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Entry Deterrence, Concentration, and Merger Policy

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Abstract

In merger enforcement, entry is considered to be a factor that potentially can mitigate otherwise anti-competitive effects of a merger. The current framework for entry analysis evaluates whether potential entrants are likely to have the incentives and ability to enter the industry under the conditions of elevated profitability that are created by an anti-competitive merger. Missing from entry analysis is the notion that incumbent firms may proactively deter entry and how such incumbent incentives may change as a result of a merger. By modeling entry as the outcome of a game between incumbents and potential entrants, we show that a merger can reduce the likelihood of entry even at elevated profit levels by increasing incumbent incentives to invest in entry deterrence. The paper has two policy implications for merger enforcement: First, a merger that is benign by traditional measures may nonetheless have the effect of reducing future entry—entry that would have made the market more competitive relative to status quo. Second, evidence of recent historical entry—which is an important criterion that is used to assess the likelihood of post-merger entry—may be of less evidentiary value than is considered under the current merger enforcement policy.

Keywords Entry deterrence · Mergers

1 Introduction

Entry plays an exculpatory role in horizontal merger investigations. It is considered to be a factor that potentially can discipline otherwise anti-competitive incentives that are created by a merger. Accordingly, in mergers that are considered to pose competitive concerns, the U.S. antitrust agencies evaluate whether entry will be

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likely, timely, and of sufficient magnitude as to discipline post-merger exercise of market power.[1] Several factors are analyzed to determine the incentives and ability of potential entrants to enter the market, including—importantly—whether there historically has been entry at times of elevated industry profits.[2,3,4]

Missing from merger reviews is the notion that the likelihood of entry depends not only on whether a market is profitable enough to attract entry but also on the extent to which incumbent firms can proactively create entry barriers. In this article, we explore the effect of mergers on incumbent incentives to create entry barriers. Our main result is that a merger can increase the strategic investments that are made by incumbents towards entry deterrence and thus potentially reduce the likelihood of entry relative to pre-merger.

The intuition for the result is straightforward: Except for the case in which the incumbent is a monopolist, entry deterrence is a public good amongst incumbents. (See the discussion of the literature with regard to non-cooperative entry deterrence in the following sub-section). As a result, incumbents have the incentive to free-ride on each other's efforts to deter entry. A merger between two incumbents increases the merged entity's contribution to the public good of entry deterrence in two ways: First, it eliminates free-riding between the merging firms. Second, a profitable merger—one in which the merged entity's profit exceeds the combined pre-merger profits of the merging firms—further increases the merged entity's private benefit from deterring entry. Both effects lead to an increase in post-merger investment in entry deterrence. The increased profitability of non-merging firms following a merger also serves to increase their private benefit from entry deterrence, which leads them to increase their entry deterrence investments as well.

Our results have at least two important implications: First, a merger can reduce the likelihood of future entry even if it is not assessed to create traditional competitive concerns such as a price increase or quality reduction. As such, the likelihood of entry should not just be a mitigating factor for mergers that pose competitive risks. The effect of a merger to reduce the likelihood of future entry—entry that would

[1] 2010 U.S Horizontal Merger Guidelines issued by the Department of Justice and the Federal Trade Commission ("Guidelines"), §9 (https://www.justice.gov/sites/default/files/atr/legacy/2010/08/19/hmg-2010.pdf).

[2] These include whether there has been successful prior entry into the relevant market, whether the necessary investments in production assets are not prohibitive, whether technology is freely available to potential entrants, whether a sufficient share of customers can freely choose to buy from a new entrant, etc.

[3] In recent years, the U.S. antitrust agencies have approved a number of mergers—especially in the technology sector—based on evidence of historical entry. See, e.g., the FTC's closing statements for Google's acquisition of AdMob (https://www.ftc.gov/sites/default/files/documents/closing_letters/google-inc./admob-inc/100521google-admobstmt.pdf) or the DOJ's closing statement for Expedia's acquisition of Orbitz (https://www.justice.gov/opa/pr/justice-department-will-not-challenge-expedias-acquisition-orbitz).

[4] The other factor that is considered to mitigate potentially anti-competitive incentives that are due to a merger is efficiencies. Efficiencies are credited when they are of the form that are likely to be passed through to consumers in the form of lower prices. To be credited, efficiencies must also be merger-specific: not achievable through means that are less anti-competitive relative to a merger. See §10 in Guidelines.

have made the market more competitive relative to status quo—may be considered as a theory of harm in its own right. Second, a merger can, by itself, heighten entry barriers, which makes historical evidence of entry to be a questionable predictor of the likelihood of post-merger entry.

1.1 Related Literature

There is a well-developed literature in economics—both theoretical and empirical—that examines non-cooperative incentives of incumbent firms to deter entry proactively.[5] Although individual firms can choose how much to invest in entry deterrence, the benefit from successful entry deterrence is enjoyed by all incumbents regardless of the level of their individual investments. Non-cooperative entry deterrence is thus a public good that can lead to under-investment relative to the industry profit-maximizing level ("optimal level"). The level of investment in entry deterrence is optimal (from the point of view of the incumbents) if the market is a monopoly in which case successful entry deterrence is not a public good but a private benefit to the monopolist.

For purposes of this paper, an important distinction in the theoretical literature is related to whether the total investment that is required to deter entry is deterministic or uncertain. Bernheim (1984) and Gilbert and Vives (1986) consider environments with complete information and show that the free-rider problem does not cause incumbents to underinvest in entry deterrence. In contrast, Waldman (1987) shows that if the result of entry deterrence is uncertain, then, for certain investment technologies, incumbents may underinvest.

There are a variety of strategies that incumbent firms can use to discourage entry. Such strategies can include: lobbying the industry regulator or legislators to enact rules that hinder entry (Stigler, 1971); limit pricing to signal lack of profitability to potential entrants (Sweeting et al., 2020); introducing additional varieties of product with the goal of crowding up the product space and denying entrants a foothold in the market (Berry & Waldfogel, 2001; Scherer, 1979; and Schmalensee, 1978);

[5] A non-exhaustive list of theoretical treatment of entry deterrence includes Gilbert and Newberry (1982), Gilbert and Vives (1986), Bernheim (1984), and Waldman (1987). In empirical work, among others, Berry and Waldfogel (2001), Ellison and Ellison (2011), Ciliberto and Zhang (2016), and Sweeting et al. (2019) find evidence of entry deterrence efforts by incumbent firms that use a variety of deterrence mechanisms in a variety of industries.

and spurious innovations to leave potential entrants seemingly behind in the race to develop newer technologies (Gilbert & Newberry, 1982).[6,7]

Each of these deterrence strategies involves costly (sunk) investments by incumbents. For example, lobbying an industry regulator entails lobbying expenditures; limit pricing involves setting a price that is below the profit-maximizing price level without the prospect of entry; cluttering the product space requires investments to introduce additional varieties that a profit maximizing incumbent may not have incurred except to deter entry; etc.[8]

Since writing the first version of our paper, we have become aware of a working paper by Cowgill et al., titled "Political Power and Market Power" (2021), which explores the relationship between industry concentration and political lobbying. There are similarities and differences between our paper and Cowgill et al.: An important contribution of the latter is that it establishes empirically that an increase in industry concentration leads to greater political lobbying effort by incumbents, by employing mergers as shocks to industry concentration. Their paper further shows that this is consistent with a theoretical model in which the public good nature of political lobbying causes mergers to reduce the extent of free-riding between incumbents.

Our paper focuses more closely on the entry deterrence effect of mergers with regards to its policy implications for merger enforcement. Among other things, we show that mergers which are not anti-competitive by traditional measures may, under certain circumstances, reduce the likelihood of future entry. We also derive sufficient conditions under which a merger between two competing firms increases total investment towards entry deterrence and demonstrate that the conditions are satisfied by commonly used oligopoly models such as Cournot and Bertrand. Further, we show that the increased deterrence effort after a merger can actually make the post-merger likelihood of entry lower than that pre-merger. Our paper indicates that merger investigations should incorporate the effect of mergers on the incentives of incumbents to proactively deter entry. We view Cowgill et al. and our inquiries to be complementary in their approach and focus.

[6] Specifically with regards to regulatory lobbying, Stigler (1971) argued that industry incumbents influence the political process and are able to acquire regulations that reduce entry and increase their profits: "regulation is acquired by the industry and is designed and operated primarily for its benefit … Every industry or occupation that has enough political power to utilize the state will seek to control entry." Djankov et al. (2002) present data on the regulation of entry in 85 countries and find that "legal entry is extremely cumbersome, time-consuming, and expensive in most countries in the world." Djankov et al. argue that the evidence supports the public choice theory over alternative theories of regulation. See also Gutiérrez and Philippon (2018; 2019).

[7] In so far as entry deterrence by incumbents is sought to be achieved by "lobbying" an industry regulator or the legislature, such lobbying may be protected by the Noerr-Pennington doctrine. In two landmark cases in 1961 and 1965, the U.S. Supreme Court decided that under the First Amendment, businesses who petitioned the government for anticompetitive actions are immune from liability under the antitrust statutes. See, e.g., Paul Gowder (2009). This may potentially limit the ability of a U.S. antitrust agency to oppose a merger purely because it might increase the incentives of the industry incumbents to impede entry by lobbying for the creation of rules or laws that increase entry barriers. At the same time, lobbying is just one of many ways to create entry barriers.

[8] Since the realization of entry is a binary event, and the amount of investment that is needed to prevent entry in our model is uncertain, this article is also related to the provision of discrete public goods with uncertain cost. See, e.g., Nitzan and Romano (1990).

1.2 A Roadmap for the Remainder of the Paper

The remainder of the paper is organized as follows. Section 2 presents a simple model of a merger between two firms that do not compete with each other but that face a common entrant into their markets. (The simple model is motivated by a recent merger that was investigated by the Antitrust Division of the U.S. Department of Justice.) Analysis of the simple model helps to illustrate the basic idea of the alleviation of free-riding incentives between the merging firms. It also helps to establish the first of the policy implications: that a merger may not pose a direct risk of anti-competitive price increase or quality reduction but may still serve to reduce the likelihood of future competition-enhancing entry and thereby warrants attention.

Section 3 introduces a model in which the merging incumbents compete with one another prior to the merger. In addition to eliminating free-riding between the merging firms, the merger engenders two additional effects: First, the elimination of competition between the merging firms increases the amount of profits that the merged firm stands to lose from entry. This further increases its optimal investment towards entry deterrence. Second, the elimination of competition between the merging firms also increases the profitability of entry relative to pre-merger. The net effect of the three forces determines the likelihood of entry. The "elimination of free-riding between the merging firms" effect and the "increase in profit at stake" effect tend to reduce the likelihood of entry by raising incumbent incentives to deter entry. The third effect—"increased profitability of entry"—tends to increase the likelihood of entry.

The current framework for entry analysis in merger investigations—which does not analyze strategic entry deterrence by incumbents—captures only this third effect. Thus, merger analysis tends to over-estimate the likelihood of entry as a mitigating factor and places undue weight on the incidence of historical entry as evidence of ease of post-merger entry.

Section 4 re-iterates policy implications and offers practical guidance to enforcers.

2 A Simple Illustration of the Effect of a Merger on Free Riding Incentives

2.1 A Motivating Example

In 2014, Comcast Corporation proposed to acquire Time Warner Cable (TWC). Broadly speaking, Comcast and TWC's geographic footprints did not overlap and, thus, they did not compete against each other for subscribers. Instead, Comcast and TWC faced common rivals in the video space from a number of fast-growing streaming video suppliers such as Netflix and Hulu. Streaming video signals have to travel over broadband internet connections in order to reach consumers. Being providers of both cable video and broadband internet to consumers, Comcast and TWC both had the incentive to slow the expansion of streaming video by slowing

the speed of signals from third party video suppliers in order to make the consumer experience of streaming video less satisfying.[9]

Crucial to the ability of Comcast and TWC to slow streaming video signals was the legality of doing so. While the merger was being investigated, the Federal Communications Commission ("FCC") was deliberating on the merits of a proposal popularly known as net neutrality: "Net neutrality is the principle that individuals should be free to access all content and applications equally, regardless of the source, without Internet Service Providers discriminating against specific online services or websites."[10]

The potential passage of net neutrality would have denied broadband providers like Comcast and TWC the legal ability to de-prioritize signals from third-party streaming video providers. Conversely, if the FCC were to not enact net neutrality, broadband providers like Comcast and TWC would have been free to de-prioritize streaming video signals in an effort to keep their cable video subscribers from switching to streaming video. Thus, the denial of net neutrality provisions by the FCC was a public good for Comcast, TWC, and other cable TV operators. The proposed merger would have eliminated any free-riding between Comcast and TWC and would have likely led to greater lobbying effort and/or more intense judicial challenges on the part of the merged entity to oppose net neutrality.[11,12,13]

[9] For an overview of issues raised by the merger, see Rogerson (2019).

[10] See Net Neutrality, Public Knowledge, available at https://www.publicknowledge.org/issues/net-neutrality.

[11] Comcast and Time Warner ultimately abandoned the proposed merger in the face of serious concerns expressed by the DOJ and the FCC. The DOJ's Press Release stated that collectively, the two firms would have controlled broadband internet access of more than 30 million subscribers—something that would have made the merged entity "an unavoidable gatekeeper for Internet-based services that rely on a broadband connection to reach consumers". (See https://www.justice.gov/opa/pr/comcast-corporation-abandons-proposed-acquisition-time-warner-cable-after-justice-department).

[12] In February 2015, the FCC voted to approve the Open Internet Order, which enacted the strongest net neutrality rules in history. The decision faced multiple legal challenges from the wireless and cable industries. Subsequently in December 2017, after the change in administration, the Republican majority of the FCC voted to repeal the Open Internet Order. The repeal in turn faced legal challenges from several states in the U.S. Court of Appeals. The Court of Appeals allowed the repeal to stand but barred the FCC from prohibiting states or local authorities from enforcing net neutrality. See https://en.wikipedia.org/wiki/Net_neutrality_in_the_United_States.

[13] One way in which incumbents can overcome the free-riding problem is by having industry associations coordinate their entry deterrence efforts. For example, the industry association can apportion the optimal entry deterrence investment across incumbent firms, say, in proportion to their private benefits from denying entry. The anti-competitive goal of such coordination is likely to invite prosecution by the antitrust authorities. Moreover, in certain situations, coordination by industry associations may not fully overcome the free-riding problem. As the Comcast-Time Warner example illustrates, preventing net neutrality rules from coming into effect would have benefitted both fixed broadband providers (such as Comcast, Time Warner, Charter, etc.) as well as mobile network service providers such as Verizon, AT&T, and T-Mobile. The two industries have separate trade associations. While the association of, say, fixed broadband providers can help to overcome free-riding among its members, it likely has little ability to dictate the amount of deterrence investments that are made by mobile network service providers.

2.2 A Model of a Profit-Neutral Merger with a Common Entrant

There are two incumbent firms; each operates in a separate market: The incumbents do not compete with each other but face a common potential entrant that decides whether to enter both markets simultaneously.[14] We will denote the two markets as market 1 and market 2. We study the change in entry deterrence investments of the firms that is due to a merger between them. We denote the profit of the firm in market i by π_i if there is no entry, and $\pi_i - \Delta_i$, if there is entry ($i = \{1,2\}$).

Each incumbent firm can invest to reduce the likelihood of entry (deterrence investment). Let x_i denote firm i's investment in entry deterrence. As an example, the entry deterrence investment can be thought of as socially wasteful lobbying expenditure to convince the industry regulator to increase requirements for the potential entrant to acquire production permits. We assume that the cost of investing x_i is $\alpha \times x_i$ where $\alpha > 0$.

Entry deterrence can take many forms; some do not entail incurring additively separable investments (x_i). Similarly, for some entry deterrence strategies, the loss of incumbent profit due to entry may not be exogenous (Δ_i). (The loss of incumbent profit from entry is modeled as endogenous in Sect. 3 when we analyze a merger between two competing firms.) An example is limit pricing in which the entry deterring investment takes the form of a less-than-profit-maximizing price rather than an additively separable investment; and the loss of profit that is due to entry is a function of prices in the games with, and without entry, and is thus endogenous.

Each form of entry deterrence potentially leads to a different game (which are worthy of being studied in their own right). For example, entry deterrence through, say, product proliferation leads to a game that is different from the game that is associated with entry deterrence through limit pricing or entry deterrence through regulatory lobbying. Insights about merger effects can then be derived only by studying a collection of different games that may result from each form of entry deterrence that the incumbents can possibly choose.

To obtain some simple insights about how a merger can fundamentally change entry deterrence incentives, we have chosen a unified framework that embodies two characteristics that are essential no matter what form entry deterrence takes: First, any form of entry deterrence requires costly investment by incumbents (x_i). Second, entry reduces incumbent profits relative to when there is no entry (Δ_i). These concentrate the study of merger effects with regard to entry deterrence into a single parsimonious framework.

In addition to Waldman (1987), a similar unified approach is taken in empirical work by Ellison and Ellison (2011) to study several different forms that entry deterrence can take in the pharmaceutical industry, without separately estimating models

[14] The analysis can be easily extended to a situation with more than two incumbents, where each operates as a monopolist in a distinct market. Similarly, as a general matter, the analysis can also be extended to a setting in which the merging firms are not monopolists in their respective markets but face within-market competition from other firms. (Within-market competition is fully discussed in the more general model introduced in Section 3).

that correspond to each individual form of entry deterrence. In our description, we use the act of socially wasteful regulatory lobbying as a convenient interpretation of the strategic variable x_i.

We follow Waldman (1987) in assuming that incumbents face uncertainty with regard to the total amount of investment that is needed to deter entry, and that the higher is the deterrence investment (across all incumbent firms) the lower is the probability of entry.[15] Realistically, the total investment that is needed for successful entry deterrence—especially when the strategy involves regulatory lobbying or delay tactics by filing lawsuits—is likely to be uncertain at the outset. Such uncertainty can be due to: the extent of a priori opposition to the desired regulatory policy among current regulators; potential change in administration during the pendency of the desired regulatory proposal, which would require the lobbying effort to have to be re-directed toward newly appointed regulators; uncertainties that are associated with legal costs and outcomes; etc.

As in Waldman (1987), we adopt a stochastic approach where the potential entrant's profit depends on the amount of deterrence investment and a random shock. Accordingly, we assume that the entrant's profits are given by $\pi^E - D\left(\sum_k x_k\right) \times u$, where: (i) π^E is the entrant's profit upon entry; (ii) $D\left(\sum_k x_k\right)$ is an upfront cost of entry that is an increasing and concave function of the total deterrence investments that are made by incumbents ($D' > 0$ and $D'' \leq 0$); and (iii) u is a random variable that is assumed to be uniformly distributed on the interval [0, 1] that reflects uncertainty about the effectiveness of the deterrence investment.[16,17]

The game has the following timing: First, incumbents make their deterrence investments in a manner such that all players—including the potential entrant—observe the investment amounts. Second, the entrant observes the realized value of the random variable, u, and decides whether to enter. Finally, incumbents (and the potential entrant if it enters) compete in the respective markets.

Since the entrant observes the investments that are made by all incumbents, it chooses to enter only if it can earn a positive profit net of its cost of entry. The likelihood of entry is then given by the probability that $\pi^E - D\left(\sum_k x_k\right) \times u > 0$. Given that u is a uniform random variable on [0.1], the probability of entry is $E\left(\frac{\pi^E}{D(\sum_k x_k)}\right) = Min\left\{1, \frac{\pi^E}{D(\sum_k x_k)}\right\}$, where E denotes the uniform cumulative distribution. The greater is the total investment by incumbents, the smaller is the probability

[15] Bernheim (1984) and Gilbert and Vives (1986) consider environments with complete information and show that the free-rider problem does not cause incumbents to underinvest in entry deterrence. In contrast, Waldman (1987) shows that if the cost of entry deterrence is uncertain, then, for certain investment technologies, incumbents may underinvest.

[16] A referee has pointed out that it is possible for a well-funded potential entrant to invest in breaking down entry barriers that are created by incumbents (say, by counter-lobbying the industry regulator to permit entry). An example may be the lobbying of city officials by a ride-hailing service to let it operate in the city over the objections of incumbent taxi-cab companies. We note that having to make additional upfront investments to neutralize entry barriers also amounts to reducing the likelihood of entry by requiring that the entrant's profit upon entry cover those (sunk) barrier-breaking investments.

[17] The concavity condition reflects the assumption of diminishing marginal returns from investing in entry deterrence.

that the potential entrant enters. Further, we assume that, in the relevant range of entry deterrence investments, the total expected private benefit to incumbents exceeds the cost of entry deterrence—collectively, it is profitable for incumbents to deter entry—which makes the free-rider problem between them the focus of attention.

2.2.1 Pre-merger Entry Deterrence Investments

Pre-merger, each incumbent maximizes its expected profit by choosing its deterrence investment, given the level of investment that is selected by the other firm:

$$\max_{x_i} : \pi_i \times \left(1 - E\left(\frac{\pi^E}{D(x_i+x_{-i})}\right)\right) + (\pi_i - \Delta_i) \times E\left(\frac{\pi^E}{D(x_i+x_{-i})}\right) - \alpha \times x_i, \tag{1}$$

which simplifies to

$$\max_{x_i} : \pi_i - \Delta_i \times E\left(\frac{\pi^E}{D(x_i+x_{-i})}\right) - \alpha \times x_i. \tag{2}$$

The first-order condition for an interior solution to (2) is:

$$\Delta_i \times \pi^E \times \frac{D'(x_i+x_{-i})}{(D(x_i+x_{-i}))^2} - \alpha = 0, \tag{3}$$

Where D' denotes the derivative of D.[18] To simplify the notation, we assume that the firms are symmetric in the amount of loss that they suffer due to entry—$\Delta_i = \Delta$—and limit the discussion of the asymmetric case to footnotes. The first-order condition—(3)—is identical for both firms. Let the total equilibrium investment by incumbents be denoted by X^{pre}, which is then determined by the condition:[19]

$$\Delta \times \pi^E \times \frac{D'(X^{pre})}{(D(X^{pre}))^2} - \alpha = 0. \tag{4}$$

The equilibrium total investment is unique, but the firm-level investment is not. Any allocation of the total investment X^{pre} across the 2 firms is an equilibrium. In other words, for any given level of investment $X^{pre}_{-i} = x_j$ that is selected by the other firm, the optimal investment of firm i is $x^*_i = X^{pre} - X^{pre}_{-i}$.[20]

[18] If the value of the first-order condition when $\sum_k x_k = 0$ is negative, then the optimal investment is 0. Note that given the assumption that $D' > 0$ and $D'' \leq 0$, the profit function is concave in x_i such that the second-order profit maximization condition is satisfied.

[19] An equilibrium exists if the derivative $D'(x)$ converges to zero or $D(x)$ converges to infinity as x goes to infinity.

[20] If firms are asymmetric, only the firm that has the most to lose from entry—the firm with the largest Δ_i—invests, while the other firms fully free-ride on that investment. See Waldman (1987).

2.2.2 Post-merger Entry Deterrence Investment

Post-merger, the merged firm selects the level of its deterrence investment—x—that maximizes the combined expected profit of the two merging firms. The combined profit is the same as that pre-merger because the two firms, by assumption, do not compete with each other:[21]

$$\max_{x} : \pi_1 + \pi_2 - E\left(\frac{\pi^E}{D(x)}\right) \times (2 \times \Delta) - \alpha \times x. \tag{5}$$

On the assumption of an interior solution, the first-order condition for the merged firm is:

$$(2 \times \Delta) \times \pi^E \times \frac{D'(x)}{(D(x))^2} - \alpha = 0. \tag{6}$$

Diminishing returns to the total entry deterrence investment (as assumed) implies that $\frac{D'(x)}{(D(x))^2}$ is a decreasing function of x.[22]

Let the total equilibrium investment by the merged firm be denoted by X^{post}. When we compare Eqs. (4) and (6), it is straightforward to see that $X^{post} > X^{pre}$: The deterrence investment post-merger is greater than that pre-merger. Since the merger does not entail the loss of competition between the merging firms, the entrant's net profit is not directly affected by the merger. Therefore, the merger-induced increase in deterrence investment reduces the likelihood of entry. Figure 1 shows a graphical depiction of the pre- and post-merger equilibria.

2.3 A New Theory of Harm for Merger Enforcement

Proposition 1 *A merger between two firms that have a common interest in deterring entry can lead to an increase in entry deterrence investment—and thus a lower probability of entry—even if the merger does not lead to any lessening of competition between the merging firms.*

In the investigative framework set forth in the U.S. Horizontal Merger Guidelines, merger investigations begin with an identification of the extent to which the merging firms compete: the extent to which their merger is likely to lessen competition and lead potentially to anti-competitive effects. A finding that the merging firms do not significantly compete with each other typically ends the investigation by making the analysis of potential mitigating factors such as entry to be moot. Proposition 1

[21] We assume that the effectiveness of the investment to deter entry is not affected by the merger itself. However, it is possible that the merged firm's investment is more effective: for example, because the merged firm can eliminate duplicative efforts between the two merging firms. In that case, the merger would reduce the likelihood of entry even more than what the model predicts.

[22] The derivative of $\frac{D'(X)}{(D(X))^2}$ with respect to X is $\frac{D''(X)\times(D(X))^2 - 2\times\left(D'(X)\right)^2\times D(X)}{(D(X))^4}$, which is negative because $D' > 0$ and $D'' \leq 0$.

indicates that depending on the circumstances a merger may have the anti-competitive effect of reducing the likelihood of future competition-enhancing entry even if it does not lessen current competition. In such cases, the entry thwarting effect of a merger may be important to investigate not just as a mitigating factor but as an anti-competitive effect in its own right.

3 Entry as a Mitigant in Anti-competitive Mergers

In the previous model, since the merger itself does not have any anti-competitive effect, the likelihood of post-merger entry is determined purely by the higher level of deterrence investment that is due to the elimination of free-riding between the merging firms. In a model in which firms compete with each other—they operate in the same market—a merger between two firms will eliminate competition between them, and thus increase their profit to a level that exceeds the sum of their pre-merger profits. This, in turn, would create a greater incentive for the merged firm to deter entry—beyond that from pure elimination of free-riding between the merging firms. The elevated level of industry profits will also increase the attractiveness of the market to potential entrants. In essence, the lessening of competition due to the merger will, by itself, increase the likelihood of entry for any given level of entry deterrence investment.

Thus, for such a merger, the likelihood of entry would be determined by the net effect of the elimination of free-riding between the merging firms, the additional incentive of the incumbents to deter entry due to the higher profits that are at stake, and the greater likelihood of entry that is created by the elevated level of industry profits. The first two effects serve to reduce the probability of entry, while the third effect increases the probability of entry. As was discussed in Sect. 1, merger investigations by the U.S. antitrust agencies consider only the third effect but not the first two entry-reducing effects.

3.1 A Model of an Anti-competitive Merger and Entry Deterrence

Let π^E_{pre} be the profit earned by a potential entrant from entering the market prior to a merger. Adopting the stochastic entry framework that was employed in the prior Section, and using analogous notation, the likelihood of pre-merger entry is $\frac{\pi^E_{pre}}{D(\sum_k x_k)}$. Let us denote by $\pi^i_{pre}(E)$ and $\pi^i_{pre}(NE)$ the pre-merger profits of incumbent firm i when there is entry, and when there is no entry, respectively. The mode of competition in the market could take any form: e.g., differentiated products Bertrand, or homogeneous product Cournot.

The game has the same timing as in the game described in the previous Section. First, each incumbent makes its deterrence investment in a way such that it is observed by all incumbents and the potential entrant. Next, the potential entrant observes the realized value of the random variable and decides whether to enter.

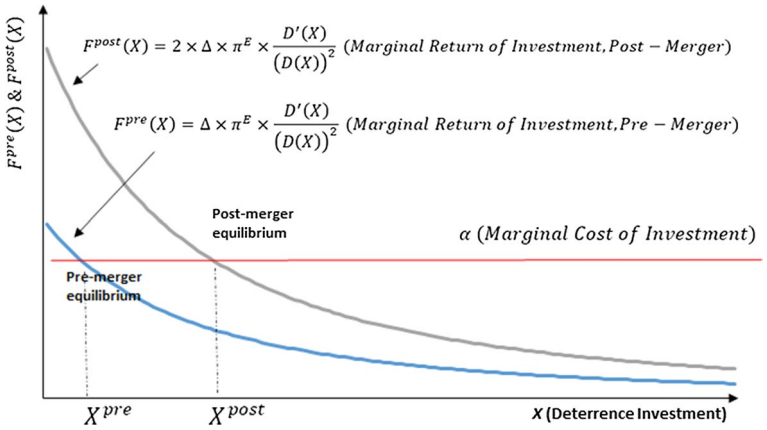

Fig. 1 Equilibrium deterrence investment

Finally, all incumbents—and the potential entrant if it decides to enter—compete in the market.

3.2 Pre-merger Entry Deterrence Investment

Let there be N incumbent firms indexed by $i = 1,\ldots,N$. Pre-merger, each incumbent firm i chooses its deterrence investment to maximize its expected profit, given the deterrence investments of rivals:

$$\max_{x_i} : \pi^i_{pre}(NE) - \frac{\pi^E_{pre}}{D(\sum_k x_k)} \times \left(\pi^i_{pre}(NE) - \pi^i_{pre}(E)\right) - \alpha x_i. \tag{7}$$

The first order condition for an interior solution associated with (7) is

$$\pi^E_{pre} \times \frac{D'\left(x_i + \sum_{k \neq i} x_k\right)}{\left(D\left(x_i + \sum_{k \neq i} x_k\right)\right)^2} \times \left(\pi^i_{pre}(NE) - \pi^i_{pre}(E)\right) - \alpha = 0. \tag{8}$$

Let X_i be the level of total investment—$X_i = x_i + \sum_{k \neq i} x_k$—that solves Eq. (8). As was explained earlier, $\frac{D'(X)}{(D(X))^2}$ is a decreasing function of X. As a result, given the level of total investment by other firms—X_{-i}—firm i's optimal decision is to invest $x_i = X_i - X_{-i}$ if $X_{-i} < X_i$, and $x_i = 0$ otherwise. This implies that in equilibrium only the firm with the most to lose from entry—the firm that has the largest value of $\pi^i_{pre}(NE) - \pi^i_{pre}(E)$—invests in entry deterrence, while the other firms free-ride on its deterrence effort.[23]

[23] If multiple firms have the same amount to lose from entry, there are multiple equilibria with the same level of total investment, and any allocation of the total investment across these firms is an equilibrium.

3.3 Post-merger Entry Deterrence Investment

Let the merging firms be firm 1 and firm 2. Let $\pi^i_{post}(E)$ and $\pi^i_{post}(NE)$ be the post-merger profit of each incumbent firm when there is entry, and when there is no entry, respectively. Finally, let π^E_{post} be the entrant's profit upon entry. Because a merger lessens competition and makes the industry more profitable relative to pre-merger:

$$\pi^E_{post} \geq \pi^E_{pre}. \tag{9}$$

The merged firm chooses its deterrence investment—x—to maximize its expected total profit. Following Eq. (8), the corresponding first order condition is:

$$\pi^E_{post} \times \frac{D'\left(x + \sum_{k>2} x_k\right)}{\left(D\left(x + \sum_{k>2} x_k\right)\right)^2} \times \left(\pi^1_{post}(NE) + \pi^2_{post}(NE) - \pi^1_{post}(E) - \pi^2_{post}(E)\right) - \alpha = 0. \tag{10}$$

For each non-merging incumbent $j > 2$, the first order condition is:

$$\pi^E_{post} \times \frac{D'\left(x_j + \sum_{k\neq j} x_k\right)}{\left(D\left(x_j + \sum_{k\neq j} x_k\right)\right)^2} \times \left(\pi^j_{post}(NE) - \pi^j_{post}(E)\right) - \alpha = 0. \tag{11}$$

Let us denote the loss of profit suffered by incumbent j due to entry post-merger by $\Omega^j_{post} \equiv \left(\pi^j_{post}(NE) - \pi^j_{post}(E)\right)$.[24] Similarly, let us denote the loss of profit suffered by j due to entry pre-merger by $\Omega^j_{pre} \equiv \left(\pi^j_{pre}(NE) - \pi^j_{pre}(E)\right)$:

Proposition 2 *If $\Omega^j_{post} > \Omega^j_{pre} \forall j$, then the merger increases each post-merger incumbent's incentive to increase its entry deterrence investment relative to pre-merger.*

Proof $\frac{D'(.X)}{(D(X))^2}$ is a decreasing function of X given the assumptions that $D' > 0$ and $D'' \leq 0$. Thus, a sufficient condition for post-merger deterrence investment of any incumbent j (including the merged entity) to be greater than its pre-merger investment is:

$$\pi^E_{post} \times \Omega^j_{post} > \pi^E_{pre} \times \Omega^j_{pre}. \tag{12}$$

By (9), we have that $\pi^E_{post} \geq \pi^E_{pre}$. Thus, a sufficient condition for post-merger deterrence investment of any incumbent j to be greater than its pre-merger investment further is:

$$\Omega^j_{post} > \Omega^j_{pre}. \tag{13}$$

[24] For the merged firm, $\Omega^{merged}_{post} = \left(\pi^1_{post}(NE) + \pi^2_{post}(NE) - \pi^1_{post}(E) - \pi^2_{post}(E)\right)$

3.3.1 QED

Note that the post-merger first-order conditions (10) and (11) are otherwise identical to the pre-merger first order condition (8), with "post" replacing "pre" in the subscripts of the profits. The first terms on the left-hand sides of (11) and of (8) are the entrant's expected profit post-merger and pre-merger respectively. The second term within the parenthesis on the left-hand side of (11) and of (8) are the amount of profit that incumbent j stands to lose in the event of entry, post- and pre-merger, respectively. Intuitively, for any given level of entry deterrence investment by incumbents, the greater is the entrant's potential profit, the greater is the likelihood of its entry; thus, the stronger are the incumbents' incentives to invest in deterring entry. Second, the greater is the amount of profit that stands to be lost due to entry (private benefits from entry deterrence), the greater are the incumbents' incentives to invest in entry deterrence for any given level of the entrant's profit.

3.4 Characterization of Post-merger Entry Deterrence Equilibrium

The first-order condition for the merged entity, (10), and that for non-merging incumbents, (11), will typically not hold with equality for all post-merger incumbents. As in the case of a profit-neutral merger that was analyzed in Sect. 2, the key term that determines which firm invests in deterrence (while the remaining firms free-ride on its entry deterrence effort) is Ω^j_{post}. Recall that the expression measures the difference between the post-merger profits of an incumbent between when there is no entry and when there is entry: the amount of profits that are at stake from entry. The merged firm would make the deterrence investment—rather than the non-merging firms' making the investment—if

$$\left(\pi^1_{post}(NE) + \pi^2_{post}(NE) - \pi^1_{post}(E) - \pi^2_{post}(E)\right) \geq \Omega^j_{post} \forall j \neq \{1,2\} \tag{14}$$

Otherwise, the non-merging firm that has the most to lose from entry—the incumbent that has the highest value of Ω^j_{post}– will be the only firm that makes deterrence investment. A merger between two incumbents can create the "largest" firm in the industry: the post-merger firm with the most to lose from entry. This can be the case, for example, when incumbents produce symmetric differentiated products and compete on prices.

On the other hand, a merger between two small firms can leave the identity of the "largest" firm unchanged. Loss of competition in a market associated with a merger between any two firms, however, increases the profits of all firms post-merger. Thus, in this case, even though the merged firm is not the one making the deterrence investment, the merger raises the private deterrence benefit of the "largest" firm, giving it more to lose from entry. The increase in private benefit makes the "largest" firm increase its investment in entry deterrence. In essence, even if a merger does not create a new firm that has the most to lose from entry, it indirectly increases the amount of profit that the non-merging firms stand to lose from entry—and thus, the latter's deterrence investment.

Typically, when a merger creates the largest firm in the industry, it induces a first-order increase in deterrence investment since the merged firm is the only one to make the investment. In contrast, when a merger leaves the identity of the largest firm intact, the increase in deterrence investment is of second-order magnitude since it is induced by the increase in profitability of the largest firm due to a merger between two smaller firms. As a result, increase in entry deterrence is likely to be a bigger concern when a merger creates the largest firm in the industry post-merger.

3.5 Sufficient Condition and Probability of Entry

Two things remain to be explored: First, in what situations does the sufficient condition in Proposition 2—$\Omega^j_{post} > \Omega^j_{pre} \forall j$—hold? Second, when is the increase in deterrence investment due to a merger sufficient to outweigh the entry-inducing effect of a merger? Equivalently: When does a merger, on net, reduce the likelihood of entry? To make headway into finding answers to these questions, we consider the two most commonly studied games: homogeneous product Cournot competition, and differentiated products Bertrand competition.

We show that the sufficient condition for deterrence investment to increase due to a merger is satisfied by both Cournot and Bertrand games.[25] We also show that the merger-induced increase in deterrence investment can make the likelihood of post-merger entry to be less than the likelihood of pre-merger entry. (Proofs can be found in the Appendix). To summarize:

Proposition 3 *A merger between two competing incumbents increases the total amount of entry-deterrence investment. Such an increase can reduce the likelihood of post-merger entry to a level that is below the pre-merger level. Failure to consider entry deterrence in merger analysis can lead to undue reliance on the likelihood of entry as a mitigating factor against anti-competitive effects.*

4 Policy Implications and Conclusion

Barriers to entry that are exogenous to firm conduct—e.g., large (and sunk) upfront investments—are known to lead to concentrated markets. In this article, we have shown that more concentrated markets may lead to higher endogenous entry barriers: entry barriers that are proactively created by incumbent firms through a variety of means. Our findings suggest two important policy prescriptions:

[25] We can obtain some intuition for why the sufficient condition holds by re-writing (13) as $\left(\pi^j_{post}(NE) - \pi^j_{pre}(NE)\right) > \left(\pi^j_{post}(E) - \pi^j_{pre}(E)\right)$; in words, the effect of a merger on any firm's profit must be larger when there are fewer firms to begin with.

4.1 The Evidentiary Value of Historical Entry

To assess whether post-merger entry is likely, the U.S. antitrust agencies assign substantial weight to whether there has been historical (pre-merger) entry into a market.[26] Evidence of historical entry is taken as an indication that post-merger entry is likely and may serve to defeat attempts by the merged entity to raise prices or reduce product quality after the merger. Our result—that a merger will likely increase the incentives of incumbents to deter entry—suggests that evidence of historical entry (prior to a merger) may have limited usefulness with regards to assuring adequate likelihood of entry after the merger.

4.2 The Deterrence of Future Entry as an Anti-competitive Concern

The standard for considering a merger to be anti-competitive is based on whether the merger will likely lead to a substantial lessening of competition in the market: whether it leads to the creation, enhancement, entrenchment, or exercise of market power.[27] As a practical matter, the antitrust agencies typically focus on whether a merger will likely lead to an increase in price or a diminution in innovation. The likelihood of entry is viewed as a mitigating factor that is assessed only after a merger is determined a priori likely to lead to increase in prices or reduction in innovation.

Our analysis shows that, under certain circumstances, a merger that is unlikely to lead to a price increase or loss of innovation may nevertheless increase entry barriers and reduce the likelihood of future entry into the market—entry that would have served to make the market more competitive relative to pre-merger. Thus, an increase in entry deterrence may be considered as an anticompetitive merger effect in its own right—just as a price increase and loss of innovation are—and not just as a potential mitigating factor.

4.3 Practical Guidance for Merger Enforcement

The extent of deterrence investment by an incumbent (and thus the likelihood of entry) depends crucially on two things: (i) the difference in profit of the incumbent between when there is no entry and when there is entry, holding fixed the entrant's expected profit; and (ii) the entrant's expected profit upon entry (see Eqs. (6) and (11)). The greater are the values of each of these variables, the larger is the incentive to deter entry. At the same time, a greater value of the entrant's expected profit increases its incentive to enter, which makes the net effect of (ii) to be ambiguous. To investigate the effect of a merger on the likelihood of entry, it is important to determine how the values of the two variables change as a result of the merger.

[26] "The Agencies consider the actual history of entry into the relevant market and give substantial weight to this evidence." Guidelines §9.

[27] Guidelines §1.

In a typical merger analysis, there is usually some information that can help determine the loss of profit that each incumbent is likely to incur when there is entry. For example, in the Comcast/Time Warner Cable (TWC) proposed merger, the DOJ and the FCC would likely have had access to information about the rate at which the parties' subscribers were switching from cable video to streaming video services such as Netflix and Hulu. The agencies would likely also have had information about the lifetime value (LTV) of each subscriber to Comcast and TWC. Such information could have been used to assess how much the merged entity stood to lose from growth in streaming video services. (Similarly, third-party streaming video providers could have been subpoenaed by the investigating agencies for information about their LTV for each additional subscriber.)

Since each merger is different from others, we do not expect merger policy to have a bright line threshold with regard to the extent of the loss of incumbent profit that is due to entry that would be dispositive of whether a merger is anti-competitive with regard to its entry deterrence effect. At the same time, all else equal, a greater value of the loss in incumbent profit that is due to entry will likely raise concerns with regard to whether entry can be relied upon to mitigate anti-competitive effects.

As we explained in Sect. 3.4, the increase in deterrence investment is of first-order magnitude when a merger creates the largest firm in the industry (or adds to the size of the already-largest firm) based on profits. On the other hand, the deterrence effect of a merger is of second order magnitude when a merger leaves intact the identity of the largest firm. As such, the antitrust agencies can screen mergers based on this criterion to decide which mergers to scrutinize in depth with regard to entry deterrence.

4.4 Conclusion

In this paper, we show that a determination of the likelihood of post-merger entry by taking entry barriers as they appear prior to a merger, and analyzing only the incentives and ability of potential entrants to overcome such barriers, may lead to an excessively lax merger policy. The likelihood of entry in merger analysis is better assessed by viewing it as the outcome of a strategic game between incumbents as they seek to deter entry. A merger gives incumbents the incentive to raise entry barriers to a level that is higher than the level prior to the merger. A merger's effect of reducing the likelihood of future entry may also be viewed as an anti-competitive merger effect in its own right—similar to the traditional concerns that are associated with mergers, such as the potential increase in prices, reduction in quality, and diminution of incentives to innovate.

Although entry deterrence is typically not a formal part of horizontal merger investigations, the notion of entry deterrence (exclusionary practices) is very much a part of investigations into monopolization of markets by dominant firms. A broader approach to entry analysis in merger investigations—by considering their potential effect to intensify proactive entry deterrence by incumbents—would seem to be well within the incipiency standard of merger enforcement and would leave fewer subsequent monopolization cases to investigate and prosecute.

Appendix 1

Sufficient Condition in Proposition 2

In this appendix, we show that—both under Cournot competition (with linear demand) and under Bertrand competition (with logit demand)—for every firm i, the loss of profit suffered by incumbent i due to entry is larger post-merger than pre-merger:

$$\left(\pi^i_{post}(NE) - \pi^i_{post}(E)\right) > \left(\pi^i_{pre}(NE) - \pi^i_{pre}(E)\right)$$

Cournot

We assume a Cournot model with N firms, where: (i) each firm has constant marginal cost c_i; and (ii) demand is linear: $P = a - b \times Q$.

Firm i's FOC is:

$$a - b \times Q - c_i - b \times q_i = 0. \tag{15}$$

Summing over the FOC of all firms implies that:

$$N \times a - N \times b \times Q - N \times \overline{c} - b \times Q = 0, \tag{16}$$

where $\overline{c}$ is the unweighted average cost across all firms: $\overline{c} = \frac{\sum_i c_i}{N}$. Therefore:

$$Q = \frac{N \times \left(a - \overline{c}\right)}{(N+1) \times b}; \text{and} \tag{17}$$

$$q_i = \frac{a - c_i}{b} - \frac{N \times \left(a - \overline{c}\right)}{(N+1) \times b}. \tag{18}$$

Furthermore, (15) implies that $P - c_i = a - b \times Q - c_i = b \times q_i$, so that firm i's profit is:

$$\pi_i = b \times \left(q_i\right)^2 = \frac{1}{b} \times \left(a - c_i - \frac{N}{(N+1)} \times \left(a - \overline{c}\right)\right)^2. \tag{19}$$

We provide an analytic proof under the assumption that $c_i = \overline{c}$. We then run Monte Carlo simulations that do not impose this restriction.

If $c_i = \overline{c}$, then $\pi_i = \frac{1}{b} \times \frac{\left(a-\overline{c}\right)^2}{(N+1)^2}$. The condition $\left(\pi^i_{post}(NE) - \pi^i_{post}(E)\right) > \left(\pi^i_{pre}(NE) - \pi^i_{pre}(E)\right)$ translates to (without loss of generality, we normalize b and $\left(a - \overline{c}\right)^2$ to 1):

$$\frac{1}{(N)^2} - \frac{1}{(N+1)^2} > \frac{1}{(N+1)^2} - \frac{1}{(N+2)^2}$$

To show this, it is sufficient to show that $\frac{1}{(X)^2} - \frac{1}{(X+1)^2}$ is decreasing in X, for $X \geq 2$. The derivative of the previous expression with respect to X is $-\frac{2}{(X)^3} + \frac{2}{(X+1)^3}$, which is clearly negative.

Now we allow for firms to have different cost c_i. We construct each Monte Carlo experiment as follows[28]:

1. Each firm's cost is drawn from a uniform between 0 and 5.
2. a is drawn from a uniform between 5 and 50.
3. The number of firms is between 2 and 10, drawn from a discrete uniform.
4. The slope b is normalized to 1.

We ran 50,000 such Monte Carlo experiments. We used only parameter configurations where all firms have a positive quantity both pre-merger and post-merger. The Monte Carlo results confirm that a merger always increases each incumbent firm's loss from entry.[29]

Bertrand

We consider a model where demand is logit and single product firms are Bertrand competitors. Because this model does not have closed-form solution, we confirmed that $\left(\pi^i_{post}(NE) - \pi^i_{post}(E)\right) > \left(\pi^i_{pre}(NE) - \pi^i_{pre}(E)\right)$ by running Monte Carlo experiments as follows:

We assume that the latent utility that consumer i derives from product j is: $U_{ij} = d_j - \alpha \times p_j + e_{ij}$, where e_{ij} follow an extreme value distribution. It follows that the demand for product j is: $q_j = \frac{\exp(d_j - \alpha \times p_j)}{1 + \sum_k \exp(d_j - \alpha \times p_j)}$.

In our baseline simulations, we construct each Monte Carlo experiment as follows:

1. d_j is drawn from a uniform between 0 and 2.
2. α is drawn from a uniform between 0 and 1.
3. Each firm's cost is drawn from a uniform between 0 and 2.
4. The number of firms is between 2 and 10, drawn from a discrete uniform.

[28] We experimented with alternative bounds for the distributions that we used to generate the model parameters, which did not change the conclusion.

[29] The STATA codes that implement the Monte Carlo simulations in the appendices are available upon request.

We ran 50,000 such Monte Carlo experiments. For each experiment, we find that[30]:

1. For non-merging firms $\left(\pi^i_{post}(NE) - \pi^i_{post}(E)\right) > \left(\pi^i_{pre}(NE) - \pi^i_{pre}(E)\right)$: The loss from entry is larger post-merger than pre-merger.
2. This may not hold for each individual merging firm, but it holds for the sum of the merging firms' profits, which is sufficient for our purposes.

Appendix 2

In this appendix we demonstrate analytically that, in the case of a symmetric Cournot model with linear demand and constant marginal cost, a merger always decreases the likelihood of entry when $D\left(\sum_k x_k\right) = \sum_k x_k$. We also implement Monte Carlo simulations that indicate that the same holds in the case of Bertrand competition with logit demand.

Cournot

As was derived in Appendix 1, the equilibrium quantity and profits are $q_i = \frac{(a-c)}{(N+1)\times b}, \pi(N) = \frac{(a-c)^2}{(N+1)^2\times b}$. In what follows, we treat N as the number of incumbent firms pre-merger. A merger reduces the number of firms to $N-1$: Given symmetry, the merged firm will remove one of the pre-merger firms from the market. Entry increases the number of firms by 1.

Pre-merger

Entry increases the number of firms from N to $N+1$. Therefore:

$$\Omega_{pre} = \pi(N) - \pi(N+1) = \frac{(a-c)^2}{b}\left[\frac{1}{(N+1)^2} - \frac{1}{(N+2)^2}\right] = \frac{(a-c)^2}{b}\frac{2N+3}{(N+1)^2\times(N+2)^2};$$

$$\pi^E_{pre} = \pi(N+1) = \frac{(a-c)^2}{(N+2)^2\times b}.$$

Post-merger

Entry increases the number of firms from $N-1$ to N. Therefore:

[30] We experimented with alternative bounds for the distributions that we used to generate the model parameters, which did not change the conclusion.

$$\Omega_{post} = \pi(N-1) - \pi(N) = \frac{(a-c)^2}{b}\left[\frac{1}{(N)^2} - \frac{1}{(N+1)^2}\right] = \frac{(a-c)^2}{b}\frac{2N+1}{(N)^2\times(N+1)^2};$$

$$\pi^E_{post} = \pi(N) = \frac{(a-c)^2}{(N+1)^2 \times b}.$$

Comparison of Entry Probabilities

Assume that $D\left(\sum_k x_k\right) = \sum_k x_k$. Then, for $l = pre, post$, Eqs. (8) and (11) imply that:

$$X^l = \left(\frac{\Omega_l \times \pi^E_l}{\alpha}\right)^{1/2}, \tag{20}$$

and the likelihood of entry is.

$$Prob\_Entry_l = \frac{\pi^E_l}{X^l} = \left(\frac{\alpha}{\Omega_l}\right)^{1/2}\left(\pi^E_l\right)^{1/2}. \tag{21}$$

Therefore;

$$\frac{Prob\_Entry_{post}}{Prob\_Entry_{pre}} = \frac{\left(\frac{\alpha}{\Omega_{post}}\right)^{1/2}\left(\pi^E_{post}\right)^{1/2}}{\left(\frac{\alpha}{\Omega_{pre}}\right)^{1/2}\left(\pi^E_{pre}\right)^{1/2}} = \left(\frac{\Omega_{pre}}{\Omega_{post}}\right)^{1/2} \times \left(\frac{\pi^E_{post}}{\pi^E_{pre}}\right)^{1/2}$$

$$= \left(\frac{\frac{2N+3}{(N+1)^2\times(N+2)^2}}{\frac{2N+1}{(N)^2\times(N+1)^2}}\right)^{1/2} \times \left(\frac{(N+2)^2}{(N+1)^2}\right)^{1/2} = \left(\frac{(2N+3)\times(N)^2}{(2N+1)\times(N+1)^2}\right)^{1/2}.$$

The ratio, which depends only on N, is always less than 1, as Fig. 2 illustrates. For example, when there are four incumbent firms pre-merger, the ratio of the probabilities is 88.4%; consequently, if the pre-merger probability of entry is 40%, then the post-merger probability of entry is 35.4% (40% × 88.4%).

Bertrand

For the Bertrand model, we implement Monte Carlo simulations (which were described in Appendix 1) that indicate that, when $D\left(\sum_k x_k\right) = \sum_k x_k$, the ratio of

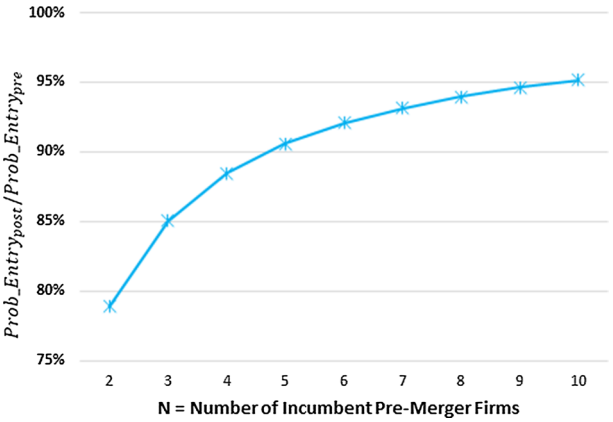

Fig. 2 Effect of the merger on the probability of entry—effect of the number of incumbents

probabilities $\frac{Prob\_Entry_{post}}{Prob\_Entry_{pre}}$ is always less than 1: The entry probability always decreases.[31]

Figure 3 illustrates the relationship between $\frac{Prob\_Entry_{post}}{Prob\_Entry_{pre}}$ and number of incumbent firms. It shows that the negative effect on entry probability is greater when the number of incumbent firms is smaller.

Table 1 illustrates the relationship between $\frac{Prob\_Entry_{post}}{Prob\_Entry_{pre}}$ and the share of the smaller of the two merging firms, conditional on the number of pre-merger incumbents. It shows that the reduction in entry probability is greater when the share of the smaller merging firm is smaller.

[31] We experimented with alternative bounds for the distributions used to generate the model parameters, which did not change the conclusion.

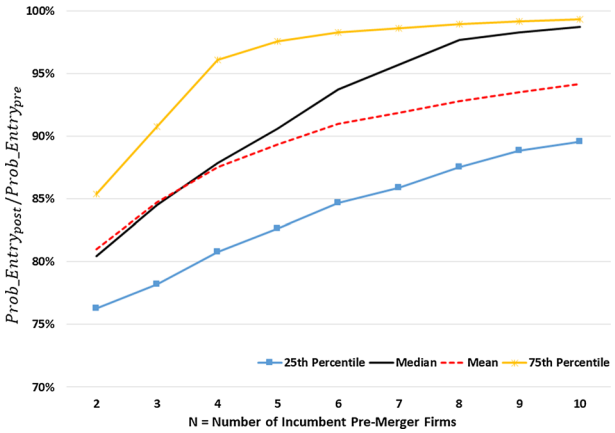

Fig. 3 Effect of the merger on the probability of entry—effect of the number of incumbents

Table 1 Effect of the merger on the probability of entry

	Bertrand Model with Logit Demand								
	N = Number of incumbent pre-merger firms								
	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)	10 (%)
Minimum share among merging firms									
0–5%	81.7	85.7	89.0	92.4	94.8	96.0	96.6	97.0	97.5
5–10%	82.6	87.6	90.8	92.2	92.8	93.1	92.9	92.4	92.4
10–15%	82.8	85.8	86.5	86.1	84.8	84.0	82.3	81.1	79.8
15–20%	80.2	80.5	79.4	77.7	76.8	75.1	75.1	73.8	73.8
20–25%	78.1	76.2	74.6	74.3	72.9	73.3	72.6	72.8	
25–30%	76.1	74.2	73.4	73.0	73.8				
30–35%	74.7	73.7	73.1						
35–40%	72.2								

The numbers in the table represent the ratio $\frac{Prob\_Entry_{post}}{Prob\_Entry_{pre}}$

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