers relative to the original market structure. Propositions 1, 2 and 4 imply that such a policy may underestimate the benefits of blocking anti-competitive mergers. Proposition 3 implies that even blocking pro-competitive mergers may benefit consumers.

An immediate implication of these findings is that competition authorities should try to assess the relevant alternative to a proposed merger. Unfortunately, the implementation of such an ambitious policy is likely to be problematic. Indeed, the authority would not only have to assess the consequences of the proposed merger, but also the impact of mergers that have not been proposed, both as regards profitability and their impact on competitors' as well as on consumers' welfare. Clearly, such a policy requires that antitrust authorities have access to a substantial amount of information. In particular, implementing such a policy requires more information than the implementation of current policies.

It may even be argued that assessing the consequences of proposed mergers is less difficult than assessing the consequences of potential ones. For example, participating firms in potential mergers (that have not been proposed) may be reluctant to reveal relevant information. Fridolfsson (2007) suggests that, in such cases, delegating to competition authorities a welfare standard with a consumer bias may be optimal.

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A Appendix

A.1 Equilibrium Structure

Lemma 1 *Consider the set of symmetric Markov perfect equilibria as* $\Delta \to 0$*. Such an equilibrium exists for all profit configurations. The following equilibria exist.*

1. *A* NME *exists if, and only if,* $I_{xx} \leq 0$ *and* $I_{xy} \leq 0$*.*

2. *An* IME_{xx} *exists if, and only if,* $I_{xx} \geq 0$ *and* $E_{xx} \geq I_{xy} - \frac{I_{xx}}{2}$*.*

3. *An* $IME_{xy,yx}$ *exists if, and only if,* $E_{xy} \leq I_{xy}$ *and* $E_{xy} \geq \frac{I_{xx}}{2}$*.*

4. *An* $IME_{xx,yx}$ *exists if, and only if,* $E_{xx} \leq I_{xy} - \frac{I_{xx}}{2} + \frac{1}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$ *and* $E_{xx} \geq I_{xy} - \frac{I_{xx}}{2} - \frac{2}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$*.*

5. *An* $IME_{xx,xy,yx}$ *exists if, and only if,* $E_{xy} < \frac{I_{xx}}{2}$ *and* $E_{xx} < I_{xy} - \frac{I_{xx}}{2} - \frac{2}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$*.*

6. *An IME such that $p_{yx} \in \left(0, \frac{1}{2}\right)$ and $(p_{xx}, p_{xy}) = (1, 0)$ exists if, and only if, $E_{xx} < I_{xy} - \frac{I_{xx}}{2} + \frac{1}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$ and $E_{xx} > I_{xy} - \frac{I_{xx}}{2}$.*

7. *A $DME_{xy,yx}$ as well as DME such that (i) $p_{yx} \in \left(0, \frac{1}{2}\right)$ and $(p_{xx}, p_{xy}) = (0, 0)$, and (ii) $p_{yx} = 0$, $p_{xx} = 0$ and $p_{xy} \in (0, 1)$ exist if, and only if, $I_{xy} \geq \frac{I_{xx}}{2}$ and $\Psi_x \equiv \frac{I_{xy}}{E_{xy} - I_{xy}} > 0$.*

8. *A $DME_{xx,xy,yx}$ as well as DME such that (i) $p_{yx} \in \left(0, \frac{1}{2}\right)$, $p_{xx} \in (0, 1)$ and $p_{xy} = 0$ and (ii) $p_{yx} = 0$ and $(p_{xx}, p_{xy}) \in \left\{(0, 1)^2 : p_{xx} + p_{xy} \in (0, 1)\right\}$ exist if, and only if, $\Theta_y \equiv \frac{I_{xy} - \frac{I_{xx}}{2}}{E_{xx} - \left(I_{xy} - \frac{I_{xx}}{2}\right)} > 0$ and $\Theta_x \equiv \frac{\frac{I_{xx}}{2}}{E_{xy} - \frac{I_{xx}}{2}} > 0$.*

All other types of equilibria exist only for non-generic profit configurations.[23]

Proof: The following proof restricts the attention to the type of equilibria that exists generically. Analyzing the equilibria that only exist for non-generic profit configurations is time consuming, but not difficult.

The proof starts by rewriting the definitions of V_{yx}^{buy}, V_{xx}^{buy}, V_{xy}^{buy}, $W_y(3)$ and $W_x(3)$. By equations (2) and (8), we have:

$$V_{yx}^{buy} = W_{xy}(2) - W_x(3) \tag{13a}$$

$$V_{xx}^{buy} = W_{xx}(2) - W_x(3) \tag{13b}$$

$$V_{xy}^{buy} = W_{xy}(2) - W_y(3). \tag{13c}$$

Let $\delta = e^{-r\Delta}$ and rearrange (5) in the following way.

$$\begin{aligned}(1-\delta)\left(W_y(3) - \frac{\pi_y(3)}{r}\right) = \frac{2\delta}{3}\Big[&p_{yx}\left(V_{yx}^{buy} - W_y(3)\right) + p_{xy}\left(V_{xy}^{sell} - W_y(3)\right)\\ &+p_{xx}\left(V_y^{out} - W_y(3)\right)\Big].\end{aligned}$$

By equations (3) and (8), we have $V_{xy}^{sell} = W_y(3)$. Eliminate V_{xy}^{sell}. Use equations (4) and (13a) to eliminate V_y^{out} and V_{yx}^{buy}.

$$\begin{aligned}(1-\delta)\left(W_y(3) - \frac{\pi_y(3)}{r}\right) = \frac{2\delta}{3}\big[&p_{yx}\left(W_{xy}(2) - W_x(3) - W_y(3)\right)\\ &+p_{xx}\left(W_y(2) - W_y(3)\right)\big].\end{aligned} \tag{14}$$

[23]Non-generic parameter configurations are such that $\frac{I_{xx}}{2} = E_{xy}$, $I_{xy} = 0$ and so on.

Rearrange (6) in a similar way. Use equations (3) and (8) to eliminate V_{xx}^{sell} and V_{yx}^{sell}. Use equations (4), (13b) and (13c) to eliminate V_{x}^{out}, V_{xx}^{buy} and V_{xy}^{buy}.

$$\begin{aligned}(1-\delta)\left(W_x(3)-\tfrac{\pi_x(3)}{r}\right) = \tfrac{\delta}{3}\,[&p_{xy}\left(W_{xy}(2)-W_y(3)-W_x(3)\right)\\ &+p_{xx}\left(W_{xx}(2)-2W_x(3)\right)\\ &+\left(p_{xy}+p_{yx}\right)\left(W_x(2)-W_x(3)\right)].\end{aligned} \tag{15}$$

Next, I derive the conditions under which each type of equilibrium exists. The proof ends by showing that an equilibrium exists for all profit configurations.

Proof of point 1: A NME is characterized by $p_{yx}=0$ and $(p_{xx},p_{xy})=(0,0)$. By equation (14), we have $W_y(3)=\pi_y(3)/r$. By equation (15), we have $W_x(3)=\pi_x(3)/r$.

First, consider firm y's equilibrium condition in (9). By equation (13a), we have $W_{xy}(2)\leq W_y(3)+W_x(3)$. Eliminate $W_y(3)$ and $W_x(3)$ by using their equilibrium values. Use (1) to eliminate $W_{xy}(2)$. Rearrange the inequality so as to use definition (11a). Then, it simplifies to $I_{xy}\leq 0$.

Second, consider the x-firms' equilibrium conditions in (10). By equations (13b) and (13c), we have $W_{xx}(2)\leq 2W_x(3)$ and $W_{xy}(2)\leq W_y(3)+W_x(3)$. Eliminate $W_y(3)$ and $W_x(3)$ by using their equilibrium values. Use (1) to eliminate $W_{xx}(2)$ and $W_{xy}(2)$. Rearrange the inequalities so as to use definitions (11b) and (11a). Then, they simplify to $I_{xx}\leq 0$ and $I_{xy}\leq 0$, respectively.

Proof of point 2: An $IME_{xx,}$ is characterized by $p_{yx}=0$ and $(p_{xx},p_{xy})=(1,0)$. Use these values to simplify equations (14) and (15). Solve for $W_y(3)$ in (14) and for $W_x(3)$ in (15). Rearrange the solutions in the following way.

$$\begin{aligned}W_y(3) &= \tfrac{\pi_y(3)}{r}+\tfrac{2\delta}{3-\delta}\left[W_y(2)-\tfrac{\pi_y(3)}{r}\right]=\tfrac{\pi_y(3)}{r}+\tfrac{2\delta}{3-\delta}E_{xx},\\ W_x(3) &= \tfrac{\pi_x(3)}{r}+\tfrac{2\delta}{3-\delta}\tfrac{1}{2}\left[W_{xx}(2)-2\tfrac{\pi_x(3)}{r}\right]=\tfrac{\pi_x(3)}{r}+\tfrac{2\delta}{3-\delta}\tfrac{I_{xx}}{2}.\end{aligned}$$

The second equality in the solution for $W_y(3)$ [for $W_x(3)$] follows from the definitions in (1) and (12b) [in (1) and (11b)].

First, consider firm y's equilibrium condition in (9). By equation (13a), we have $W_{xy}(2) \leq W_y(3) + W_x(3)$. Eliminate $W_y(3)$ and $W_x(3)$ by using their equilibrium values as $\delta \to 1$ ($\Delta \to 0$). Use (1) to eliminate $W_{xy}(2)$. Rearrange the inequality so as to use definition (11a). Then, it simplifies to $E_{xx} \geq I_{xy} - \frac{I_{xx}}{2}$.

Second, consider the x-firms' equilibrium conditions in (10). By equations (13b) and (13c), we have $W_{xx}(2) \geq 2W_x(3)$ and $W_{xx}(2) - W_x(3) \geq W_{xy}(2) - W_y(3)$. Eliminate $W_x(3)$ in the first inequality by using its equilibrium value (where $\delta < 1$). Use (1) to eliminate $W_{xx}(2)$. Rearrange the inequality so as to use definition (11b). Then, it simplifies to $I_{xx} \geq 0$. Next, eliminate $W_y(3)$ and $W_x(3)$ in the second inequality by using their equilibrium values as $\delta \to 1$ ($\Delta \to 0$). Use (1) to eliminate $W_{xx}(2)$ and $W_{xy}(2)$. Rearrange the inequality so as to use definitions (11a) and (11b). Then, it simplifies to $E_{xx} \geq I_{xy} - \frac{I_{xx}}{2}$.

Proof of point 3: An $IME_{xy,yx}$ is characterized by $p_{yx} = \frac{1}{2}$ and $(p_{xx}, p_{xy}) = (0, 1)$. Use these values to simplify equations (14) and (15). Then, one gets a system of two equations with two unknowns: $W_y(3)$ and $W_x(3)$. Solve this system. Use (1) to eliminate $W_{xy}(2)$ and $W_x(2)$ in the resulting solutions. Rearrange so as to use definitions (11a) and (12a).

$$W_y(3) = \frac{\pi_y(3)}{r} + \frac{\delta}{6-5\delta}\left[(2-\delta) I_{xy} - \delta E_{xy}\right],$$
$$W_x(3) = \frac{\pi_x(3)}{r} + \frac{\delta}{6-5\delta}\left[2(1-\delta) I_{xy} + (3-2\delta) E_{xy}\right].$$

First, consider firm y's equilibrium condition in (9). By equation (13a), we have $W_{xy}(2) \geq W_y(3) + W_x(3)$. Eliminate $W_y(3)$ and $W_x(3)$ by using their equilibrium values (where $\delta < 1$). Use (1) to eliminate $W_{xy}(2)$. Rearrange the inequality so as to use definition (11a). Then, it simplifies to $E_{xy} \leq$

$(2-\delta)\, I_{xy}$. Let $\delta \to 1$ $(\Delta \to 0)$ to get $E_{xy} \leq I_{xy}$.

Second, consider the x-firms' equilibrium conditions in (10). By equations (13b) and (13c), we have $W_{xy}(2) \geq W_y(3) + W_x(3)$ and $W_{xy}(2) - W_y(3) \geq W_{xx}(2) - W_x(3)$. We already know that the first inequality simplifies to $E_{xy} \leq I_{xy}$ as $\delta \to 1$. Eliminate $W_y(3)$ and $W_x(3)$ in the second inequality by using their equilibrium values as $\delta \to 1$ $(\Delta \to 0)$. Use (1) to eliminate $W_{xy}(2)$ and $W_{xx}(2)$. Rearrange the inequality so as to use definitions (11a) and (11b). Then, it simplifies to $E_{xy} \geq \frac{I_{xx}}{2}$.

Proof of point 4: An $IME_{xx,yx}$ is characterized by $p_{yx} = \frac{1}{2}$ and $(p_{xx}, p_{xy}) = (1, 0)$. Use these values to simplify (14) and (15). Then, one gets a system of two equations with two unknowns: $W_y(3)$ and $W_x(3)$. Let $\delta \to 1$ $(\Delta \to 0)$ in both equations. The LHS in both equations then equals to 0, since $W_y(3)$ and $W_x(3)$ are bounded. Solve the resulting system of equations. Use (1) to eliminate $W_{xy}(2)$, $W_{xx}(2)$, $W_x(2)$ and $W_y(2)$. Rearrange so as to use definitions (11a), (11b), (12a) and (12b).

$$W_y(3) = \frac{\pi_y(3)}{r} + \frac{1}{3}\left[I_{xy} - \left(\frac{4}{5}\frac{I_{xx}}{2} + \frac{1}{5}E_{xy}\right)\right] + \frac{2}{3}E_{xx},$$
$$W_x(3) = \frac{\pi_x(3)}{r} + \frac{4}{5}\frac{I_{xx}}{2} + \frac{1}{5}E_{xy}.$$

First, consider firm y's equilibrium condition in (9). By equation (13a), we have $W_{xy}(2) \geq W_y(3) + W_x(3)$. Eliminate $W_y(3)$ and $W_x(3)$ by using their equilibrium values. Use (1) to eliminate $W_{xy}(2)$. Rearrange the inequality so as to use definition (11a). Then, it simplifies to $E_{xx} \leq I_{xy} - \frac{I_{xx}}{2} + \frac{1}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$.

Second, consider the x-firms' equilibrium conditions in (10). By equations (13b) and (13c), we have $W_{xx}(2) \geq 2W_x(3)$ and $W_{xx}(2) - W_x(3) \geq W_{xy}(2) - W_y(3)$. Eliminate $W_x(3)$ in the first inequality by using its equilibrium value. Use (1) to eliminate $W_{xx}(2)$. Rearrange the inequality so as to use definition (11b). Then, it simplifies to $E_{xy} \leq \frac{I_{xx}}{2}$. Next, eliminate $W_y(3)$ and $W_x(3)$ in the second inequality by using their equilibrium values. Use (1) to eliminate $W_{xy}(2)$ and $W_{xx}(2)$. Rearrange the inequality so as to use definitions (11a) and (11b). Then, it simplifies to $E_{xx} \geq I_{xy} - \frac{I_{xx}}{2} - \frac{2}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$.

Finally, note that $E_{xy} \leq \frac{I_{xx}}{2}$ is fulfilled if the two other conditions are fulfilled.

Proof of point 5: An $IME_{xx,xy,yx}$ is characterized by $p_{yx} = \frac{1}{2}$ and $(p_{xx}, p_{xy}) \in \left\{(0,1)^2 : p_{xx} + p_{xy} = 1\right\}$. Eliminate p_{yx} in equations (14) and (15) as well as p_{xy}, using the fact that $p_{xy} = 1 - p_{xx}$. Then, one gets a system of two equations with two unknowns: $W_y(3)$ and $W_x(3)$. Let $\delta \to 1$ ($\Delta \to 0$) in both equations. The LHS in both equations then equals to 0, since $W_y(3)$ and $W_x(3)$ are bounded. Solve the resulting system of equations. Use (1) to eliminate $W_{xy}(2)$, $W_{xx}(2)$, $W_x(2)$ and $W_y(2)$. Rearrange so as to use definitions (11a), (11b), (12a) and (12b).

$$\begin{aligned} W_y(3) = {} & \tfrac{\pi_y(3)}{r} \\ & + \tfrac{1}{1+4p_{xx}}\left[I_{xy} - E_{xy} + 4p_{xx}E_{xx} + \tfrac{2}{3}p_{xx}\left(I_{xy} - I_{xx} + E_{xy} - E_{xx}\right)\right], \\ W_x(3) = {} & \tfrac{\pi_x(3)}{r} + \tfrac{I_{xx}}{2} \\ & - \tfrac{1}{1+4p_{xx}}\left[\tfrac{I_{xx}}{2} - E_{xy} - \tfrac{4}{3}p_{xx}\left(1 - p_{xx}\right)\left(I_{xy} - I_{xx} + E_{xy} - E_{xx}\right)\right]. \end{aligned}$$

First, consider the equality $V_{xx}^{buy} = V_{xy}^{buy}$, that is one of the x-firms' equilibrium conditions in (10). By equations (13b) and (13c), we have $W_{xx}(2) - W_x(3) = W_{xy}(2) - W_y(3)$. Eliminate $W_x(3)$ and $W_y(3)$ by using their equilibrium values. Use (1) to eliminate $W_{xx}(2)$ and $W_{xy}(2)$. Rearrange the equality so as to use definitions (11a) and (11b). Finally, rearrange in the following way:

$$f\left(p_{xx}\right) \equiv \frac{3\left(1 - 2p_{xx}\right)}{p_{xx}\left(7 - 2p_{xx}\right)} = \frac{I_{xy} - I_{xx} + E_{xy} - E_{xx}}{\frac{I_{xx}}{2} - E_{xy}}. \tag{16}$$

Equation (16) defines p_{xx} implicitly as a function of the exogenous variables in the RHS of (16), since $f'\left(p_{xx}\right) < 0 \; \forall p_{xx} \in (0,1)$.

Second, consider the inequality $V_{xy}^{buy} \geq W_x(3)$, that is the x-firms' other equilibrium condition in (10). By equation (13c), we have $W_{xy}(2) \geq W_x(3) + W_y(3)$. Eliminate $W_x(3)$ and $W_y(3)$ by using their equilibrium values. Use (1) to eliminate $W_{xy}(2)$. Rearrange so as to use definition (11a). The inequality then simplifies to

$$-6\left(\frac{I_{xx}}{2} - E_{xy}\right) \leq (3 + 2p_{xx})(I_{xy} - I_{xx} + E_{xy} - E_{xx}).$$

Assume that $\frac{I_{xx}}{2} > E_{xy}$ and rearrange the inequality in the following way:

$$-\frac{6}{3 + 2p_{xx}} \leq \frac{I_{xy} - I_{xx} + E_{xy} - E_{xx}}{\frac{I_{xx}}{2} - E_{xy}}.$$

By equation (16), the RHS equals $f(p_{xx})$. Simplify to get $3 + 10p_{xx} - 8p_{xx}^2 \geq 0$, which is true $\forall p_{xx} \in (0,1)$. Conversely, the inequality $V_{xy}^{buy} \geq W_x(3)$ simplifies to $3 + 10p_{xx} - 8p_{xx}^2 \leq 0$ if $\frac{I_{xx}}{2} < E_{xy}$, which is not true for any $p_{xx} \in (0,1)$. Hence, if $V_{xx}^{buy} = V_{xy}^{buy}$, then $V_{xy}^{buy} \geq W_x(3)$ if, and only if, $E_{xy} < \frac{I_{xx}}{2}$.

Third, note by (13a), that firm y's equilibrium condition in (9) is equivalent to $W_{xy}(2) \geq W_x(3) + W_y(3)$, that is the inequality treated above.

Finally, note that $\lim_{p_{xx} \to 0} f(p_{xx}) = +\infty$ and $f'(p_{xx}) < 0$ $\forall p_{xx} \in (0,1)$. Since $p_{xx} \in (0,1)$, equation (16) has a unique solution if, and only if,

$$\frac{I_{xy} - I_{xx} + E_{xy} - E_{xx}}{\frac{I_{xx}}{2} - E_{xy}} > f(1) = -\frac{3}{5}$$

Since $\frac{I_{xx}}{2} > E_{xy}$, this inequality simplifies to $E_{xx} < I_{xy} - \frac{I_{xx}}{2} - \frac{2}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$.

Proof of point 6: In this equilibrium, $p_{yx} \in \left(0, \frac{1}{2}\right)$ and $(p_{xx}, p_{xy}) = (1, 0)$. Eliminate p_{xx} and p_{xy} in equations (14) and (15). Let $\delta \to 1$ ($\Delta \to 0$) in both equations. Since $W_y(3)$ and $W_x(3)$ are bounded, the two equations simplify to

$$0 = p_{yx}[W_{xy}(2) - W_y(3) - W_x(3)] + W_y(2) - W_y(3) \quad (17)$$

$$0 = W_{xx}(2) - 2W_x(3) + p_{yx}[W_x(2) - W_x(3)] \quad (18)$$

First, consider firm y's equilibrium condition in (9). By equation (13a), we have $W_{xy}(2) = W_y(3) + W_x(3)$. This equation and equation (17) constitute a system of two equations with two unknowns: $W_y(3)$ and $W_x(3)$. Solve this system. Use (1) to eliminate $W_y(2)$ [$W_{xy}(2)$] in the solution for $W_y(3)$ [$W_x(3)$]. Rearrange so as to use definitions (11a) and (12b). The solutions are then $W_y(3) = \frac{\pi_y(3)}{r} + E_{xx}$ and $W_x(3) = \frac{\pi_x(3)}{r} + I_{xy} - E_{xx}$.

Second, consider the x-firms' equilibrium conditions in (10). By equations (13b) and (13c), we have $W_{xx}(2) \geq 2W_x(3)$ and $W_{xx}(2) - W_x(3) \geq W_{xy}(2) - W_y(3)$. Eliminate $W_x(3)$ in the first inequality by using its equilibrium value. Use (1) to eliminate $W_{xx}(2)$. Rearrange so as to use definition (11a). The inequality then simplifies to $E_{xx} \geq I_{xy} - \frac{I_{xx}}{2}$. Similarly, the second inequality also simplifies to $E_{xx} \geq I_{xy} - \frac{I_{xx}}{2}$.

Finally, it is required that $p_{yx} \in \left(0, \frac{1}{2}\right)$. To obtain an expression for p_{yx}, insert the equilibrium values of $W_y(3)$ and $W_x(3)$ into (18). Use (1) to eliminate $W_{xx}(2)$ and $W_x(2)$. Rearrange so as to use definitions (11b) and (12a). Solving for p_{yx} yields that $p_{yx} = 2\frac{E_{xx} - (I_{xy} - I_{xx}/2)}{I_{xy} - (E_{xy} + E_{xx})}$. Hence, it is required that $\frac{1}{2} > 2\frac{E_{xx} - (I_{xy} - I_{xx}/2)}{I_{xy} - (E_{xy} + E_{xx})} > 0$. Since $E_{xx} \geq I_{xy} - \frac{I_{xx}}{2}$, these two inequalities imply that $I_{xy} > E_{xy} + E_{xx}$ and $E_{xx} > I_{xy} - \frac{I_{xx}}{2}$ and $E_{xx} < I_{xy} - \frac{I_{xx}}{2} + \frac{1}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$. The two latter inequalities imply that the former one is fulfilled.

Proof of point 7: I only prove the conditions under which a $DME_{xy,yx}$ exists. Following the same steps as below, it is straightforward to prove that the two other DME exist under the same conditions as the $DME_{xy,yx}$.

A $DME_{xy,yx}$ is characterized by $p_{yx} \in \left(0, \frac{1}{2}\right)$ and $p_{xx} = 0$, $p_{xy} \in (0, 1)$.

Consider firm y's equilibrium condition in (9). By equation (13a), we have $W_{xy}(2) = W_y(3) + W_x(3)$. This equation and equation (14) constitute a system of two equations with two unknowns: $W_y(3)$ and $W_x(3)$. Solve this system, using the fact that $p_{xx} = 0$. The solutions are $W_y(3) = \frac{\pi_y(3)}{r}$ and $W_x(3) = W_{xy}(2) - \frac{\pi_y(3)}{r} = \frac{\pi_x(3)}{r} + I_{xy}$ (the second equality follows from definitions (1) and (11a)).

Next, eliminate $W_x(3)$ in the LHS in (15) by using its equilibrium value. The LHS then equals I_{xy}. The RHS in (15) equals $\frac{1}{3}\frac{\delta}{1-\delta}(p_{xy} + p_{yx})(W_x(2) - W_x(3))$, since $p_{xx} = 0$ and $W_{xy}(2) = W_y(3) + W_x(3)$. Note that $W_x(2) - W_x(3) = E_{xy} - I_{xy}$ (which follows from the equilibrium value of $W_x(3)$ and the definitions in (1) and (12a)). Hence:

$$p_{xy} + p_{yx} = 3\frac{1-\delta}{\delta}\frac{I_{xy}}{E_{xy} - I_{xy}} = 3\frac{1-\delta}{\delta}\Psi_x. \tag{19}$$

Since $p_{xy} + p_{yx} > 0$, it is necessary that $\Psi_x > 0$. As $\delta \to 1$ ($\Delta \to 0$), the RHS tends to 0 so that there exists probabilities p_{xy} and p_{yx} satisfying the above equality (in fact, there exists a continuum of such probabilities). Thus, the condition $\Psi_x > 0$ is also sufficient in order to satisfy the above equality.

Finally, consider the x-firms' equilibrium conditions in (10). By equations (13b) and (13c), we have $W_{xy}(2) = W_y(3) + W_x(3)$ and $W_{xy}(2) - W_y(3) \geq W_{xx}(2) - W_x(3)$. We already know that the equality is fulfilled. Use (1) to eliminate $W_{xy}(2)$ and $W_{xx}(2)$ in the inequality. Eliminate $W_y(3)$ and $W_x(3)$ by using their equilibrium values. Rearrange so as to use definitions (11a) and (11b). The inequality then simplifies to $I_{xy} \geq \frac{I_{xx}}{2}$.

Proof of point 8: I only prove the conditions under which a $DME_{xx,xy,yx}$ exists. Following the same steps as below, it is straightforward to prove that the two other DME exist under the same conditions as the $DME_{xx,xy,yx}$.

A $DME_{xx,xy,yx}$ is characterized by $(p_{xx}, p_{xy}) \in \left\{(0,1)^2 : p_{xx} + p_{xy} \in (0,1)\right\}$ and $p_{yx} \in \left(0, \frac{1}{2}\right)$.

Consider the x-firms' equilibrium condition in (10). By equations (13b) and (13c), we have $W_{xy}(2) = W_y(3) + W_x(3)$ and $W_{xx}(2) - W_x(3) = W_{xy}(2) - W_y(3)$. Use these equations to solve for $W_y(3)$ and $W_x(3)$. The solutions are $W_y(3) = W_{xy}(2) - \frac{W_{xx}(2)}{2} = \frac{\pi_y(3)}{r} + I_{xy} - \frac{I_{xx}}{2}$ and $W_x(3) = \frac{W_{xx}(2)}{2} = \frac{\pi_x(3)}{r} + \frac{I_{xx}}{2}$ (the second equality in the first [second] solution follows from the definitions in (1), (11a) and (11b) [(1) and (11b)]).

Next, eliminate $W_y(3)$ in the LHS in (14) by using its equilibrium value. The LHS then equals $I_{xy} - \frac{I_{xx}}{2}$. The RHS in (14) equals $\frac{2}{3}\frac{\delta}{1-\delta} p_{xx}(W_y(2) - W_y(3))$, since $W_{xy}(2) = W_y(3) + W_x(3)$. Note that $W_y(2) - W_y(3) = E_{xx} - \left(I_{xy} - \frac{I_{xx}}{2}\right)$ (which follows from the equilibrium value of $W_y(3)$ and the definitions in (1) and (12b)). Hence:

$$p_{xx} = \frac{3}{2}\frac{1-\delta}{\delta}\frac{I_{xy} - \frac{I_{xx}}{2}}{E_{xx} - \left(I_{xy} - \frac{I_{xx}}{2}\right)} = 3\frac{1-\delta}{\delta}\Theta_y.$$

Since $p_{xx} > 0$, it is necessary that $\Theta_y > 0$. As $\delta \to 1$ ($\Delta \to 0$), the RHS tends to 0 so that there exists a probability p_{xx} satisfying the above equality. Thus, the condition $\Theta_y > 0$ is also sufficient in order to satisfy the above equality. Similarly, by simplifying equation (15), it is straightforward to show that there exists probabilities p_{xy} and p_{yx} satisfying equation (15) if, and only if, $\Theta_x = \frac{I_{xx}/2}{E_{xy} - I_{xx}/2} > 0$.

Finally, consider firm y's equilibrium condition in (9). By equation (13a), we have $W_{xy}(2) = W_y(3) + W_x(3)$, which we know is fulfilled.

Existence: To complete the proof, it remains to show that at least one type of equilibrium exists for all profit configurations.

Consider the case in Figure 3, that is, profit configurations such that $I_{xx} > 0$ and $\frac{I_{xx}}{2} > I_{xy}$. Next, I show that there exists an equilibrium for all pairs (E_{xx}, E_{xy}), given that the above conditions on I_{xx} and I_{xy} are fulfilled. First, assume that $E_{xx} > I_{xy} - \frac{I_{xx}}{2}$. By point 2, there exists an IME_{xx}, since $I_{xx} > 0$. Second, assume that $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$ and $E_{xy} > \frac{I_{xx}}{2}$. By point 8, there exists a $DME_{xx,xy,yx}$, since $I_{xy} - \frac{I_{xx}}{2} < 0$ and $I_{xx} > 0$. Third, assume that $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$ and $E_{xy} < \frac{I_{xx}}{2}$. By point 5, there exists an $IME_{xx,xy,yx}$ if $E_{xx} < I_{xy} - \frac{I_{xx}}{2} - \frac{2}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$. If instead $E_{xx} > I_{xy} - \frac{I_{xx}}{2} - \frac{2}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$, there exists an $IME_{xx,yx}$. Indeed, this latter inequality constitutes one of the two conditions for an $IME_{xx,yx}$ to exist (see point 4). Moreover, the second condition for such an equilibrium to exist is $E_{xx} < I_{xy} - \frac{I_{xx}}{2} + \frac{1}{5}\left(\frac{I_{xx}}{2} - E_{xy}\right)$. This condition is fulfilled if $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$ and $E_{xy} < \frac{I_{xx}}{2}$.

To check the existence for all possible profit configurations, repeat similar arguments for the following three cases: (i) $I_{xy} > \frac{I_{xx}}{2} > 0$ (that is, the case in Figure 2), (ii) $I_{xy} > 0$ and $I_{xx} < 0$ and (iii) $I_{xx}, I_{xy} < 0$. QED.

A.2 Proofs of Propositions:

All proofs below build upon the equilibrium structure derived in Lemma 1.

A.2.1 Proof of Proposition 1:

By Lemma 1, Figures 2 and 3 illustrate the conditions under which each equilibrium exists when $I_{xy} \geq \frac{I_{xx}}{2} \geq 0$ and $\frac{I_{xx}}{2} \geq I_{xy} \geq 0$, respectively. First, assume that $I_{xy} \geq \frac{I_{xx}}{2} \geq 0$. Then, $E_{xx} > I_{xy} - \frac{I_{xx}}{2}$, since $I_{xy}, I_{xx} > 0$, $E_{xx} > 0$ and $|E_{xx}| > I_{xy}$. Moreover, $E_{xy} < 0 < \frac{I_{xx}}{2}$. By Figure 2, the IME_{xx} is then unique or exists simultaneously with the $IME_{xx,yx}$. Consequently, the xx-merger occurs with probability 1 (in the IME_{xx}) or 2/3 (in the $IME_{xx,yx}$). Second, assume that $\frac{I_{xx}}{2} \geq I_{xy} \geq 0$. Then, $E_{xx} > I_{xy} - \frac{I_{xx}}{2}$, since $E_{xx} > 0 \geq I_{xy} - \frac{I_{xx}}{2}$. The same conclusion as in the first case follows from Figure 3. QED.

A.2.2 Proof of Proposition 2:

By Lemma 1, Figure 2 illustrates the conditions under which each equilibrium exists when $I_{xy} \geq \frac{I_{xx}}{2} \geq 0$. Since $E_{xx} < 0$ and $I_{xy} > \frac{I_{xx}}{2}$, we have that $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$. Moreover, $E_{xy} > I_{xy}$, since $E_{xy} > 0$ and $|E_{xy}| > I_{xy}$. By Figure 2, the $DME_{xy,yx}$ is then unique.

It remains to show that the xy-merger occurs with probability 1 in the long run. Note that there are t/Δ time periods between time 0 and time t. In a $DME_{xy,yx}$, the triopoly remains until time t with probability $\left(1-\frac{2}{3}\left(p_{yx}+p_{xy}\right)\right)^{t/\Delta}=\left(1-2\frac{1-e^{-r\Delta}}{e^{-r\Delta}}\Psi_x\right)^{t/\Delta}$ where the second inequality follows from (19) and the fact that $\delta=e^{-r\Delta}$. Let $q_0\left(\Delta\right)\equiv 1-2\frac{1-e^{-r\Delta}}{e^{-r\Delta}}\Psi_x$ and define the cumulative distribution function indicating the probability that a merger has not occurred before time t, as

$$G_0\left(t\right)=\lim_{\Delta\to 0}\left[q_0\left(\Delta\right)\right]^{t/\Delta}.$$

Since the logarithm is continuous

$$\ln G_0\left(t\right)=t\lim_{\Delta\to 0}\frac{\ln q_0\left(\Delta\right)}{\Delta}.$$

Note that $\lim_{\Delta\to 0}q_0\left(\Delta\right)=1$. Hence, $\lim_{\Delta\to 0}\frac{\ln q_0(\Delta)}{\Delta}=\text{"}\frac{0}{0}\text{"}$. By l'Hopital's rule: $\lim_{\Delta\to 0}\frac{\ln q_0(\Delta)}{\Delta}=\lim_{\Delta\to 0}\frac{q_0'(\Delta)}{q_0(\Delta)}=\lim_{\Delta\to 0}q_0'\left(\Delta\right)$. Hence:

$$\ln G_0\left(t\right)=t\lim_{\Delta\to 0}q_0'\left(\Delta\right)=-2rt\Psi_x.$$

Thus, $G_0\left(t\right)=e^{-2rt\Psi_x}$. Define the probability of an xy-merger having occurred at time t as $G\left(t\right)\equiv 1-e^{-2rt\Psi_x}$. $\lim_{t\to\infty}G\left(t\right)=1$ for all $\Psi_x>0$. QED.

A.2.3 Proof of Proposition 3:

By Lemma 1, Figures 2 and 3 illustrate the conditions under which each equilibrium exists when $I_{xy}\geq\frac{I_{xx}}{2}\geq 0$ and $\frac{I_{xx}}{2}\geq I_{xy}\geq 0$, respectively. First, assume that $I_{xy}\geq\frac{I_{xx}}{2}\geq 0$. By Figure 2, the $IME_{xx,yx}$ or the $IME_{xx,xy,yx}$ is unique if $E_{xy},E_{xx}<0$. Second assume that $\frac{I_{xx}}{2}\geq I_{xy}\geq 0$. Then, $E_{xx}<I_{xy}-\frac{I_{xx}}{2}$, since $I_{xy},I_{xx}>0$, $E_{xx}<0$ and $\left|E_{xx}\right|>I_{xx}$. By Figure 3, the $IME_{xx,yx}$ or the $IME_{xx,xy,yx}$ is then unique if $E_{xy},E_{xx}<0$.

The lower bound probability remains to be proved . Consider first the simple case when the $IME_{xx,yx}$ is unique. In such an equilibrium, the xy- (xx-) merger occurs with probability 1/3 (2/3). Hence, the least pro-competitive merger must occur with a lower bound probability of 1/3.

Next, consider the more difficult case when the $IME_{xx,xy,yx}$ is unique. In such an equilibrium, the xy-merger occurs with a lower bound probability of 1/3 while the xx-merger may occur with an arbitrarily small probability. It thus remains to determine the lower bound probability for the xx-merger to occur in the cases when it is the least pro-competitive, that is when $0 > E_{xx} > E_{xy}$ (by Assumption 2). This amounts to finding a lower bound for p_{xx}, which is implicitly defined by equation (16). Since $f'(p_{xx}) < 0$ and $\lim_{p_{xx}\to 0} f(p_{xx}) = 0$, the lower bound of p_{xx} is found by solving the following maximization problem.

$$\max_{\{I_{xx},I_{xy},E_{xx},E_{xy}\}} \frac{I_{xy} - I_{xx} + E_{xy} - E_{xx}}{\frac{I_{xx}}{2} - E_{xy}},$$

subject to $E_{xy} - E_{xx} \leq 0$, $I_{xx}, I_{xy} \geq 0$ and $E_{xy}, E_{xx} \leq -\max\{I_{xx}, I_{xy}\}$. By noting that the existence of an $IME_{xx,xy,yx}$ requires that $\frac{I_{xx}}{2} > E_{xy}$, solving the above maximization problem is straightforward. The solutions are given by $\{(I_{xx}, I_{xy}, E_{xx}, E_{xy}) : I_{xx} = 0 \text{ and } E_{xx}, E_{xy} = -I_{xy}\}$. The maximized expression equals 1 at its maximum. Replacing the RHS in (16) by 1 and solving the resulting equation yields that $p_{xx} = \frac{13}{4} - \frac{1}{4}\sqrt{145}$. Moreover, the xx-merger occurs with probability $\frac{2}{3}p_{xx}$. By continuity, it follows that the xx-merger occurs with a lower bound probability of $\frac{2}{3}\left(\frac{13}{4} - \frac{1}{4}\sqrt{145}\right) \simeq 0.16$. QED.

A.2.4 Proof of Proposition 4:

By Lemma 1, Figure 3 illustrates the conditions under which each type of equilibrium exists when $I_{xx} > 0$ and $I_{xy} < 0$. First, consider profit configurations such that $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$ and $E_{xy} < \frac{I_{xx}}{2}$. By Figure 3, either the $IME_{xx,yx}$ or the $IME_{xx,xy,yx}$ is then unique. Hence, the xy-merger then occurs immediately with strictly positive probability. Second, consider profit configurations such that $E_{xx} < I_{xy} - \frac{I_{xx}}{2}$ and $E_{xy} > \frac{I_{xx}}{2}$. By Figure 3, the $DME_{xx,xy,yx}$ is then unique. In the proof of Proposition 2, it was shown that in a $DME_{xy,yx}$, the probability of an xy-merger having occurred at time t is $1 - e^{-2rt\Psi_x}$. Similarly, it can be shown that in a $DME_{xx,xy,yx}$, the probability of some merger having occurred at time t is $1 - e^{-rt(2\Theta_x + \Theta_y)}$. Since $\lim_{t\to\infty} 1 - e^{-rt(2\Theta_x+\Theta_y)} = 1$, it follows that some merger occurs with probability 1 in the long run. Moreover, it is easy to show that, conditional on the event that some merger has occurred, the probability of an xy-merger having occurred is $\frac{2\Theta_x}{2\Theta_x+\Theta_y} > 0$. QED.