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ARTICLE

Horizontal mergers, cost savings, and network effects

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Abstract

We consider a horizontally differentiated oligopoly and investigate the relationship between merger cost savings and network effects for the incentives of firms to merge and for the postmerger welfare outcomes. We show that it is more profitable to be an insider rather than an outsider of the merger, unless both cost savings and network effects are too low. Mergers can improve customer and total welfare provided both cost savings and network effects are high enough. We find that the possibility for network effects to lead to a Pareto improvement through merger is shown to depend on the number of outside firms.

KEYWORDS

compatibility, cost savings, horizontal differentiation, horizontal merger, network effect

JEL CLASSIFICATION

L13, L14, L41

1 | INTRODUCTION

Markets are structurally transformed by horizontal mergers because they trigger changes in the firms' conduct and raise key issues for market competition. Regulators want to understand when

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mergers occur, and whether the transaction will be beneficial to society; such information helps regulators decide whether an intervention to ban the merger is warranted, or whether it should be allowed to proceed.

The general answer provided by traditional models of oligopoly is that horizontal mergers are often both welfare reducing and unprofitable. These mergers internalize pricing effects between (former) rivals, and they increase market power. Nevertheless, merging partners often fail to fully exploit the situation. They raise the price but lose demand, whereas outsiders benefit from both a price increase and higher market shares. This free-rider problem (Stigler, 1950) is the basis of the horizontal merger profitability paradox.¹ Furthermore, any horizontal merger inevitably involves the loss of a direct competitor on the market, which is likely to lead to a price increase and ultimately to a loss for customers and even for total welfare. Such likely outcomes stem from the very mechanism supporting the merger profitability paradox: Following a merger, the insiders' decrease in output or increase in price following the merger is typically larger than the outsiders' responding increase in output or price; the situation leads to a reduction in customer surplus, which calls for public intervention in the form of merger control.

Following Williamson (1968), the welfare analysis of horizontal mergers focused on the trade-off between the market power effect and the potential cost savings. Clearly, the cost savings will benefit customers when mergers trigger a price drop; for this reason, the matter of cost savings has become particularly relevant for merger control.² But, at the same time, cost savings also impact the profitability of the merger, and thereby these savings may solve the merger paradox. That is because the insiders' market share increases when the merged firms operate with low enough postmerger production costs³; when that happens, being an insider is typically more profitable than being an outsider because outsiders incur cost disadvantages after the merger.

Alternatively, a purely demand-driven solution may be contemplated as offering an explanation for the merger paradox. In some industries, the large size of the merged firm can confer an advantage in terms of product value for buyers, thanks to direct network effects. Such demand-side efficiencies typically arise in communication products/services markets (see Rohlfs, 1974). Horizontal mergers in these industries provide firms with an incentive to increase output due to the internalization of the positive network effect. When customers (strongly) value the network size, the insiders have a competitive advantage compared to the outsiders and, hence, can charge higher prices without losing too much—if anything at all—of their previous market shares. And even if the network effect is negative, it is still possible to alleviate the merger's negative impact on insiders' profits and customers' welfare. The fact that utility from own consumption is negatively affected by others' consumption of the same good (Veblen, 1899) may be due to congestion (Leibenstein, 1950), which, in turn, is often related to some capacity constraints. Horizontal

¹ Arguably, there are actually two sides to this paradox. Often, the merger is not profitable for the participants (see, for instance, Norman et al., 2014), and, generally, a merger benefits outsiders more from the merger than the insiders (see, e.g., Brito, 2003; Posada & Straume, 2004). Importantly, the paradox occurs both with price competition (Deneckere & Davidson, 1985; Levy & Reitzes, 1992) and quantity competition (see, e.g., Salant et al., 1983) but to different degrees. The strategic complementarity in the Bertrand case makes horizontal mergers internally profitable, whereas the strategic substitutability of the standard Cournot case prevents this.

² The 2010 U.S. Horizontal Merger Guidelines, at §10, provide that “to make the requisite determination, the Agency considers whether cognizable efficiencies likely would be sufficient to reverse the merger's potential to harm customers in the relevant market, e.g., by preventing price increases in that market.”

³ See, for instance, Perry and Porter (1985) for the Cournot case and Brito (2005) for the Bertrand game.

mergers in markets affected by congestion⁴ can relax this constraint for the insiders, who may be more aggressive as a result, and, thus, may serve more customers before congestion does become an issue for them.

Our paper focuses on the interplay between cost savings and direct network effects. It examines the impact of this interaction on the incentives to merge, on the potential for the merger paradox to occur, and on merger-induced outcomes (prices, industry profits, customer, and total welfare). We base our analysis on the spatial framework of price competition à la Vickrey (1964) and Salop (1979). Without network effects, this workhorse model for the analysis of horizontal mergers allows for localized competition and for the possibility of exploiting captive customers, making room for mergers (between neighboring firms) that are profitable at the expense of both customers and rival firms.⁵ We check the extent to which such conclusions still hold when the merger generates cost savings in a market in which demand exhibits direct network effects.⁶ To examine this, we consider positive values, so as to better investigate the interplay between merger cost savings and demand externalities.⁷ Indeed, various contributions have previously shown that positive network effects intensify price competition, whereas negative network effects soften it.⁸ In our merger scenarios, we assume that the merger results in compatible networks of the merging firms; we examine the outcomes (prices, profits, and customer and total welfare) of three types of bilateral mergers: (i) a three-to-two merger, (ii) a four-to-three merger between adjacent firms, and (iii) a four-to-three merger between distant firms.

Our findings reveal the following: In a market that initially has three firms, adding network effects does not reverse the standard outcome in terms of postmerger pricing decisions. The insiders' and the outsider's prices drop only when enough cost savings are high enough. By extending the regular profitability results, we show that the merger is always profitable for the participants. This also means that even though insiders may end up charging a lower price, they still gain enough additional customers to compensate for the lower margin. Note that this could potentially limit or even avoid customer surplus losses (see below). Furthermore, the merger lowers the outsider's profit when cost savings are high enough. We also find that part of the merger paradox still

⁴ Telecom markets may yet again be an example for this, as is illustrated by the British Telecom/MCI merger (EU case no. IV/M856). Prior to the merger, a capacity shortage had emerged for transmission facilities in the market for international voice telephony services between the United Kingdom and the United States (Häckner & Razo, 2004).

⁵ See, for example, Cabral (2003), Brito (2003, 2005), Foros et al. (2011), and Brekke et al. (2017).

⁶ Several contributions incorporate network effects into the price-competition circular city model, albeit without addressing either the incentives for or the outcomes of horizontal mergers. Navon et al. (1995), Friedman and Grilo (2005), and Heikkinen (2014) all examine the properties of the free-entry equilibrium. Their work uses the symmetric price equilibrium with symmetric firm locations and checks alternative assumptions for the shape of network effects (whether they are or are not purely linear) or those of transportation costs (whether these are linear or quadratic); they all conclude that the equilibrium number of suppliers exceeds the optimum, for a large range of values of the network effects, both positive and negative. In the same general framework, Lundberg (2015) finds that, on the contrary, entry may be insufficient in equilibrium if the network effects are nonmonotonic. Finally, Jonard and Schenk (2004) address the impact of positive network effects on the threat of potential entry; they show that network compatibility (as implied by coordinated location choices to reduce product differentiation and afford a larger network) in a duopoly favors the entry of a competitor.

⁷ We also comment on negative network effects throughout the paper.

⁸ See, for example, Heikkinen (2014) and Lundberg (2015). The intuition is quite straightforward. Price competition is more intense with positive network effects because a lower price by one firm increases its market share, which, in turn, makes it more attractive to customers, thanks to the positive demand externality. By contrast, negative network effects that result, for example, from congestion lead to a price increase, restricting the number of buyers because a smaller market share will increase the supplier's attractiveness. In other words, negative network effects increase market power, whereas positive network effects limit market power.

holds—despite the price competition assumption, the presence of a single outsider, and network effects. Entering into the merger is less profitable than being outside of it as long as the cost savings are low enough, both with positive and negative network effects. Arguably, this implies that the cost efficiencies are a valid explanation for horizontal mergers in markets with network effects. Nonetheless, the amount of cost savings generated may still not be enough to prevent negative effects on customers. We find that both customer welfare and total welfare increase only when cost savings are high enough, both with negative and positive network effects—even though (and as expected) the threshold amount of cost efficiencies is higher for customer welfare than for total welfare. Moreover, the levels of cost savings necessary to ensure lower prices or higher welfare after the merger are generally decreasing with the level of the network effect. We find that the merger can be Pareto improving with positive demand externalities yet low enough cost savings. Compatibility between the insiders' networks allows their customers to benefit from an increased network size,⁹ despite the higher prices charged by the merger participants.

We then extend our analysis to a slightly less concentrated industry and examine both adjacent and distant bilateral mergers that take place in a market that initially consists of four firms. For the four-to-three merger between neighboring firms, we find that all results are robust, except for the last one. We thus identify a non-monotonic impact of the network effect, which can result in a Pareto-improving outcome in a three-to-two merger, but not in a four-to-three merger. The difference between the two merger situations is due to the share of customers who pay a higher price without enjoying the wider network of the merging firms. A four-to-three distant merger basically leads to the same outcome as in the standard framework of circular spatial competition without network effects (see Brito, 2005). For instance, the distant four-to-three merger is profitable for the insiders only if the enough cost savings are high enough and if the network effects are positive¹⁰; by contrast, a distant four-to-three merger is always internally profitable for a negative demand externality.¹¹ We also find overall the same profile for the total welfare variation after merger irrespective of the network effect for four-to-three mergers of both types (involving adjacent or distant firms).

Some policy implications can be derived from our results. A key implication stems from the fact that the levels of cost savings necessary to ensure lower prices or higher welfare postmerger generally decrease with the level of network externality. This suggests that competition agencies should assess the intensity of network effects when agencies determine how much the insiders' postmerger cost should drop to prevent adverse competitive effects; this is because the level of cost savings required is not the same when the market does not exhibit network effects. A further policy implication is that the level of cost savings from a merger remains crucial for the price and welfare analyses of horizontal mergers, even when the network effects are present. This indicates that a “network efficiency defense” may not easily replace the much called-for “cost-efficiency

⁹ On mobile telecom markets, consumers have been shown to prefer networks with a larger number of subscribers, which suggests that the network effect operates at the firm level rather than at the industry level (see Kim & Kwon, 2003).

¹⁰ With a negative demand externality, the outcome is the same as for the adjacent four-to-three merger.

¹¹ Incidentally, this is different from the case of indirect/two-sided network effects examined by the paper closest to ours, Baranes et al. (2019). They find that, for instance, outsiders to the four-to-three distant merger always incur a profit loss, regardless of the level of the merger's cost savings and the sign of the indirect cross-group externality. Similarly, customer surplus is shown to always increase on both sides of the market after this type of merger. This signals that the direct and indirect network-effect settings are not fully isomorphic.

defense,”¹² despite the fact that the intensity of the demand externality would be easier to measure than the merger’s possible cost savings.¹³ Finally, the similar profile for the total welfare variation after a merger for four-to-three mergers involving either adjacent or distant firms suggests that the closeness of competition between merging firms should not be crucial for establishing whether the merger is anticompetitive.¹⁴

The paper proceeds as follows: The next section discusses the related literature. Section 3 presents the theoretical framework and provides the results for the three-to-two merger and the two four-to-three mergers. (The Online [Appendix](#) provides the detailed expressions for prices, profits, and welfare levels of the four-to-three mergers.) The final section concludes. A technical appendix available upon request provides the detailed derivation of all our results and a graphical illustration.

2 | RELATED LITERATURE

Few contributions in the literature examine how networks affects the incentives of firms to merge and the resulting welfare outcomes. Most explorations of this subject take on the issue through a Cournot framework, with positive, direct network effects à la Katz and Shapiro (1985). Jami-son (2002) and Weisman (2005) consider a multimarket provider setting with complementary demands; they conclude that the horizontal merger of multimarket firms can increase welfare in the absence of merger cost savings.¹⁵ More recently, Toshimitsu (2017, 2019) analyzes a three-firm differentiated Cournot oligopoly allowing for both direct network effects and compatibility between the firms’ respective products/services and without any efficiencies on the supply/cost side. These contributions conclude that the horizontal merger can be internally profitable and improve customer and total welfare at the same time—provided that the network compatibility is sufficiently large between the insiders as compared with the product substitutability parameter. A

¹² See, for instance, “Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings,” OJ C31, 5.2.2004, p. 5. Genakos et al. (2018) note that, so far, merging firms have typically failed to successfully persuade regulators to adopt an efficiency defense in European merger control.

¹³ A “network efficiency defense” can be considered public information (see, for instance, Doganoglu & Grzybowski, 2007; Grajek, 2010; Kim & Kwon, 2003), whereas the “cost-efficiency defense” is typically the private information among the merging partners.

¹⁴ The EC Horizontal Merger Guidelines (para. 28–30) mention that the finding of a significant impediment to effective competition is more likely when there is a closeness of competition between merging parties that captures the degree of substitutability between their products. In May 2020, the European General Court rendered its judgment on the appeal against the Commission’s decision to prohibit the acquisition of Telefónica Europe Plc. (that is, “O2”) by CK Hutchison Holdings Limited through its indirect subsidiary Hutchison 3G UK Investments Ltd (that is, “Three”); the appeal concerned a proposed four-to-three merger in the UK mobile market (see GCEU, May 28, 2020, CK Telecoms UK Investments Ltd, Case T-399/16, EU:T:2020:217). The General Court found that the Commission had not established that O2, and Three were particularly close competitors (para. 247), and, hence, the court said that “mere fact that they were relatively close competitors in some segments of a concentrated market with four players is not sufficient to prove that the parties exerted important competitive constraints on each other” (para. 249). To put it short, the General Court stated that the Commission was wrong to conclude (as it did in the prohibition decision) that this merger would have substantially reduced competition because it had not established sufficient closeness premerger between the merging parties (see, e.g., Casparly & Bozhikov, 2020).

¹⁵ Arguably, this results from the fact that such horizontal mergers actually replicate the vertical integration for complementary product markets. Consequently, merger profitability is not an issue, and the postmerger higher number of complementary markets to those of the insiders will restrict prices, thus contributing to improved welfare.

merger can even be Pareto improving when compatibility within the whole industry (i.e., among all firms) increases in its wake. By contrast, Häckner and Razo (2004) addressed the impact of direct negative network effects on postmerger prices and welfare in a model of price competition; they find that a horizontal merger can alleviate the congestion problem that generates the negative demand externality and thereby leads to lower prices and, eventually, higher customer welfare. As a policy implication, Häckner and Razo (2004) argue that the level of merger cost savings needed to guarantee that customers are not harmed should be lower when negative demand externalities are present. However, their model does not allow for cost efficiencies.

The merger-related interaction between supply- and demand-side efficiencies has hardly been tackled in the rest of the literature. To the best of our knowledge, only three other papers consider both cost savings and network effects in a model of a horizontal merger. A first attempt is made by Doluca (2012), who adds direct, positive network effects to the dynamic Cournot homogenous product, three-to-two merger game of Motta and Vasconcelos (2005) to check whether the so-called “efficiency offense” argument may hold. The other two papers consider indirect network effects and deal with two-sided markets. Correia-da-Silva et al. (2018) consider quantity competition among two-sided platforms to examine the price effects of horizontal mergers that do not affect the industry average marginal cost.¹⁶ Finally, Baranes et al. (2019) consider a four-platform, two-sided circular-city model to compute the level of cost savings necessary to keep prices, profits, and welfare constant following a bilateral merger between either adjacent or distant platforms competing in membership fees. Allowing for asymmetric valuation (and, hence, for demand externalities) between users on opposite sides of the market, their analysis extends the profitability results from one-sided models of Bertrand mergers on the unit circle (see, for instance, Brito, 2005), while also affording new conclusions that are specific to the two-sided framework. In particular, it is shown that the indirect network effects are consistent with opposite price behavior across the market sides after the merger. For a given level of merger cost savings, postmerger prices (and ultimately, customer welfare) can decrease on one side but simultaneously increase on the other.

3 | MODEL AND RESULTS

In this section, we describe the setup and then analyze three merger scenarios: a three-to-two merger, a four-to-three merger of two adjacent firms, and a four-to-three merger of two distant firms.

3.1 | Framework

Consider the circular market with a circumference of one (Salop, 1979; Vickrey, 1964). Firms are horizontally differentiated and located at equal distances from each other. Denote by c the constant marginal production cost, which initially is the same for all firms. Normalize fixed costs to zero. Firms sell to customers of mass one; customers are uniformly distributed along the circular city. Customers have unit demand, and they travel (or incur disutility) to buy at the firms’ locations. A customer who is located at a distance d_i from firm i incurs transport costs of d_i^2 when

¹⁶ The paper identifies sufficient conditions for such mergers to benefit users on either side of the market. It finds that the externality adjusted, premerger price must be below the average marginal cost on the corresponding side.

buying from that firm. With n firms active in the market, suppose that firm i is located at $l_i = (i - 1)/n$ (with $i = \{1, 2, \dots, n\}$).

The market is assumed to exhibit (positive) network effects. Customers benefit from the fact that other customers buy the same product/from the same firm. Denote by α the strength of the network effect.

As a result, a customer located at x , buying from firm i that has an expected market share (network size) of y_i (according to customers' expectations) and charges a price p_i , will derive the following utility:

$$u(x; p_i) = v + \alpha y_i - p_i - (x - l_i)^2, \tag{1}$$

where v denotes the basic utility from using the network product. We assume throughout the paper that v is sufficiently large, such that every customer buys from a firm (i.e., the market is covered).

3.2 | Three-to-two-firm merger

In this section, we first analyze the premerger situation with three firms before we turn to the merger case. Then, we compare both scenarios to evaluate the effects of the merger.

3.2.1 | Premerger equilibrium

Let \tilde{x}_i denote the location of the customer who is indifferent between buying from firm i and from firm $i + 1$ for $i \in \{1, \dots, n - 1\}$; \tilde{x}_n denotes the location of the marginal customer between firm n and firm 1. Then, the indifferent customer between i and $i + 1$ is derived from solving the following equation for \tilde{x}_i :

$$v + \alpha y_i - p_i - (\tilde{x}_i - l_i)^2 = v + \alpha y_{i+1} - p_{i+1} - (l_{i+1} - \tilde{x}_i)^2. \tag{2}$$

Solving the system of three indifferent customers leads to

$$\begin{aligned} \tilde{x}_1 &= \frac{1}{6} + \frac{3}{2}p_2 - \frac{3}{2}p_1 + \frac{3}{2}\alpha y_1 - \frac{3}{2}\alpha y_2, \\ \tilde{x}_2 &= \frac{1}{2} + \frac{3}{2}p_3 - \frac{3}{2}p_2 + \frac{3}{2}\alpha y_2 - \frac{3}{2}\alpha y_3, \\ \tilde{x}_3 &= \frac{5}{6} + \frac{3}{2}p_1 - \frac{3}{2}p_3 - \frac{3}{2}\alpha y_1 + \frac{3}{2}\alpha y_3. \end{aligned} \tag{3}$$

Because individual demands write as $D_1 = \tilde{x}_1 + (1 - \tilde{x}_3)$, $D_2 = \tilde{x}_2 - \tilde{x}_1$, $D_3 = \tilde{x}_3 - \tilde{x}_2$, respectively, imposing rational expectations; that is, $y_i = D_i$. Solving for D_i yields the individual demands as functions of the prices charged by the three firms:

$$\begin{aligned} D_1 &= \frac{1}{6-27\alpha}(2 - 9\alpha - 18p_1 + 9p_2 + 9p_3), \\ D_2 &= \frac{1}{6-27\alpha}(2 - 9\alpha + 9p_1 - 18p_2 + 9p_3), \\ D_3 &= \frac{1}{6-27\alpha}(2 - 9\alpha + 9p_1 + 9p_2 - 18p_3). \end{aligned} \tag{4}$$

The maximization of firm i 's profit $\pi_i = (p_i - c)D_i$ with respect to p_i yields the following symmetric equilibrium premerger outcomes (denoted by the asterisk):

$$\begin{aligned} p^* &= c + \frac{1}{9} - \frac{\alpha}{2}, \\ \tilde{x}_i^* &= l_i + \frac{1}{6}, \\ D^* &= \frac{1}{3}, \\ \pi^* &= \frac{1}{27} - \frac{\alpha}{6}. \end{aligned} \quad (5)$$

Note first that the network effect must be sufficiently low for all firms to be active before the merger; that is, $\alpha \leq 2/9$.¹⁷ Furthermore, a stronger positive network effect intensifies competition and, hence, lowers profits. The intuition is straightforward. As compared with the case without network effects, firms have more to gain when they cut their prices because a price drop increases the market share of the undercutting firm—which becomes even more attractive due to the increase in the number of customers buying from it.¹⁸

In the premerger equilibrium, the resulting customer and total welfare, net of the basic utility v , are

$$\begin{aligned} CS^* &= 6 \int_0^{\frac{1}{6}} \alpha D^* - p^* - x^2 dx = \frac{5\alpha}{6} - c - \frac{13}{108}, \\ W^* &= 3\pi^* + CS^* = \frac{\alpha}{3} - c - \frac{1}{108}. \end{aligned} \quad (6)$$

There is no impact of α on the size of demand served by any firm because the underlying symmetry leads to constant market shares for the three firms. This will change in the postmerger setting, because the merger will give rise to asymmetry between firms.

3.3 | Postmerger equilibrium

Consider now a bilateral exogenous merger between firms 1 and 2. Assume that the merger changes the ownership pattern; that is, the merger leads to joint pricing decisions by the two insiders, without modifying the location of the two outlets or the number of outlets open/active after the merger. Furthermore, customers buying from any of the merging firms benefit from the customer base attracted by *both* firms.^{19,20} Thus, insiders benefit to a different extent than the

¹⁷ This is a standard assumption in the literature on network effects. Alternatively, this restriction can be interpreted as the transport-cost parameter being sufficiently high.

¹⁸ The opposite holds when assuming a negative network effect that increases market power. In this case, customers will stick with a firm despite a price increase because customers want to avoid joining other customers.

¹⁹ This can be interpreted as full (and costless) compatibility between the insiders' products after the merger. A real-life example of immediate and full compatibility between parties that surfaced in the wake of a merger is Google's acquisition of Waze and the ensuing full interoperability of Google Maps and Waze.

²⁰ It is beyond the scope of our paper to examine the choice of compatibility or interoperability between the firms' networks. Katz and Shapiro (1985) established in the homogenous Cournot setting that customers always benefit from inter-

outsider from the positive consumption externality, which basically boils down to allowing for merger-related network synergies on the demand side.²¹ Finally, let the merging firms benefit from production cost savings. After the merger, the two insiders operate with a constant marginal production cost of $c - s$, where $s \in [0, c]$ denotes the amount of merger efficiency gains.

The indifferent customer located at \tilde{x}_2 between the outsider firm 3 and the insider firm 2 is defined by

$$\begin{aligned}
 v + \alpha(y_1 + y_2) - p_m - \left(\tilde{x}_2 - \frac{1}{3}\right)^2 &= v + \alpha y_3 - p_o - \left(\frac{2}{3} - \tilde{x}_2\right)^2 \\
 \Leftrightarrow \tilde{x}_2 &= \frac{3}{2}p_o - \frac{3}{2}p_m + \frac{3}{2}\alpha(y_1 + y_2) - \frac{3}{2}\alpha y_3 + \frac{1}{2},
 \end{aligned}
 \tag{7}$$

where p_m and p_o are the prices charged by the insiders and the outsider, respectively.

Symmetry between the insiders implies that the marginal customer is located halfway between them. With postmerger demand functions being $D_o = 2(2/3 - \tilde{x}_2) = (1 - 9\alpha - 9p_o + 9p_m)(3(1 - 6\alpha))$ and $D_m = (1 - D_o) = (2 - 9\alpha - 9p_m + 9p_o)(3(1 - 6\alpha))$, and given the profit functions of the merged entity, $\pi_m = (p_m - c + s)D_m$, and of the outsider, $\pi_o = (p_o - c)D_o$, we can now simultaneously solve the system of first-order conditions, still assuming rational expectations for the customers. This yields the following equilibrium results:

$$\begin{aligned}
 p_m^* &= c + \frac{5}{27} - \frac{2s}{3} - \alpha, \\
 p_o^* &= c + \frac{4}{27} - \frac{s}{3} - \alpha, \\
 \tilde{x}_m^* &= \frac{9s + 2 - 9\alpha}{18(1 - 6\alpha)}, \\
 D_m^* &= \frac{27\alpha - 4 + 9s}{9(1 - 6\alpha)}, \\
 D_o^* &= \frac{4 - 27\alpha - 9s}{9(1 - 6\alpha)}, \\
 \pi_m^* &= \frac{(5 - 27\alpha + 9s)^2}{243(1 - 6\alpha)}, \\
 \pi_o^* &= \frac{(27\alpha - 4 + 9s)^2}{243(1 - 6\alpha)}.
 \end{aligned}
 \tag{8}$$

connection and that firms do not interconnect enough from the social welfare point of view. By contrast, Spulber (2008a, 2008b) argued instead that with Bertrand competition and differentiated services, customers might not always benefit from interconnection, and, as a result, firms might interconnect too much.

²¹ For instance, in the Sprint/T-Mobile merger, T-Mobile President G. Michael Sievert argued that out of “the \$43.6 billion in cost savings, \$25.7 billion will come from eliminating the duplication of T-Mobile’s and Sprint’s existing networks” (see “Description of Transaction, Public Interest Statement, and Related Demonstration,” Appendix C, Declaration of G. Michael Sievert—Written Testimony of Scott Wallsten, PhD, President and Senior Fellow, Technology Policy Institute, An Economic Analysis of the T-Mobile-Sprint Merger Before the Subcommittee on Antitrust, Commercial, and Administrative Law Committee on the Judiciary United States House of Representatives, March 12, 2019).

Note that the condition ensuring that both firms that remain in the market are active²² is different from the one prevailing in the premerger situation, due to the presence of cost savings. This condition still requires that the network effect cannot be too strong: $\alpha \leq (4/9 - s)/3 \equiv \bar{\alpha}(s)$, where $\bar{\alpha}$ is such that $p_o - c = 0$. Here the threshold depends on the amount of cost savings. For instance, $\bar{\alpha} = 0$ for $s = 4/9$. Equivalently, there is an upper bound on the amount of cost savings s achievable through merger, $s \leq \bar{s} \equiv (4 - 27\alpha)/9$, which ensures that the outsider can still make a positive margin.

At the postmerger equilibrium, the resulting customer and total welfare, net of the basic utility v , amount to

$$\begin{aligned} CS_M^* &= 2 \int_{\frac{1}{6}}^{\frac{1}{6} + \frac{D_m^*}{2}} \alpha D_m^* - p_m^* - \left(x - \frac{1}{3}\right)^2 dx + 2 \int_{\frac{1}{6} + \frac{D_m^*}{2}}^{\frac{2}{3}} \alpha D_o^* - p_o^* - \left(\frac{2}{3} - x\right)^2 dx \\ &= \frac{504s + 3564\alpha - 5832s\alpha + 162s^2 - 23814\alpha^2 + 52488\alpha^3 + 17496s\alpha^2 - 175}{972(1 - 6\alpha)^2} - c \quad (9) \end{aligned}$$

and

$$\begin{aligned} W_M^* &= CS_M^* + \pi_m^* + \pi_o^* \\ &= -\frac{6264s\alpha - 636\alpha - 576s - 810s^2 + 6318\alpha^2 - 17496\alpha^3 - 17496s\alpha^2 + 3888s^2\alpha + 11}{972(1 - 6\alpha)^2} \quad (10) \end{aligned}$$

3.4 | Comparisons

Given the results from the previous section, we can now compare prices, profitability, and surpluses.

3.4.1 | Prices

Comparing the postmerger prices of the insiders (p_m^*) and the outsider (p_o^*) with the premerger price (p^*) is quite straightforward. We find that in the limit case in which the merger does not yield any synergies, the insiders' price would increase for any level of the network effect within the relevant range, but the outsider's price would decrease for a sufficiently high network effect. We thus find that without merger cost savings, the network effect enhances the market power effect of the merger and the ensuing insiders' incentive to raise their price. In contrast, the outsider only raises its price for a low network effect. However, when the network effect is strong, customers of merged firms benefit more from the larger network, so the outsider can then only lower its price to cope with the likely decrease in market share.

Recall also that merger cost savings typically provide incentives to lower the price because then insiders can serve a larger demand without sacrificing their unit margin. But it takes high enough cost savings to compensate for the market power effect of the merger and lead the insiders to lower their price. For such strong merger synergies, we find that the network effect no longer plays a role,

²² We do not address here the possibility for the merger to trigger the outsider's exit and to thus generate a monopoly.

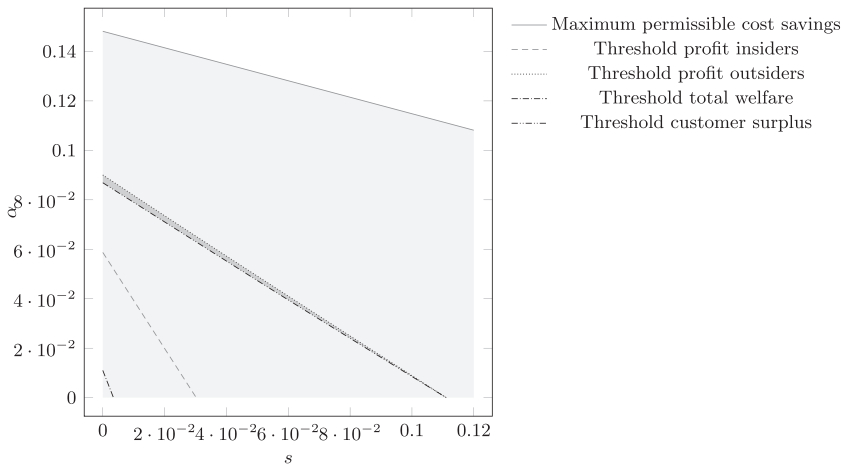


FIGURE 1 Merger-induced effects on profits, customers, and welfare

Notes: The light-shaded area represents those combinations of parameter values for α and s , which are considered in the text, and which imply a covered market. The dark-shaded area represents those combinations of parameter values for α and s , which imply a Pareto improvement resulting from the merger.

either for the insiders or for the outsider. (The outsider also decreases its price through strategic complementarity.)

We can summarize the findings as follows:

Result 1. *The price comparison reveals that*

1. *For high enough cost savings, all prices fall throughout the market, whatever the level of the network effect.*
2. *For lower cost savings, the network effect affects the price differentials as follows:*
 - *All prices increase for sufficiently low network effects.*
 - *The prices of the insiders increase, whereas the price of the outsider decreases for an intermediate range of the size of the network effect.*
 - *All prices decrease for a large enough network effect.*

3.4.2 | Profitability

Despite the potentially lower price, the merger is always internally profitable as in the limit case without cost savings or network effects (Levy & Reitzes, 1992), and it continues to be profitable for all combinations of cost savings and network effects. This is due to the lower marginal cost and a larger demand served.

The impact of the network effect is different for the outsider. For low cost savings, the outsider benefits from the merger only if the network effect is low enough. In contrast, for higher cost savings, the merger always leads to a lower profit for the outsider (see Figure 1).²³ The explanation is that the outsider only benefits from the merger if prices increase, given that the network effect

²³ This extends previous results from the literature without network effects—such as the work by Brito (2003).

clearly favors the insiders with a larger demand. But prices only rise for low enough network effects *and* cost savings.

Finally, the relative profit gain from participating (versus not participating) in the merger is positive whenever the network effect is larger than some threshold that is decreasing in cost savings (see Figure 1). In other words, part of the merger profitability paradox²⁴ still holds for small network effects and efficiency gains. Intuitively, this requires that the outsider benefits from the merger, as explained above, and also that the insiders' profit differential, albeit positive, be very small, which occurs when *both* reasons improving merger profitability are sufficiently weak.

We can summarize the findings as follows:

Result 2. *A profit comparison reveals that*

1. *The merger is always internally profitable.*
2. *The outsider only benefits from the merger if the network externality and the cost savings are low enough.*
3. *Becoming an insider is more profitable than being an outsider unless the cost savings and the network effect are both too low.*

Figure 1 illustrates our findings. We stress that it is not immediate that both network effects and cost savings impact profits in a similar way due to the different effects that these two aspects have for customers. Whereas network effects always have a positive effect for customers (possibly even if prices increase), customers only benefit from cost savings when postmerger prices fall. This, however, turns out not to make any difference for the profit comparisons. This has to do with the outside firm. In both cases, the outsider has a disadvantage vis à vis the insiders.

3.4.3 | Welfare levels

First note that because $D_m^* - 2D^* = 2(9\alpha + 9s - 1)/18(1 - 6\alpha)$, the insiders' postmerger market share increases unless the network effect and the cost savings are very low. As a result, the combination of network effects and efficiency gains results in more captive customers for the merged firms than would be the case if only either the cost savings or the network effects were present. At the same time, the average network size increases and products are supplied more efficiently (on average). Moreover, customers also benefit from lower prices after the merger if the network effects or the cost savings are high enough (see above).

Straightforward comparisons reveal that $CS_M^* > CS^*$ when the network effect is higher than some threshold, and similarly, $W_M^* > W^*$ when the network effect is higher than some threshold. Both thresholds decrease in the efficiency parameter (see Figure 1). We can summarize:

Result 3. *Surpluses are affected by the merger as follows:*

1. *Customer surplus rises as long as both cost savings and network effects are not too weak.*
2. *The merger is socially beneficial unless both cost savings and network effects are too weak.*

With high enough cost savings and network effects, all prices decline, and this price drop more than compensates for the overall increase in transport costs for customers. By contrast, only profits

²⁴ More precisely, not engaging in the merger can actually be (even) more profitable.

increase for (very) low values of cost savings and network effects. Because this case involves very few network benefits and efficiency gains, total welfare is also lower after the merger in this range.

Comparing the effects on total welfare and customer surplus gives the following result:

Result 4. *Higher cost savings or stronger network effects are necessary for customers to benefit from a merger, rather than just for the benefits to accrue to society as a whole.*

It has already been established that the efficiency level that guarantees a positive change in aggregate welfare is lower than the one that ensures a similar change for customers (see, e.g., Neven & Röller, 2005). We find that the same holds for the case with network effects.²⁵

Hence, despite the ex ante different effects for customers, the qualitative impact of cost savings and network effects is the same. However, a subtle difference remains:

Result 5. *With positive network effects but low enough cost savings, the merger can result in a Pareto improvement (on a group basis).*

Figure 1 shows that whenever the strength of the network effect is such that we are in the dark shaded area, firm profits, total welfare, and customer surplus increase.²⁶ Such a Pareto improvement is possible here because customers as a group can benefit from an increased network size despite higher prices charged by the merger participants.²⁷ Note further that for this outcome to materialize, the level of merger cost savings must be low enough for the outsider firm to benefit from the merger. This further highlights the interaction between efficiency gains and the type of network effect that we consider. For very high cost savings, the effect that leads to very intense competition for the outsider dominates, and the outsider loses out.

3.5 | Four-to-three-firm merger

In what follows, we report the results from a robustness check of our results.²⁸ To this end, we consider a change in the number of firms in the market. We examine the outcome of a bilateral merger between adjacent and distant insiders in a market that initially had four symmetric firms.²⁹

²⁵ Recall that after the merger, the network effect tends to relax competition in the absence of synergies; this is because the insiders would increase their price independent of the level of the network effect, whereas the outsider would decrease its price only for a high enough network effect. Moreover, a merger also increases the benefits of the network for the customers buying from the merger participants. Thus, a relatively low level of externality is sufficient to guarantee an increase in industry profits as well as higher welfare for the insiders' customers; that is, the merger leads to higher welfare than was the case before it occurred. But for all customers to benefit, the network effect must be high enough to induce the outsider firm to drop its price.

²⁶ More precisely, the dark-shaded area represents the range of the network effect, such that the customer surplus increases after the merger, and the outsiders' profit does, too. Recall also that the merger is always profit increasing for the insiders, and the dark-shaded area also corresponds to a range of the network effect for which total welfare increases.

²⁷ This result is different from the conclusion of Toshimitsu (2019), in which compatibility in the *whole* industry (among all firms) must increase after the merger in order to achieve a Pareto improvement.

²⁸ We present here the outline of the calculations. A detailed derivation of results can be provided upon request.

²⁹ Note that negative network effects do not qualitatively change the results for adjacent mergers. For distant mergers, a negative network effect leads to the same results as for adjacent mergers. In what follows, we discuss the results for positive network effects.

As in the case of a three-to-two merger, firms take their expectations of future demand served as a given when deciding on the level of prices they charge buyers.³⁰ Accordingly, equilibrium demands in our setting depend on all market prices, and, as a result, the demand of any firm will be affected by both adjacent and nonadjacent firms' price changes. In short, our four-to-three merger analysis reveals that network effects combined with rational expectations makes spatial competition become nonlocalized, which has not been highlighted before in the literature.³¹

3.5.1 | Prices

Comparing the pre- and postmerger prices reveals that insiders' and outsiders' prices decrease for sufficiently high cost savings under adjacent mergers. For a nonadjacent merger, postmerger prices always decrease for both insiders and outsiders. In this case, it is more difficult for insiders to coordinate their price setting and outsiders face more efficient (i.e., more competitive) rival firms on both sides.

Hence, our results indicate that mergers in highly concentrated markets with (positive) network effects can lead to higher prices for customers—particularly when the merging partners are close competitors, and the cost savings are weak. This is consistent with the conclusions of several empirical studies of four-to-three mergers on European telecom markets.³²

3.5.2 | Profitability

With regard to profits, the four-to-three merger between neighboring firms is always internally profitable. The insiders benefit from the combination of market power, cost savings, and a larger network. Under a distant merger, some small cost savings are nonetheless necessary for the insiders' profits to increase. The outsiders make a higher profit after the adjacent merger whenever cost- and demand-side merger synergies are low enough. Due to the negative effect on prices, outsiders always make lower profits in the nonneighboring merger case. As a consequence, becoming an insider is always more profitable than being an outsider under a nonadjacent merger, but becoming an insider requires sufficiently high cost savings and network effects under adjacent mergers.

³⁰ This is the “fulfilled expectation” concept of Katz and Shapiro (1985) and Hoernig (2012).

³¹ We thank an anonymous associate editor and an anonymous referee for bringing this aspect to our attention. Jonard and Schenk (2004) derive equilibrium demands in the same way without, however, mentioning the formation of expectations in their three-firm model. By contrast, Lundberg (2015) explicitly makes the assumption of fulfilled expectations to derive the symmetric n -firm price equilibrium, but fixes all other prices when determining the individual best-reply function. All other papers allow for direct network effects on the circular market, starting with Navon et al. (1995) up to Heikkinen (2014), do not mention the formation of expectation for the demands served by firms in equilibrium.

³² Grajek et al. (2019) provide an ex post evaluation of domestic horizontal mergers in the European wireless sector; they find that four-to-three mergers in the Netherlands and Denmark did lead to price increases. Genakos et al. (2018) consider hypothetical four-to-three symmetric mergers between telecom operators by using a sample of 33 countries that are part of the Organisation for Economic Co-operation and Development; examining the period from 2002 and 2014, they find that the average such merger would have increased prices for users by 16.3%. Aimene et al. (2019) document empirically an increase in voice unitary price following four-to-three mergers between mobile operators; their work is based on a quarterly panel of country-level unitary prices across 22 countries over 7 years. (The countries that experienced such mergers were Austria, Germany, Ireland, and Norway.)

3.5.3 | Welfare

Finally, the four-to-three merger between neighboring firms increases both customer and total welfare as long as cost savings and network effects are not too weak. By contrast, the merger between distant firms always results in higher customer and total welfare (as long as the network effect is positive).

However, there is an important difference between the three-to-two merger and both types of four-to-three mergers. Four-to-three mergers are never Pareto improving. With three outlets in the market, the bilateral merger can lead to a higher profit for the outsider and a higher customer welfare because enough customers (those buying from the insiders) benefit from a larger network despite paying a higher price. With four outlets in the market, the bilateral merger between two neighboring firms allows this for relatively fewer customers, since now the two remaining outsiders enjoy captive customers located between them.³³ With nonadjacent merging firms, the outsiders face intense competition from both neighbors. Hence, we arrive at the seemingly counterintuitive result that a four-to-three merger cannot be Pareto improving, whereas this can be true for a three-to-two merger.

4 | DISCUSSION AND FINAL REMARKS

The main contribution of this paper is to add to the literature on horizontal mergers among horizontally differentiated firms by studying the interaction between network effects and merger cost savings. We use a simple model to study the outcome of bilateral mergers in highly concentrated network industries (a three-firm and a four-firm market) and show that both cost savings and demand externalities impact the merger's profitability, as well as its price and welfare outcomes.

Given the substantial merger activity in telecom mobile markets and the subsequent debate around the impact of this market consolidation,³⁴ it is certainly useful to have a better understanding of the interaction between network effects and merger cost savings from a competition policy point of view. Our paper discusses to what extent accounting for both cost savings and network externalities might modify the competitive assessment of mergers in highly concentrated industries with (positive) network effects, such as the telecom markets.³⁵

Several conclusions derived from our results have a bearing on such assessments. First, the levels of cost savings necessary to ensure lower prices or higher welfare in the wake of the merger are shown to be generally decreasing with the level of the network effect. This suggests that competition agencies should assess the intensity of network effects when determining the amount of cost savings necessary to prevent the merger-related adverse competitive effects; this is important because the level of cost efficiencies required is not the same when the market does not exhibit network effects. In other words, the accuracy of merger control decision-making would increase if

³³ This was not the case with the three-to-two merger in which the outsider faces competition from the insiders on both sides.

³⁴ See, for instance, Manigrassi et al. (2016) and, especially, Allen et al. (2017).

³⁵ Using a consumer survey for the Korean mobile telephone market, the analysis by Kim and Kwon (2003) concludes that customers prefer operators with larger consumer bases. Doganoglu and Grzybowski (2007) analyzed demand for mobile telecommunication services in Germany from January 1998 to June 2003 to show that network effects played a significant role in the diffusion of mobile services. Grajek (2010) estimated a structural demand model for the Polish mobile telephone market over the 1996–2001 period to show strong network effects.

such effects were taken into account.³⁶ Second, our analysis also shows that the amount of merger cost savings remains crucial for the price and welfare analysis of horizontal mergers, despite the presence of network effects. This indicates that a defense of the submitted mergers is putting stronger emphasis on the presence of demand externalities rather than on the existence of substantial cost savings is unlikely to replace the often invoked cost-based “efficiency defense.” Third, we identify a non-monotonic impact of the network externality that can lead to a Pareto-improving outcome for a three-to-two merger, but not for a four-to-three merger. This highlights the crucial role played by the number of firms (degree of market concentration). Finally, our results show that network effects combined with fulfilled expectations on behalf of customers result in nonlocalized competition. These findings suggest that the closeness of competition between merging partners should not be given excessive weight in establishing whether the merger will have an adverse competitive effect.

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³⁶ Incidentally, note that the empirical analysis in Grajek (2010) concludes that ignoring network effects leads to overestimation of demand elasticity.

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