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# The Sale of Data: Learning Synergies Before M&As\*

Antoine Dubus<sup>†</sup> Patrick Legros<sup>‡</sup>

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## Abstract

Firms may share information to discover potential synergies between their data sets and algorithms, eventually leading to more efficient mergers and acquisitions (M&A) decisions. However, as pointed out by Arrow, information sharing also modifies the competitive balance when companies do not merge, and a firm may be reluctant to share information with potential rivals. Under general conditions, we show that firms benefit from (partially) sharing information. By doing so, they can merge conditionally based on high synergies. If the firms' best alternative is to compete, information sharing allows M&As to occur when synergies are high. In contrast, if their best alternative is to merge under incomplete information, information sharing allows firms to avoid M&As when synergies are low. Compared to a laissez-faire situation, the presence of a regulator allowing or refusing the M&A may decrease or increase information sharing and consumer surplus.

**Keywords:** Synergies; Mergers; Incomplete Information; Antitrust; Privacy.

**JEL:** G34; K21; L1; L21; L24; L5; L86.

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Mergers fail, acquisitions are reversed, previously acquired assets are divested, and claimed efficiencies are not realized. Is this because firms claim M&As will yield efficiency gains in the hope of convincing authorities? Is it because firms did not do their homework and incorrectly evaluated the extent of synergies? Or is it because synergies exist only “on average,” and therefore, there is a probability that synergies may not be realized after the M&A?

These questions are relevant in a world where firms are uncertain of the extent of synergies at the time of a M&A. In such an environment, more precise information about the synergies that will follow a M&A is valuable for the companies involved and a regulator willing to maximize social welfare.

For digital products that rely heavily on data to provide consumers with a high-quality experience, a M&A generates new types of synergies – and uncertainty over the merger outcome – resulting from the merger of data sets and data sources. While the profits of a firm can be enhanced by leveraging the data accumulated by the target into its algorithms, this is not a certainty: the synergies between the data and algorithms of firms are unknown before the M&A, even if both companies have a good understanding of the likelihood of these synergies. The sale (potentially at a zero price) of data between merger participants can allow a firm to evaluate better the complementarity of data and algorithms that the two firms have developed and the extent of synergies that may arise after a M&A.

[Arrow \(1962a,b\)](#) famously pointed out the benefits and the difficulty of inducing such collaborations among competitors: providing assets to competitors enhances their ability to compete, and sharing its assets can be costly for a firm.<sup>1</sup> Indeed, sharing information changes the firms’ competitive positions if the M&A does not go through.

Our contribution in this paper is to show when firms benefit from sharing information before a merger and to characterize the optimal level of information sharing. If firms learn that synergies are high after exploration, acquisition becomes profitable. However, suppose synergies are learned to be low. In that case, an acquisition is not beneficial, and firms compete, placing the firm that has shared its data in a worse situation than in the absence of information sharing. Hence, information sharing allows firms to anticipate the value of information synergies and make their

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<sup>1</sup>Throughout the article, we use equivalently the terms information “sharing” and “selling,” consistently with the literature ([Hörner and Skrzypacz, 2016](#)) and with the definitions adopted in recent data protection laws (see for instance the [California Consumer Privacy Act](#)).

merger decision conditional on high information synergies. This increases their expected payoff by enabling them to make efficient M&A decisions. Still, it also comes at a cost, as information sharing enhances the intensity of competition in case firms compete.

The nature of the efficiency gains from sharing information depends on the alternative to sharing for the firms. If their alternative is to merge under incomplete information, sharing allows firms to avoid mergers when synergies are low. If their alternative is to compete, sharing allows M&As to take place when synergies are high. Information sharing will be profitable if these efficiency gains dominate the expected competitive losses.

We show that firms always benefit from sharing information if their alternative is to merge under incomplete information. This suggests that when firms can share information, they never merge under incomplete information. In other words, according to our model, if firms engage in a M&A, they necessarily have shared information before doing so and know the value of synergies at the time of the M&A. This result holds even if firms have an excellent estimate of the likelihood of synergies before sharing and are almost sure that synergies are high. In this case, firms still benefit from sharing information and learning the value of synergies before the M&A, as the probability that they don't merge and end up competing more fiercely because of the shared information is low.

If the alternative to sharing is to compete, we show that sharing information will be the equilibrium strategy if the likelihood of low synergies is lower than a cutoff value. Again, this condition implies that firms' competition probability is low, so the loss resulting from information sharing is also low.

A regulator such as a competition authority will have a lenient view on information sharing practices: competition between firms will be fiercer after the information is shared, to the benefit of consumers. However, for this reason, the regulator will be tempted not to allow M&As even if synergies are high, reducing the incentives for information sharing. Assuming that the weight placed by a regulator on consumer surplus is uncertain when firms engage in M&A proceedings, we show that the presence of a regulator has an ambiguous impact on the equilibrium amount of information shared by the companies. If the regulator values competition between firms, a M&A is more likely to be refused when more information has been shared. Perhaps less obvious, we show that the prospective buyer may want to acquire more or less information when there

is a risk that the M&A is not allowed, as by doing so, it can also increase its profits in case the merger is blocked, and firms compete with the information shared. Thus, the amount of information firms share in the presence of the regulator balances the resulting changes in the probability that the merger is accepted and the increase or decrease in the competitive profits if the merger is blocked.

Hence, while the regulator protects consumers through its ability to block the M&A, consumer surplus can be lower in the presence of the regulator than in a *laissez-faire* situation. If firms share less information when there is a regulator, they compete less intensively to the detriment of consumers. This negative effect can dominate the surplus gain from M&A avoidance. This result is in the spirit of second-best analysis. It suggests that the protection of consumers through merger control can be detrimental to their surplus and that no regulatory intervention may be best for both consumers and firms. This negative impact of regulatory oversight can be offset if the regulator can mandate information sharing by the firms.

The remainder of this article is organized as follows. We review the literature on M&As in Section 1, we describe the model in Section 2, and we characterize the equilibrium in Section 3. We analyze in Section 4 how regulation shapes information sharing and welfare. We extend the model in several directions in Section 5. We conclude in Section 6.

## 1 Literature

Our main contribution highlights a novel rationale for rival firms to benefit from sharing information. When firms share information, the resulting competition becomes more intense, in line with the effects analyzed by [Arrow \(1962a\)](#), and by [d'Aspremont, Bhattacharya and Gérard-Varet \(2000\)](#) and [Anton and Yao \(2002\)](#) in the case of innovation. However, we show that efficiency gains compensate for this competitive loss as firms learn the synergies from merging their data sets and make their M&A decision according to the value of these synergies. A follow-up contribution is to show that this trade-off has nontrivial effects on the optimal regulation of information-sharing practices. Sharing information among rival firms, data-driven mergers, and regulating information sharing have been separately studied in the literature.

The early literature on information sharing among competitors is reviewed by [Bergemann and](#)

[Bonatti \(2019\)](#), who emphasize trade associations' role in enabling information sharing between competitors. This issue has later been revisited in the case of competing firms sharing consumer data for the identification of loyal and switching customers ([Chen, Narasimhan and Zhang, 2001](#); [Liu and Serfes, 2006](#)), and more recently for first-degree price discrimination purposes ([Choe, Cong and Wang, 2024](#)) and when data generates a consumption externality ([Bhargava, Dubus, Ronayne and Shekhar, 2024](#)). In these models, firms directly sell data to their competitors in exchange for a money transfer without using a trade association, a setting that we also use in our model.

Concerning data-driven M&A, [Farronato, Fong and Fradkin \(2024\)](#) assesses empirically the welfare impact of a merger between platforms, highlighting a tension between the loss of variety and more substantial network effects. [Chen, Choe, Cong and Matsushima \(2022\)](#) and [Taylor and de Cornière \(2024\)](#) theoretically analyze the impacts of a data-driven merger on consumers when data can be used for product personalization. In [Chen et al. \(2022\)](#), a data-driven merger increases consumer surplus as long as competitors remain in the market. This is not always the case in [Taylor and de Cornière \(2024\)](#), and a merger's impact on consumers depends on whether the effect allows firms to extract surplus. [Bounie, Dubus and Waelbroeck \(2023\)](#) analyze mergers between data intermediaries and show that their competitive impacts on product markets depend on how a merger changes the selling strategies of intermediaries and their incentives to collect data. A merger is always profitable for a firm in these models, focusing on consumer merger impacts. We use a general formulation of firms' profits and consumer surplus before and after a M&A, such that our model nests these different micro-founded effects. In turn, we show how accounting for uncertainty over the merger outcome critically changes the M&A decisions of the firms and consumer surplus.

Learning synergies is central for firms engaging in M&A (and for regulators) since most M&As between digital firms fail to deliver positive outcomes.<sup>2</sup> In particular, several flagship mergers have failed because synergies have been inaccurately anticipated, including Twitter/Vine, Yahoo/Tumblr, and America Online/Netscape. As emphasized by Experian, the role of data quality and information synergies is becoming more and more central for M&As between digital firms and brings significant uncertainty over merger outcomes [The critical role of data quality in mergers](#)

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<sup>2</sup>See [The Three Reasons Why Tech M&A Deals Fail To Deliver Value, Forbes, October 19, 2017](#).

and acquisitions, Experian, last accessed, March 19, 2024.

There is an active policy debate on how to regulate data-driven digital markets. When data has pro-competitive effects, Crémer, de Montjoye and Schweitzer (2019) and Tirole (2023) propose to foster data-sharing practices to ensure competition on a level playing field. An extreme way of doing so is through mandated data sharing rules forcing firms to share data with their competitors (Feasey and de Streel, 2020). For instance, the Digital Markets Act recently enacted in Europe enforces a data access right under Article 61, which requires large digital gatekeepers providing online search services to make their search data accessible to other digital firms under fair, reasonable, and non-discriminatory terms.<sup>3</sup> Our contribution to these debates will be to characterize the conditions for a regulator to allow firms to share information and to mandate data sharing between rival firms.

Finally, competition authorities have also implemented a new merger remedy to prevent firms from acquiring data dominance. In merger cases such as Facebook/WhatsApp and Google/Fitbit, the merging firms have been forbidden to merge their data sets after the merger occurred (Krämer, Shekhar and Hofmann, 2021). Our model accounts for such a data-siloing remedy, and we show that firms share more information when they anticipate that data silos may be requested.

## 2 Model

We consider two firms, indexed by 1 and 2, that are competitors for providing a service or product and making individual profits  $\pi_1^0$  and  $\pi_2^0$ . The industry profit is  $\pi^0 := \pi_1^0 + \pi_2^0$ . The baseline model in Section 3 assumes that if firms decide to merge, no regulator can prevent the M&A. Regulatory oversight is explored in Section 4.

Figure 1 introduces the sequence of events; we then delve into each stage, the variables of interest, and our main assumptions. The Appendix provides a quality competition rationale for the assumptions made below.

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<sup>3</sup>Digital Markets Act, last accessed, April 17, 2024.

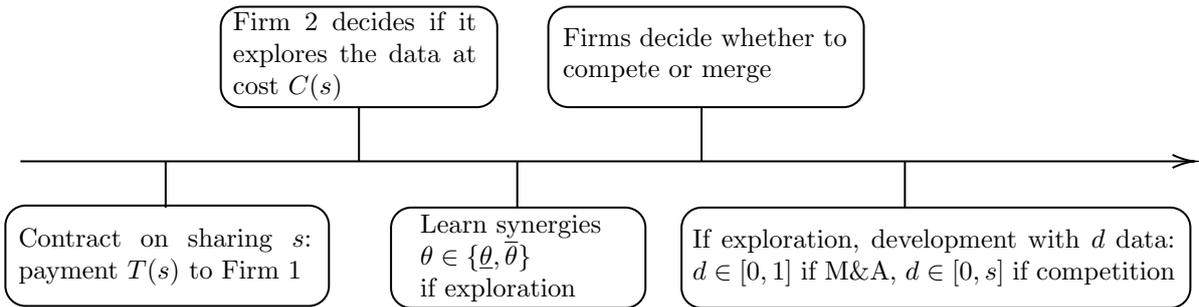


Figure 1: Sequence of events

**Sharing and contracting.** Firms have a stock of data generated by their activities. Firm 1 can share a proportion  $s \in [0, 1]$  of its data with Firm 2 in exchange for a lump sum transfer  $T(s)$ .

**Synergies and exploration.** Combining data from Firms 1 and 2 will generate information synergies of value  $\theta \in \{\underline{\theta}, \bar{\theta}\}$ ,  $\bar{\theta} > \underline{\theta}$ , which will impact the profits of the firms and the surplus of consumers. The value of  $\theta$  is unknown to firms, but each company knows that  $\theta = \underline{\theta}$  with probability  $\alpha$ , and  $\theta = \bar{\theta}$  with probability  $1 - \alpha$ .<sup>4</sup>

By exploring Firm 1's data, Firm 2 may learn the value of the synergies and will, in turn, learn how to develop a product that uses the data from Firm 1. This learning entails a cost of exploration of  $C(\cdot)$ , which depends on the amount of data explored. To simplify, we assume in the basic model analysis that both firms learn synergies when Firm 2 engages in exploration.<sup>5</sup>

It is well documented in the literature on statistics and machine learning that inferring information from missing data is costly and that statistical models perform better when more data is available (see, e.g., [Neiswanger and Xing \(2017\)](#)).<sup>6</sup> For this reason, we assume that the exploration cost  $C(\cdot)$  required to learn the level of synergies decreases with the amount of information

<sup>4</sup>Our results also hold for the general distribution of probabilities over a continuous set of outcomes of the type  $\theta \in [\underline{\theta}, \bar{\theta}]$ . For simplicity, we focus on the binary case.

<sup>5</sup>We can show that if synergies are learned privately, the equilibrium outcome is identical to the one with symmetric information, as the change in the price of an acquisition perfectly translates in a change in the price of information. Hence, when it acquires information, Firm 2 faces the same expected profits whether synergies are learned privately or publicly. A detailed resolution of the game with private learning is available upon request.

<sup>6</sup>Intuitively, if more data increases the cost of exploration, Firm 2 can always focus on a subset of the database.

explored. For simplicity, we also make standard Inada conditions:

$$(H1) \quad \text{Exploration cost: } C(\cdot), C''(\cdot) \geq 0, C(0) = +\infty, C'(0) = -\infty, \text{ and } C'(1) = 0.$$

Hence, if  $s$  information has been shared and Firm 2 opts for exploration, it will explore all the  $s$  available data to minimize  $C(\cdot)$ , and the exploration cost will equal  $C(s)$ .

**Merger decision.** The decision to merge can happen under imperfect information if synergies are not learned (either because no information is shared or because Firm 2 does not explore). The merged firm then decides whether to explore the data after the merger. Without exploration, the merged firm cannot develop a new product using the data from both firms. If Firm 2 has acquired and explored data from Firm 1, firms can also merge with perfect information about the synergy.

Hence, firms face the following options at the beginning of the game: compete; merge under incomplete information and explore the data after the M&A; merge under incomplete information without exploration; share information before the M&A and make their M&A decision with perfect information over the synergies.

At the M&A stage, we focus on Firm 2 making a TIOLI offer to Firm 1 and capturing all industry surplus from the merger.

**Development.** After learning the value of the synergies, Firm 2 can improve its product using the data. This induces development costs, like structural costs to store and analyze the data, develop new algorithms, and integrate the data into its systems.

Hence, after exploration, Firm 2 chooses the amount of data  $d$  to further improve its product, with  $d \in [0, s]$  if  $s$  data has been shared and  $d \in [0, 1]$  if firms have merged.

**Competition with development.** If there is development and competition, the firms' profits (which include the development costs for Firm 2) are denoted by  $\pi_i^C(d, \theta)$ , continuous in  $d \in [0, s]$  for any  $\theta$ .

Integrating data from Firm 1 into its algorithms allows Firm 2 to enhance the consumer value for its product to an extent that depends on the value of information synergies. In a competitive

setting, this may negatively impact the profit of Firm 1 (Arrow, 1962a; Anton and Yao, 2002), and we assume that  $\pi_1^C(d, \theta)$  decreases with  $d$ .

$$(H2) \quad \text{Arrow effect: } \frac{\partial \pi_2^C(d, \theta)}{\partial d} \geq 0 \geq \frac{\partial \pi_1^C(d, \theta)}{\partial d}.$$

Under this assumption, Firm 2 will develop a product using all the available data when competing with Firm 1, so Firm 2 chooses  $d = s$ . Hence, the competitive profits in case data is explored are equal to  $\pi_1^C(s, \theta)$  and  $\pi_2^C(s, \theta)$ . We denote by  $\pi^C(s, \theta)$  the total industry profit under competition in state  $\theta$  when Firm 2 has explored and developed its product with  $s$  data from Firm 1.

The Arrow assumption is compatible with an industry profit that increases with the amount of data shared and developed. We assume that sharing data reduces the industry's total profits when synergies are low, leaving the possibility that industry profits increase with  $s$  when synergies are high.

$$(H3) \quad \text{Industry loss with low synergies: } \frac{\partial \pi^C(s, \theta)}{\partial s} < 0.$$

In the limit case where  $s = 0$ , the firms make the baseline competitive profits (which do not depend on the value of information synergies):

$$\forall i, \theta, \pi_i^C(0, \theta) = \pi_i^0.$$

**Merger with development.** If firms merge after data has been shared and explored, they choose the amount of data  $d \in [0, 1]$  to use to develop their product after the merger. We denote by  $\pi^M(d, \theta)$  the profit of the merged firm, which depends on  $d$  and the value of the synergies. More data used to develop a product increases the monopoly profit in any state. But, as we have assumed under competition, synergies have no effect without exploration or information sharing.

$$(H4) \quad \begin{aligned} \pi^M(d, \theta) \text{ is increasing in } d, \theta, \\ \pi^M(0, \bar{\theta}) = \pi^M(0, \underline{\theta}). \end{aligned}$$

Hence, if data has been explored, the merged firm will then use all the available data to develop a product ( $d = 1$ ) and make monopoly profits equal to  $\pi^M(1, \theta)$ .

For ex-ante information sharing to create an option value, we assume that the industry profit is more significant under a merger than under competition only if there are high synergies, that is

$$(H5) \quad \begin{aligned} \text{Option value: } & \forall s, \pi^M(1, \bar{\theta}) > \pi^C(s, \bar{\theta}), \\ & \& \pi^M(1, \underline{\theta}) < \pi^C(s, \underline{\theta}). \end{aligned}$$

Hence, once information is shared, a merger will be profitable only when synergies are high, and information sharing will allow the firms to avoid mergers when synergies are low. Gaining this option is costly for firms because Firm 2 incurs the exploration cost  $C(s)$ , the industry competitive profits are reduced when information is shared, and synergies are low under (H3).

We now analyze how these different forces drive the decision of the firms to share and explore data before a merger or to merge under incomplete information about the value of synergies.

## Exploration Decision, M&A and Competitive Profits

**Firm 1 shares  $s$  and Firm 2 explores the data.** If Firm 1 has shared  $s$  data and Firm 2 opts for exploration, it incurs a cost equal to  $C(s)$ . After exploration, firms know the value of the synergies. Under Assumption (H5), firms are willing to merge when synergies are high (with prob.  $1 - \alpha$ ) and make profits equal to  $\pi^M(1, \bar{\theta})$ . If synergies are low (with prob.  $\alpha$ ), a merger is not profitable, and firms compete with a total industry profit equal to  $\pi^C(s, \underline{\theta})$ . Overall, the industry ex-ante profit, if  $s$  is shared before the merger and exploration happens, is

$$(1) \quad \Pi(s) := (1 - \alpha)\pi^M(1, \bar{\theta}) + \alpha \pi^C(s, \underline{\theta}) - C(s).$$

**Firms merge under imperfect information.** If a M&A takes place under incomplete information, the merged firm chooses whether it explores after the M&A and, in case of exploration, how much data it wants to explore.

Without exploration, the profits are independent of the level of synergy and equal to  $\pi^M(0, \bar{\theta}) =$

$\pi^M(0, \underline{\theta})$  (see H4). For simplicity, we assume in the main text that firms prefer competition over merging without exploring, so the competitive profits  $\pi^0$  are greater than  $\pi^M(0, \bar{\theta}) = \pi^M(0, \underline{\theta})$ .

$$(2) \quad \pi^0 \geq \pi^M(0, \bar{\theta}) = \pi^M(0, \underline{\theta}).$$

Such a case is relevant if the M&A induces high merger costs. Mergers without exploration can also yield higher profits than competition if the merger generates sufficient gains, a case that we consider in Section 5.1.

Thus, firms that merge under incomplete information explore the data after the M&A. In this case, the merged firm minimizes  $C(\cdot)$  by exploring all the available data and incurs a data exploration cost equal to  $C(1)$ . In turn, we have shown that the firm also develops a product using all the data after the merger ( $d = 1$ ), making profits equal to  $\pi^M(1, \bar{\theta})$  when synergies are high (with prob.  $\alpha$ ) and to  $\pi^M(1, \underline{\theta})$  when synergies are low (with prob.  $1 - \alpha$ ). Thus, the expected payoff of the industry if there is a merger under imperfect information and exploration is

$$\mathbb{E}[\pi^M(1, \theta)] - C(1),$$

where  $\mathbb{E}[\pi^M(1, \theta)] := (1 - \alpha)\pi^M(1, \bar{\theta}) + \alpha\pi^M(1, \underline{\theta})$ . Hence, a merger under incomplete information is beneficial only if

$$(3) \quad \mathbb{E}[\pi^M(1, \theta)] - C(1) \geq \pi^0.$$

A M&A is efficient for firms if condition (3) is satisfied and the expected payoff of a merger under imperfect information is more significant than total industry profits without information sharing. It is clear that without information, Firm 2 will acquire Firm 1 only when the M&A is ex-ante efficient.

## Discussion of the Assumptions

**Firms do not know the synergies ex-ante.** Our analysis relies on firms' uncertainty over merger outcomes. While companies such as Google and Facebook have a reasonable estimation of the type of data owned by other digital firms, we assume that they cannot anticipate perfectly the

synergies that will result from a merger between their data and those of another firm. Otherwise, a merger will only occur when synergies are high, a case we consider in our first-best analysis at the end of Section 3.3.

This assumption is relevant as companies may not know the quality of their data. For instance, Unity lost 110 million USD in 2022 after training AI algorithms on bad-quality data accessed through a client and integrated into its own data sets.<sup>7</sup>

**Lump sum transfer  $T(s)$ .** As mentioned earlier, Firm 2 can acquire a share  $s$  of the information of Firm 1 against a lump sum transfer  $T(s)$ . In practice, side payments to acquire another firm’s data occur routinely in data marketplaces (Spiekermann, 2019). In particular, Scaria, Berghmans, Pont, Arnaut and Leconte (2018) assesses data sharing between firms in various industries and shows how side payments for data acquisition have become common. The theoretical literature on information sharing between firms (Chen et al., 2001; Liu and Serfes, 2006; Choe et al., 2024) also classically considers side payments for data.

Contracting over a share of data  $s$  requires Firm 2 to know the total stock of data owned by Firm 1 or at least to have a reasonable estimation of this total amount of information. This is usually the case for digital firms that regularly disclose their number of users and for which data protection laws require consumers’ consent before collecting their data. For instance, a mobile application must ask for consumer approval before accessing specific sources of information, such as the microphone, camera, or specific folders, and before collecting the related data (Kesler, Kummer and Schulte, 2020; Affeldt and Kesler, 2021).

Overall, in digital M&As, firms now regularly assess which data their potential targets have access to and the size of their data stock. For instance, Facebook had a good idea of the size of the consumer base of WhatsApp and Instagram and of the type of data collected by the social media before initiating the M&As,<sup>8</sup> and similarly for Google before acquiring Fitbit.<sup>9</sup>

Nevertheless, as mentioned earlier, we can consider alternative scenarios in which data sharing occurs without side payments. For instance, we show in Section 5.2 that information sharing

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<sup>7</sup>The Impact of Bad Data and Why Observability is Now Imperative, IBM, June 2, 2022.

<sup>8</sup>See In One Chart, Here’s Why Facebook Is Blowing \$19 Billion On WhatsApp. Forbes, February 19, 2014.

<sup>9</sup>See Google closes \$2.1B acquisition of Fitbit as Justice Department probe continues. Fierce, January 14, 2021. In general, it is easy for a firm such as Google to reverse-engineer a Fitbit device, identify the different sensors and captors that collect data, and understand the type of data to which Fitbit has access.

can still happen without side payments when firms share the spoils from a merger according to a cooperative Nash bargaining game.

**Take-it-or-leave-it offer for the acquisition.** Firm 2 can acquire Firm 1 by doing a TIOLI offer. We will see that this bargaining mode yields an equilibrium amount of data shared that also maximizes industry profits. We analyze other distributions of bargaining power in Section 5.2. In particular, we will show that the amount of information shared by Firm 1 depends on the bargaining power of each firm and that a different bargaining power may impact the willingness of Firm 1 to share information and engage in a merger. Hence, the interactions of the firms at the time of the M&A - which firm makes the TIOLI offers and how is the surplus from the merger distributed among the firms - are not neutral and may impact the outcome of the game.

**Arrow effect.** The profits of Firm 2 increase when it receives more data from Firm 1, while those of Firm 1 decrease. In practice, receiving data allows a firm to personalize its product to customers' needs, improve recommendations, and optimize its advertising campaigns. In the quality competition framework that we analyze in the Appendix, data directly increases the product's quality and the consumers' utility to the detriment of the competitor.

The literature has shown that data sharing may increase or decrease the profits of firms that share information. For instance, information sharing can facilitate coordination between firms and increase the profits of the firm sharing its data. Nevertheless, sharing a valuable asset can reduce a firm's profits, as analyzed by Anton and Yao (2002). Vives (1984) and Gal-Or (1986) have also shown that firms may lose profits when sharing information on market demand or private cost structures with their competitors. If the first effect dominates, there is no tradeoff between the competitive loss and the merger gain, and our mechanism starts playing a role as long as the profits of Firm 1 decrease for a nontrivial set bounded above by one. For simplicity, we assume that the second effect dominates the first and that data sharing reduces the profits of Firm 1 for all values of  $s$ .

**Option value.** Depending on the value of synergies, the profit from a merger may be greater or lower than the total industry profits before the merger when firms compete. Hence, we focus on M&A, for which, absent information synergies, there is always a loss of value after the merger.

This does not rule out the possibility for the merger to generate other types of synergies, such as resulting from human resources management, the combination of patent portfolio, or R&D teams. Our baseline setting focuses on the case where the gains resulting from these other types of synergies are dominated by concomitant negative impacts of the merger on firms' activities.

For instance, in the case of digital products that intensively use consumer data, the developer's identity of a product is not neutral: a product developed by Google has the stamp "Google" on it; in particular, it inherits consumers' concerns about privacy. In the case of Google and Fitbit, the acquisition of Fitbit's data by Google has raised red flags among data protection agencies willing to protect consumer privacy, and many consumers were reluctant to have their health data acquired by a privacy-threatening firm like Google.

For this reason, when a company such as Google or Facebook acquires another digital firm, the profits of the merged entity can decrease overall despite other positive synergies. This loss also captures the costs firms incur when engaging in a M&A, and a merger may be detrimental to firms. A merger will yield a positive outcome only if the information synergies are high and dominate the total losses induced by the M&A.

**Divestment** The baseline model ignores the possibility of firms undoing the merger if they lose profits when they merge (see Condition 3). This is without loss of generality, as we show in Section 5.3, where we analyze the possibility of divestment.

Such divestments are usually costly to realize, as illustrated by the Nokia/Withings acquisition: Nokia bought Withings in 2016 – a company specialized in health wearables – and distributed watches under the Nokia name, but later divested at a loss; watches sold under the Withings name again.<sup>10</sup>

The acquisitions of WhatsApp and Instagram by Facebook and Fitbit by Google also highlight the difficulties firms face in undoing a merger in the presence of privacy concerns that play an important role in consumers' valuation of digital products. Such concerns could hardly be forgotten if, after the merger, synergies were low and firms were to separate their activities.<sup>11</sup>

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<sup>10</sup>Nokia is selling its digital health business back to the co-founder of Withings, [The Verge](#), May 2, 2018.

<sup>11</sup>See for instance 'Tossed my Fitbit in the trash': users fear for privacy after Google buys a company, [The Guardian](#), November 6, 2019.

### 3 Equilibrium Analysis

Given our assumption that both firms learn the level of synergy if there is exploration, the game is one of symmetric information. Our concept of equilibrium is subgame perfection, and as usual, we proceed backward in our analysis.

We first consider Firm 2, which has acquired data from Firm 1. We derive Firm 2's expected payoff and characterize the optimal amount of information acquired by Firm 2. We then provide conditions for information sharing to be the optimal strategy.

#### 3.1 Profits with Information Sharing

Suppose Firm 1 shares  $s$  with Firm 2, and Firm 2 agrees to pay  $T(s)$  to Firm 1 for this amount of data. Upon receiving  $s$ , Firm 2 can decide to invest  $C(s)$  to learn the value of synergies. In this case, the two firms anticipate payoffs  $\pi_i^C(s, \theta)$  if there is no M&A. In particular, Firm 1 makes expected profits when sharing  $s$  information equal to  $\mathbb{E}[\pi_1^C(s, \theta)] = (1 - \alpha)\pi_1^C(s, \bar{\theta}) + \alpha \pi_1^C(s, \underline{\theta})$ . According to the Arrow effect, Firm 1 incurs a competitive loss from sharing information, and Firm 2 pays  $T(s) = \pi_1^0 - \mathbb{E}[\pi_1^C(s, \theta)]$  to compensate for this loss and to acquire information  $s$ .

Upon exploring and learning the level of synergies, Firm 2 wants to merge only when synergies are high under Assumption (H5). In this case, Firm 2 can make a TIOLI offer to buy Firm 1's asset at a price  $\pi_1^C(s, \bar{\theta})$  that will make Firm 1 indifferent between merging and not merging.

**Lemma 1.** *Firm 2 pays  $T(s) = \pi_1^0 - \mathbb{E}[\pi_1^C(s, \theta)]$  for sharing  $s$ . If synergies are learned to be high, Firm 2 pays  $\pi_1^C(s, \bar{\theta})$  to acquire Firm 1.*

Firm 2 is willing to acquire information only if it can recoup the exploration cost  $C(s)$  and the price of information  $T(s)$ . We note  $u_2(s)$  the expected value of Firm 2 purchasing information  $s$  from Firm 1 and exploring, net of the no-sharing payoff  $\pi_2^0$ :

$$(4) \quad u_2(s) := \underbrace{(1 - \alpha)(\pi^M(1, \bar{\theta}) - \pi_1^C(s, \bar{\theta}))}_{\text{Firm 2's profits if } \bar{\theta} \text{ and firms merge}} + \underbrace{\alpha \pi_2^C(s, \underline{\theta})}_{\text{Firm 2's profits if } \underline{\theta}} - \underbrace{(\pi_1^0 - \mathbb{E}[\pi_1^C(s, \theta)])}_{\text{Price of data } T(s)} - \pi_2^0 - C(s) \\ = \Pi(s) - \pi^0$$

Hence, the value of ex-ante sharing will be to create an option for Firm 2 when making its merger

decision. It will be able to merge only when synergies are high, and the merger is efficient, thereby avoiding inefficient mergers when synergies are low.

Note that because Firm 2 makes TIOLI offers to Firm 1 when acquiring information and at the time of the merger, it captures all of the industry's profits. Hence, the optimal amount of information shared by Firm 1 will maximize  $u_2(\cdot)$  as well as the total industry's profits  $\Pi(\cdot)$ .

**Optimal amount of information shared.** An increase in the amount of information shared has two opposite effects on the expected profits of Firm 2. On the one hand, more information is costly to acquire from Firm 1. Under Assumption (H3),  $\frac{\partial \pi^C(s, \theta)}{\partial s} < 0$  and the potential gains for Firm 2 acquiring  $s$  information in the competition mode when synergies are low are always dominated by the loss of Firm 1, captured by transfer  $T(s)$ . To minimize this loss, Firm 2 needs to learn the value of synergies using the smallest possible information.

On the other hand, more information decreases the data exploration cost  $C(s)$ . Under (H1), using only a tiny share of data to learn the synergies induces a very high cost, which is not profitable for Firm 2. Overall, the optimal amount of information shared balances these two opposite effects of information acquisition on the profits of Firm 2, and the equilibrium amount of information shared by firms  $s^*$  satisfies

$$(5) \quad \alpha \frac{\partial \pi^C(s^*, \theta)}{\partial s} = C'(s^*).$$

For simplicity, we assume a unique  $s^*$  satisfies this condition. This is the case, for instance, when  $\pi^C(s, \theta)$  is quasi concave in  $s$ .

### 3.2 Equilibrium Information Sharing

There will be sharing of information if the maximal industry expected payoff when information is shared and explored before the merger  $\Pi(s^*)$  is greater than (i) the expected profits of merging under imperfect information with exploration and development after the merger  $\mathbb{E}[\pi^M(1, \theta)] - C(1)$  and (ii) the competitive profits of the firms  $\pi^0$ :

$$\Pi(s^*) \geq \max[\mathbb{E}[\pi^M(1, \theta)] - C(1), \pi^0].$$

The benefits of sharing information depend on the best alternative to sharing for the firms, i.e., merging under incomplete information or competing. If competition dominates a merger under incomplete information, sharing can allow M&As when synergies are high. If merging under incomplete information and exploring dominates competition, sharing allows the firms to avoid mergers when synergies are low.

Information sharing will be profitable if it yields a greater expected payoff than this best alternative. In the rest of this section, we first show that Firm 2's equilibrium profits with information sharing are always greater than those when merging under incomplete information. We then provide conditions for information sharing to dominate competition.

**Sharing information dominates merging under incomplete information.** Sharing information gives Firm 2 the option to avoid mergers when synergies are low, thereby yielding profits that are always greater than a merger under incomplete information. The exploration cost and competitive loss in case of low synergies resulting from information sharing are offset by the gains from merger avoidance in case of low synergies.

**Proposition 1.** *Information sharing and exploration are more profitable than merging under incomplete information and exploring.*

*Proof.* We can rearrange the expression of the expected profits of Firm 2 with information sharing (which are equal to those of the industry):

$$\Pi(s) = \mathbb{E}[\pi^M(1, \theta)] - C(1) + \underbrace{\alpha(\pi^C(s, \underline{\theta}) - \pi^M(1, \underline{\theta}))}_{\text{Gains from merger avoidance if } \underline{\theta} > 0 \text{ (H5)}} + \underbrace{C(1) - C(s)}_{\text{Increased exploration cost from partial access to data, } < 0 \text{ (H1)}}$$

From (4), we know that the equilibrium amount of information shared  $s^*$  maximizes  $\Pi(s)$ . Hence, necessarily,  $\Pi(s^*) \geq \Pi(1) > \mathbb{E}[\pi^M(1, \theta)] - C(1)$ .  $\square$

Proposition 1 shows that, by sharing information and learning the value of synergies before the M&A, firms can always do better than merging under incomplete information and exploring the data. This is because the benefit of having the option not to merge when synergies are low is first order, while the incremental competitive and exploration costs when partial sharing is second order. This suggests that M&As under incomplete information do not occur as long as

firms can share information and learn the value of synergies. In other words, in our model, if a merger takes place, firms necessarily shared information before the merger and did not make their merger decision under incomplete information.

**Merging vs. competing.** While industry profits  $\pi^0$  are independent from the degree of uncertainty of the synergies before the merger, this is not the case for  $\mathbb{E}[\pi^M(1, \theta)] - C(1)$  and  $\Pi(s)$ , which depend non trivially on the value of  $\alpha$ .

In particular,  $\mathbb{E}[\pi^M(1, \theta)] - C(1)$  and  $\Pi(s)$  are the highest when  $\alpha$  is equal to zero, in which case they both are equal to  $\pi^M(1, \bar{\theta}) - C(1)$ .<sup>12</sup> Therefore, a necessary condition for a merger to take place is

$$(6) \quad \pi^M(1, \bar{\theta}) - C(1) \geq \pi^0.$$

Otherwise, firms always prefer competition to mergers and to sharing information.

When  $\alpha$  increases, the probability of low synergies becomes higher and  $\mathbb{E}[\pi^M(1, \theta)] - C(1)$  and  $\Pi(s)$  decrease. In the limit case where  $\alpha = 1$ , (H3) and (H5) ensure that a merger is never profitable and firms always compete.

Hence, under condition (6), there exist  $\alpha_1$  and  $\alpha_2$ , with  $0 < \alpha_1 < \alpha_2 < 1$  such that firms share information before the merger if and only if  $\alpha \leq \alpha_2$ . When  $\alpha$  is smaller than  $\alpha_1$ , sharing information dominates merging under incomplete information and exploring which constitutes the best outside option. In this case, information sharing allows firms to avoid mergers when low synergies exist. When  $\alpha_1 < \alpha < \alpha_2$  sharing information dominates competition and will enable M&As to take place when synergies are high. When  $\alpha$  is greater than  $\alpha_2$ , firms compete. Figure 2 illustrates these results, with the thick line representing the equilibrium expected profits of the industry.

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<sup>12</sup>When  $\alpha = 0$ ,  $\Pi(s)$  is equal to  $\pi^M(1, \bar{\theta}) - C(\cdot)$ . The firms share all the data ( $s^* = 1$ ) and incur an exploration cost equal to  $C(1)$ , so that  $\Pi(1)$  in this case is equal to  $\pi^M(1, \bar{\theta}) - C(1)$ .

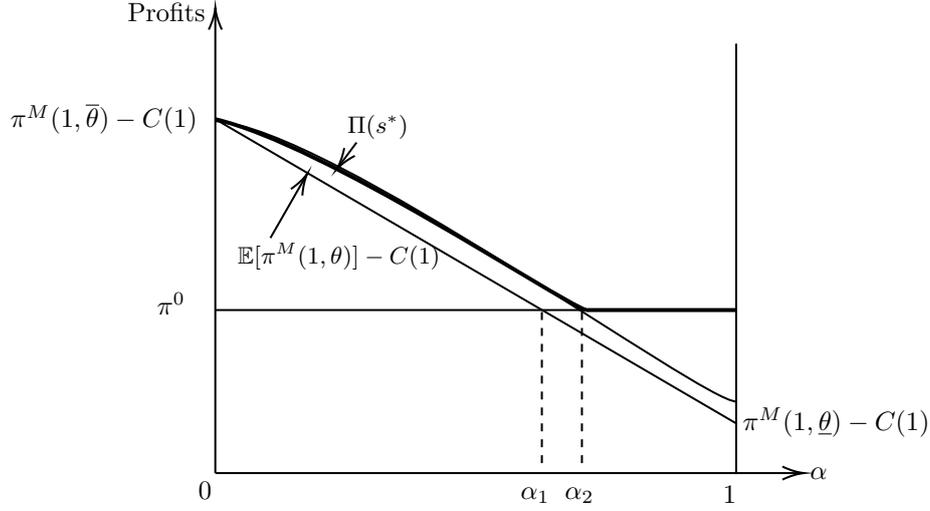


Figure 2: Equilibrium profits.

This intuition is formally established in the following proposition.

**Proposition 2.**

- (i) *There is information sharing only if  $\pi^M(1, \bar{\theta}) - C(1) \geq \pi^0$ .*
- (ii) *Under this condition, there exist  $\alpha_1$  and  $\alpha_2$ , with  $0 < \alpha_1 < \alpha_2 < 1$  such that:*
  - *information sharing happens if, and only if,  $\alpha \leq \alpha_2$ ,*
  - *sharing prevents firms from merging when synergies are low if  $\alpha \leq \alpha_1$  and allows mergers to occur when synergies are high if  $\alpha \in (\alpha_1, \alpha_2]$ .*

Proposition 2 shows that firms can benefit from information sharing even if they have an excellent estimate ( $\alpha$  close to one or zero.) In particular, when  $\alpha$  is close to zero, sharing almost all data is the optimal strategy because the probability of firms competing is low (see (5)). While merging under incomplete information dominates competition when  $\alpha$  is close to zero, sharing and exploring information gives the option not to merge when synergies are low at a small incremental cost for exploration (since  $s^*$  is close to one.)

### 3.3 Efficiency Benchmarks

We can understand the implications of uncertainty over merger outcomes by considering a benevolent planner controlling the firms' sharing and merging decisions to maximize the industry's profits.

**Second-best analysis.** Consider first a planner with the same (incomplete) information as the firms before the M&A occurs. We have shown that Firm 2 chooses an amount of information that maximizes industry profits. Hence, the amount of information firms share coincides with the second-best planner optimum when synergies are unknown ex-ante.

**First-best analysis.** When the planner has complete information on the value of synergies ex-ante, information sharing does not occur before the M&A and the planner has the firms merge only when synergies are high. Overall, the planner's industry's profits with complete information at the beginning of the game  $\Pi^P$  are equal to

$$\Pi^P = (1 - \alpha)(\pi^M(1, \bar{\theta}) - C(1)) + \alpha \pi^0.$$

We can compare this first-best profit with the second-best outcome:

$$\Pi(s^*) - \Pi^P = \alpha(\pi^C(s^*, \underline{\theta}) - \pi^0) - C(s^*) + (1 - \alpha)C(1).$$

Firms can learn the value of the synergies by exploring data before the merger, but this generates three types of inefficiencies. First, because data is explored before synergies are learned, the firms pay the exploration cost even when synergies are low. This is not the case in the first-best outcome, where  $C(1)$  is incurred only when synergies are high to enable the further use of data for the development of the product (as we have assumed that exploring the data is a precondition for further product development). Secondly, according to the Arrow effect, competitive profits are lower if information is shared when synergies are low. There is too much information shared compared to the first-best outcome, according to this inefficiency. Thirdly, only a portion of Firm 1's data is used for exploration in the second-best scenario, increasing the exploration cost. Hence, too little information is shared compared to the first-best outcome according to this last

inefficiency.

We have focused our discussion on a planner maximizing the industry's profits. Yet, in the case of M&As, competition authorities are typically involved in decisions protecting social welfare, and they do not focus on the industry's profits but on consumer surplus. In the following section, we analyze such a competition authority that can allow or block mergers and regulate information-sharing practices among firms.

## 4 Information Sharing in the Shadow of a Regulator

We introduce a competition authority in charge of allowing or preventing the M&A. The authority's decision depends on the impacts of the M&A on consumers, and on principle, a M&A can go through only if it increases consumer surplus. This starting point aligns with current merger guidelines in the US ([Wilson, 2019](#)) and with the doctrine of competition authorities in Europe, which focus on protecting consumer surplus when assessing the impacts of a merger.

From a theoretical perspective, this representation of the authority raises two issues that are at odds with actual market practices. On the one hand, as changes in consumer surplus are known to firms, they would not ask for a merger that will be denied. Yet, some M&A are blocked by competition authorities, highlighting that firms face uncertainty before requesting approval. On the other hand, even if regulators should focus on consumer surplus on principle, their ultimate decision may reflect different political or economic considerations ([Hovenkamp, 2012](#)).<sup>13</sup>

We model this by distinguishing between the authority, such as the DG Competition in Europe, and its regulatory agents (or regulators), for instance, the various teams in charge of M&A review. The authority has for principles to protect consumer surplus. Still, a regulator who decides to block a M&A may also include changes in industry profits in its overall assessment of variations in welfare due to the M&A. For example, each agent can be subject to greater or lesser intense lobbying or have a biased case analysis, affecting their final decision.

In the spirit of [Baron and Myerson \(1982\)](#), we assume that the regulator maximizes a welfare

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<sup>13</sup>For instance, the recent decision of the European Commission to prevent the merger between Alstom and Siemens was made in the shadow of intense political lobbying by the French and German governments, and many factors, beyond consumer surplus, were considered by the commission ([Vestager should stand against Siemens-Alstom M&A](#); [Financial Times, January 17, 2019](#).)

function that balances industry profits and consumer surplus. We denote by  $\rho \in [0, 1]$  the weight the agents place on consumer surplus and by  $1 - \rho$  the weight placed on industry profits. This welfare function includes as a special case regulators that are entirely oriented towards consumers when  $\rho = 1$ .

We bring uncertainty over the final regulator's decision by assuming that firms do not know the value of  $\rho$  before sharing information and requesting M&A approval.<sup>14</sup> After firms have asked for a review of the merger, the type of regulator is drawn from the distribution  $F(\rho)$ , and the regulator makes a decision.

This assumption seems empirically relevant and highlights the possibility that the merging parties may not perfectly anticipate the regulators' decisions. It would be otherwise difficult to understand why the parties (and antitrust authorities) go through a complicated and costly merger approval process with a certain outcome. Note that this model is isomorphic to a setting in which the bias of the regulatory agent is public knowledge (and with  $\rho = 1$ ) but where there is noise on a per-case basis.<sup>15</sup>

**Consumer surplus.** Without sharing or exploration,  $CS^0$ , and  $CS^M$  denote the consumer surplus when the firms compete and when there is a merger. If exploration and development occur, consumer surplus is a function of the synergies  $\theta$ .  $CS^C(d, \theta)$  and  $CS^M(d, \theta)$  are the consumer surpluses when a portion  $d$  of data is used for development when firms compete and when there is a merger.

As shown in the previous section, if there is exploration, it is optimal for the merged entity to develop a new product using all available data of Firm 1. In this case, the firms and the regulator, therefore, anticipate that a merger will yield a consumer surplus of  $CS^M(1, \theta)$  when synergies are known to be  $\theta$  or  $(1 - \alpha)CS^M(1, \bar{\theta}) + \alpha CS^M(1, \underline{\theta})$  if synergies are unknown. When a portion  $s$  of data has been shared, and firms compete in state  $\theta$ , consumer surplus will equal  $CS^C(s, \theta)$ .

We assume that consumer surplus under competition increases with the amount of informa-

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<sup>14</sup>Note that our main qualitative takeaway regarding the impact of the regulator on the amount of information shared by firms and the resulting implications for consumer surplus would hold if firms had perfect information on  $\rho$  at the time they share information. A detailed resolution is available upon request.

<sup>15</sup>We thank a referee for this alternative interpretation.

tion shared (and developed) and that a merger harms consumers.

$$(H6) \quad \text{Consumer surplus: for all } (s, \theta), \frac{\partial CS^C(s, \theta)}{\partial s} \geq 0, \text{ and } CS^C(s, \theta) > CS^M(1, \theta).$$

Assumption (H6) is consistent with a narrative where consumers benefit from a better product quality sold by Firm 2 and a higher intensity of competition between firms when  $s$  increases. When firms merge, Assumption (H6) implies that the reduction of competition dominates the potential increase of product quality for the merged firm, which is detrimental to consumers.

As industry profits increase when firms merge, a regulator would always allow the merger if consumers were to also benefit from it. Assumption (H6) ensures that a regulator has incentives to block the merger.

#### 4.1 The Ambiguous Effect of a Regulator on Information Sharing

While synergies can arise during the M&A process, they can also be realized under competition when Firm 2 exploits the data provided by Firm 1. Positive synergies create a two-edged sword for the regulator because welfare can increase both under M&A *and* under competition. Consumers benefit if the regulator prevents the M&A, as firms compete more fiercely after sharing information. Therefore, when evaluating a M&A proposal, the regulator will compare the relative industry gain weighted by  $1 - \rho$  to the relative loss of consumer surplus weighted by  $\rho$ .

**M&A decision without information sharing.** Without information sharing, the regulator and the firms have a common interest if the merger increases the expected consumer surplus. In this case, firms ask for approval when the merger yields positive expected gains for the industry, and the regulator always allows a merger to go through. If the merger reduces the expected consumer surplus, the regulator's decision balances the expected loss of surplus, denoted by  $L$ , and the expected gains in terms of industry profits, denoted by  $G$ . Overall, the regulatory welfare

gain from the M&A, denoted by  $W^M(\rho)$  for a regulator of type  $\rho$ , is:

$$(7) \quad W^M(\rho) := (1 - \rho) \underbrace{((1 - \alpha)\pi^M(1, \bar{\theta}) + \alpha \pi^M(1, \underline{\theta}) - C(1) - \pi^0)}_{\text{Industry gains } G} + \rho \underbrace{((1 - \alpha)CS^M(1, \bar{\theta}) + \alpha CS^M(1, \underline{\theta}) - CS^0)}_{\text{Loss of surplus } L}.$$

The regulator allows the M&A when this welfare function is greater than zero. Hence, a threshold exists  $\rho^* = \frac{G}{G-L}$  such that the regulator authorizes the M&A if, and only if,  $\rho \leq \rho^*$ . The probability that a M&A is approved equals  $F(\rho^*)$ .

**M&A decision with information sharing.** At the time the regulator has to evaluate a M&A, Firm 1 has already shared  $s$  with Firm 2. Hence, the exploration cost  $C(s)$  is sunk, and both firms know the value of  $\theta$ . Firms request M&A approval if synergies are high, and the regulator can infer the value of  $\theta$  from their M&A request.

Firm 2 asks for merger approval only when  $\theta = \bar{\theta}$ , and the industry gain if the M&A is allowed is  $G(s) = \pi^M(1, \bar{\theta}) - \pi_1^C(s, \bar{\theta}) - \pi_2^C(s, \bar{\theta})$ .<sup>16</sup> The difference in consumer surplus after and before the merger is equal to  $L(s) = CS^M(1, \bar{\theta}) - CS^C(s, \bar{\theta})$  and depends on the amount of data shared  $s$ . Under Assumption (H6), this difference is always negative, and the merger is detrimental to consumers.

Hence, the regulator balances the gains in industry profits and the surplus losses when making its merger approval decision. Overall, the regulatory welfare gain from the M&A denoted by  $W^M(\rho, s)$  for a regulator of type  $\rho$  when  $s$  information is shared is:

$$(8) \quad W^M(s, \rho) := (1 - \rho) \underbrace{(\pi^M(1, \bar{\theta}) - \pi^C(s, \bar{\theta}))}_{\text{Industry gains } G(s)} + \rho \underbrace{(CS^M(1, \bar{\theta}) - CS^C(s, \bar{\theta}))}_{\text{Surplus loss } L(s)}.$$

By (H5),  $G(s) > 0$  so that Firm 2 is willing to merge, and by (H6),  $L(s) < 0$  so that the merger reduces consumer surplus and may be blocked by the regulator depending on the value of  $\rho$ .

At the time Firm 2 acquires information,  $\rho$  is unknown by firms, and firms share information before the merger, accounting for the resulting expected impact on the regulator's decision.

<sup>16</sup>Here again Firm 2 develops the product using all the available data.

**Lemma 2.** *Letting*

$$(9) \quad \rho^*(s) = \frac{G'(s)}{G(s) - L(s)},$$

*the regulator authorizes the M&A if, and only if,  $\rho \leq \rho^*(s)$ . Hence, the probability of a M&A is  $F(\rho^*(s))$ .*

Simple computations show that  $\rho^*(s)$  increases with  $s$  only if  $\frac{L'(s)}{L(s)} > \frac{G'(s)}{G(s)}$ , that is when the loss elasticity is greater than the gain elasticity with respect to  $s$ . Under (H6),  $L'(s)$  is negative and  $\rho^*(s)$  increases only if  $G'(s)$  is negative too. As more information shared benefits consumers when firms compete, industry profits under competition with high synergies must also decrease for information sharing to increase the chances for the merger to go through.

When  $\frac{L'(s)}{L(s)} < \frac{G'(s)}{G(s)}$ , the probability  $F(\rho^*(s))$  that a M&A is allowed decreases with  $s$ . Companies compete more fiercely when more information is shared, which benefits consumers, and this effect always dominates the increased industry gains from a merger. The opportunity cost of a M&A is thus higher for higher values of  $s$ , and a M&A is beneficial only if  $\rho$  is large enough.

Consequently, with the presence of the regulator, the expected payoff of Firm 2, net of the no-sharing payoff  $\pi_2^0$ , when purchasing information  $s$  from Firm 1 is denoted  $u_2^R(s)$  and equal to:

$$(10) \quad u_2^R(s) = (1 - \alpha) \left[ F(\rho^*(s)) \underbrace{(\pi^M(1, \bar{\theta}) - \pi^0)}_{\text{Industry gains if the merger is approved}} + (1 - F(\rho^*(s))) \underbrace{(\pi^C(s, \bar{\theta}) - \pi^0)}_{\text{Industry profit change if the merger is blocked}} \right] \\ + \alpha \underbrace{(\pi^C(s, \underline{\theta}) - \pi^0)}_{\text{Competitive loss if } \underline{\theta}}$$

While it is immediate that Firm 2's expected payoff is reduced in the presence of a regulator, it does not follow that the marginal incentives for information sharing decrease. Using (1) and

(10), we can write for  $s \in [0, 1]$ :

$$(11) \quad \begin{aligned} u_2^R(s) &= u_2(s) - (1 - \alpha)K(s) \\ \text{where } K(s) &:= (1 - F(\rho^*(s))) \underbrace{(\pi^M(1, \bar{\theta}) - \pi^C(s, \bar{\theta}))}_{\substack{\text{Industry profit loss} \\ \text{from merger prevention}}} \end{aligned}$$

where  $u_2(s)$  is the value from sharing  $s$  information for Firm 2 when there is no regulator (see (1)). Let  $s^R$  be the equilibrium amount of data shared by the firms with regulatory oversight, that is  $s^R := \operatorname{argmax} u_2^R(s)$ .<sup>17</sup> Because  $u_2(s^R)$  has the same variation as  $K(s^R)$ , and we have assumed that  $u_2(s)$  is single-peaked, there is less information sharing without than with regulation if, and only if,  $K(s^R)$  has negative variation, that is when:

$$(Hazard) \quad \rho^{*'}(s^R) \frac{f(\rho^*(s^R))}{1 - F(\rho^*(s^R))} > \frac{G'(s^R)}{G(s^R)}.$$

**Proposition 3.** *Companies exchange more information under regulatory oversight if and only if condition (Hazard) holds.*<sup>18</sup>

The firms' decisions to share more or less information in the presence of the regulator will depend on the impact of information sharing on the industry's competitive payoffs when synergies are high and on the likelihood that the regulator accepts the merger. A comparative static analysis is complex because  $s^R$  depends on  $F$ . However, as we show in Appendix C, we can understand the intuition behind condition (Hazard) by considering the variations of the functions  $G(s)$  and  $\rho^*(s)$  at  $s^R$ .

Firms can increase competitive profits when synergies are high as well as the likelihood that the merger is accepted by sharing: (i) more information when  $G(s^R)$  is decreasing and  $\rho^*(s^R)$  increasing with  $s$ ; (ii) less information when  $G(s^R)$  is increasing and  $\rho^*(s^R)$  decreasing with  $s$ . In the former case, condition (Hazard) is always satisfied, while it does not hold in the latter case.

<sup>17</sup>Note that there can be multiple optimal amounts of information shared when there is a regulator.

<sup>18</sup>When  $F$  is the uniform distribution, we can rewrite the (Hazard) condition as  $\frac{L'(s^R)}{L^2(s^R)} > \frac{G'(s^R)}{G^2(s^R)}$  which is equivalent to  $\left(\frac{1}{L(s^R)}\right)' < \left(\frac{1}{G(s^R)}\right)'$ .

When the functions  $G(s)$  and  $\rho^*(s)$  decrease at  $s^R$ ,<sup>19</sup> firms balance changes in the likelihood that the merger is accepted and variations in the industry's competitive profits when synergies are high. More information is shared when condition (Hazard) holds, as it ensures that the loss from a reduced probability of merger is dominated by the gains in competitive profits when synergies are high. Otherwise, the profit loss in case of merger denial is dominated by increased chances of approval.

## 4.2 The Impact of the Regulator on Consumer Surplus

Even though the regulator may account for variations in industry profits when making its merger review, we have assumed that the authority only cares about consumer surplus. Because the authority is uncertain about the decision of the regulators to allow or prevent the merger ex-post, surplus with information sharing depends on the probability that the merger will be authorized. Therefore, the expected welfare of the *authority* when firms share  $s^R$  information, denoted by  $W^A(s^R)$ , is equal to

$$(12) \quad W^A(s^R) = (1 - \alpha) \underbrace{[F(\rho^*(s^R)) CS^M(1, \bar{\theta})]}_{\substack{\text{Surplus if } \bar{\theta} \\ \& \text{ M\&A approved}}} + \underbrace{(1 - F(\rho^*(s^R))) CS^C(s^R, \bar{\theta})}_{\substack{\text{Surplus if } \bar{\theta} \\ \& \text{ M\&A blocked}}} + \alpha \underbrace{CS^C(s^R, \underline{\theta})}_{\text{Surplus if } \underline{\theta}}$$

Firms share  $s^*$  information without regulatory oversight, and the merger is accepted. This yields welfare that we denote by  $W^{no}$  and equal to

$$W^{no} = (1 - \alpha) CS^M(1, \bar{\theta}) + \alpha CS^C(s^*, \underline{\theta})$$

We can assess the impact of regulatory oversight on welfare by comparing both functions:

$$(13) \quad W^A(s^R) - W^{no} = (1 - \alpha) \underbrace{(1 - F(\rho^*(s^R))) (CS^C(s^R, \bar{\theta}) - CS^M(1, \bar{\theta}))}_{\substack{\text{Welfare gains from} \\ \text{M\&A control} > 0}} + \alpha \underbrace{(CS^C(s^R, \underline{\theta}) - CS^C(s^*, \underline{\theta}))}_{\substack{\text{Variations of surplus} \\ \text{from changes in } s}}$$

<sup>19</sup>Note that, as explained in Appendix C, the definition of  $\rho^*(s)$  precludes the case where  $G(s)$  and  $\rho^*(s)$  increase at  $s^R$ .

While consumer surplus increases with merger control, regulatory oversight does not necessarily benefit consumers overall, as firms may share more or less information in the regulator's presence.

**Firms share more information with the regulator.** When (Hazard) is satisfied, more information is shared, and consumer surplus is higher when synergies are low, and firms compete under Assumption (H6),  $CS^C(s^R, \underline{\theta}) \geq CS^C(s^*, \underline{\theta})$ . This positive effect adds up to the surplus gain from merger control, and overall, the presence of the regulator yields a higher consumer surplus than in a laissez-faire situation.

**Firms share less information with the regulator.** If we are outside the scope of the (Hazard) condition, the presence of a regulator lowers the incentives of Firm 2 to acquire information, and regulatory oversight has ambiguous effects on consumer surplus compared to a laissez-faire policy.

On the one hand, less information sharing reduces consumer surplus when synergies are low, and  $CS^C(s^R, \underline{\theta}) < CS^C(s^*, \underline{\theta})$ . On the other hand, by preventing some mergers from going through, the regulator increases the expected consumer surplus when synergies are high. Whether the overall impact of regulatory oversight on welfare is positive depends on the magnitude of these effects. The presence of the regulator increases consumer surplus if and only if the gains from merger control dominate the loss from less information sharing:

$$(14) \quad (1 - \alpha)(1 - F(\rho^*(s^R)))(CS^C(s^R, \bar{\theta}) - CS^M(1, \bar{\theta})) > \alpha (CS^C(s^R, \underline{\theta}) - CS^C(s^*, \underline{\theta})).$$

For instance, in the limit case where  $CS^C(s^R, \bar{\theta})$  is close to  $CS^M(1, \bar{\theta})$ , this inequality is not satisfied, and the gains from merger control are dominated by the loss of surplus when synergies are low. In this case, the presence of the regulator reduces the expected consumer surplus. Proposition 4 summarizes this discussion.

**Proposition 4.** *Suppose that information sharing is profitable. Then, the presence of the regulator increases the expected consumer surplus if condition (Hazard) holds. Otherwise, the expected consumer surplus decreases if the loss from less information sharing is greater than the gain from merger control.*

### 4.3 Regulating Pre-M&A Information Sharing

Another tool for the regulatory authority is to allow or prevent Firm 2 from purchasing information from Firm 1. Contrary to M&A reviews and approval, the decision to allow or avoid sharing information is not case-specific but holds for all industries.

Without information sharing, consumer surplus depends on firms' merger decisions. If firms choose to compete, consumer surplus is equal to  $CS^0$ . If firms merge under incomplete information, the expected consumer surplus depends on the realization of synergies and is equal to  $\alpha CS^M(1, \underline{\theta}) + (1 - \alpha)CS^M(1, \bar{\theta})$ . If the surplus increases with a M&A, the merger is approved. Otherwise, we have shown in (7) that without information sharing, the probability that the merger is approved is equal to  $F(\rho^*)$  with  $\rho^* = \frac{G}{G-L}$ . We focus on this second case, and the welfare function of the authority without sharing, denoted by  $W^A$ , depends on  $F(\rho^*)$  and is equal to

$$(15) \quad W^A = F(\rho^*) [(1 - \alpha)CS^M(1, \bar{\theta}) + \alpha CS^M(1, \underline{\theta})] + (1 - F(\rho^*))CS^0.$$

Hence, a regulator allows firms to share information when the expected welfare  $W^A(s^R)$  defined in (12) is greater than without information sharing.

$$(16) \quad \begin{aligned} W^A(s^R) - W^A = & (1 - \alpha) \overbrace{[F(\rho^*(s^R)) - F(\rho^*)]}^{\text{Change in prob. of M\&A approval}} CS^M(1, \bar{\theta}) \\ & + (1 - \alpha) \underbrace{[(1 - F(\rho^*(s^R)))CS^C(s^R, \bar{\theta}) - (1 - F(\rho^*))CS^0]}_{\text{Surplus change if } \bar{\theta} \text{ \& M\&A blocked}} \\ & + \alpha \underbrace{[CS^C(s^R, \underline{\theta}) - CS^0]}_{>0 \text{ (H6)}} + \alpha F(\rho^*) \underbrace{[CS^0 - CS^M(1, \underline{\theta})]}_{>0 \text{ (H6)}} \end{aligned}$$

We can illustrate the ambiguous effects of information sharing on consumer surplus by considering the limit case where  $\alpha$  is close to zero. Consider first the case where  $\rho^*(s^R) = \rho^*$  so that information sharing does not change the probability that the M&A will be blocked. Allowing firms to share information increases consumer surplus when firms compete, so the expected welfare, in this case, is greater than without information sharing.

Conversely, consider then the special case where  $CS^C(s^R, \bar{\theta}) = CS^0$ , so that the welfare gain is equal to  $(F(\rho^*(s^R)) - F(\rho^*))(CS^M(1, \bar{\theta}) - CS^0)$ . We have shown after Lemma 2 that  $\rho^*(s^R)$  can increase or decrease depending on the relative variations of the industry competitive payoff and consumer surplus when synergies are high. Hence, if  $F(\rho^*(s^R)) > F(\rho^*)$ , welfare is lower when firms can share information.

For general values of  $\alpha$ , a knife-edge case is when the regulators represent the authority so that  $\rho = 1$ . The welfare difference is positive in this case, and information sharing increases consumer surplus.

**Proposition 5.** *As  $\rho$  gets close to 1, authorizing information sharing is weakly optimal for the regulator. It is strictly optimal if firms choose to share information when they can.*

A regulator strongly oriented toward consumer surplus sees information-sharing practices keenly, leading to a higher consumer surplus if the M&A is prevented. However, we have seen that Firm 2's expected payoff decreases when the regulator can prevent some M&As from going through. Indeed, information sharing when the merger is blocked with a probability close to 1 yields industry's profits equal to

$$(1 - \alpha)\pi^C(s, \bar{\theta}) + \alpha \pi^C(s, \underline{\theta}) - C(s)$$

These profits are smaller than those without control  $\Pi(s^*)$ , so there is a range of values of  $\alpha$  below  $\alpha_2$  such that the presence of the regulator discourages firms from sharing information. This implies that a strong regulator bias toward consumer surplus can prevent companies from sharing information and firms prefer to compete or merge under imperfect information.

#### 4.4 Mandated Data Sharing

Recent policies, such as the Data Act in Europe, have aimed at regulating information-sharing practices among firms.<sup>20</sup> Here, we consider an authority controlling the amount of information firms share. This authority will chose  $s$  to maximize  $W^A(s)$  defined in (12).

A direct consequence of the authority having control over the information shared by the firms is that it can avoid the welfare losses resulting from changes in the amounts of information shared

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<sup>20</sup>Data Act, December 22, 2023.

by firms in the presence of regulatory oversight. Consider indeed (13): by mandating firms to share  $s^*$ , the regulator can ensure that welfare with merger control and mandated data sharing is greater than welfare in a laissez-faire situation.

Moreover, when the probability that the merger is approved  $\rho^*(s)$  decreases with  $s$ , we can show that the authority forces firms to share all their available information before the merger. Indeed, under (H6)  $CS^C(s, \underline{\theta})$  and  $CS^C(s, \bar{\theta})$  increase with  $s$ , so full data sharing yields the highest consumer surplus and maximizes the chances that the merger will be blocked by the agents in charge of its review, to the benefit of consumers.

**Proposition 6.** *Regulatory oversight, merger control, and a mandated data-sharing policy yield a greater consumer surplus than a laissez-faire situation.*

*When  $\rho^*(s)$  decreases with  $s$ , a mandated data-sharing policy enforcing full information sharing ( $s = 1$ ) maximizes consumer surplus.*

When  $\rho^*(s)$  increases with  $s$ , mandated data sharing increases consumer surplus but reduces the probability that the regulator will block the merger. The equilibrium amount of mandated data sharing balances these two opposite effects.

## 4.5 Merger Remedy: Data Silos

In recent flagship M&As such as Facebook/WhatsApp and Google/Fitbit, the European Commission implemented a new type of merger remedy, allowing the M&As to go through but preventing the combination of data sources from the merging parties (Krämer et al., 2021). The rationale behind such data silos is to allow for the positive effects of a merger unrelated to data, such as efficiency gains or the complementarity of the companies' patent portfolios, while preventing potential negative impacts of data-driven effects. The latter usually relate to privacy issues and increased market power resulting from the merger of data sources.

We consider such data silos and analyze whether they increase or decrease the willingness of companies to share their data. We introduce an exogenous probability  $\gamma$  under which the data sources of firms cannot be merged in case the M&A goes through, and the merging firm cannot fully benefit from the resulting synergies. Consequently, a M&A with data silos is motivated only by reduced competition, and  $\pi^M(s, \bar{\theta})$  are the profits after the merger when data silos are

requested.

Another option for the regulator is to block the merger when synergies are high. To simplify, this probability is fixed and does not vary with  $s$  and is known to be  $\psi \in [0, 1]$ , corresponding to  $1 - F(\rho)$  in our previous notations.

With probability  $(1 - \gamma)(1 - \psi)$  firms merge and make a profit equal to  $\pi^M(1, \bar{\theta})$ ; with probability  $\gamma(1 - \psi)$ , firms merge, but data remain separate, and the only synergies that take place are those resulting from the data shared before the M&A, yielding industry profits equal to  $\pi^M(s, \bar{\theta})$ . Therefore, Firm 2 is still interested in acquiring Firm 1 in the case of high synergies. With probability  $(1 - \alpha)\psi$ , there are high synergies, but the merger is blocked. Hence, the expected gains of Firm 2, denoted by  $u_2^{silo}$ , are equal to:

$$\begin{aligned}
 (17) \quad u_2^{silo}(s) &= (1 - \alpha)(1 - \psi) \left[ \underbrace{(1 - \gamma)\pi^M(1, \bar{\theta})}_{\text{Profits if M\&A without silos}} + \underbrace{\gamma \pi^M(s, \bar{\theta})}_{\text{Profits if silos requested}} \right] \\
 &\quad + (1 - \alpha)\psi \pi^C(s, \bar{\theta}) + \alpha \pi^C(s, \underline{\theta}) - \pi^0 - C(s) \\
 &= u_2^R(s) - (1 - \alpha)(1 - \psi)\gamma [\pi^M(1, \bar{\theta}) - \pi^M(s, \bar{\theta})]
 \end{aligned}$$

where  $u_2^R(s)$  is defined in (10).

The main lesson here is that, for a fixed  $\psi$ , data silos increase the incentives of Firm 2 to acquire information because, according to (H4)  $\pi^M(s, \bar{\theta})$  increases with  $s$ . While the firms' incentive to share information increases, their expected payoff decreases when the probability of a data silo remedy increases.

**Proposition 7.** *For a fixed probability of blocking a merger under high synergies, a silo remedy will increase information sharing.*

## 5 Extensions

In this section, we consider several extensions of the baseline model. As in the basic model, we do not explicitly introduce a regulator in these extensions, but it should be clear that the qualitative effects identified in Section 4 will be similar.<sup>21</sup>

<sup>21</sup>This also corresponds to the case where the regulator is entirely oriented toward the industry ( $\rho = 0$ ).

In Section 5.1, we consider mergers under incomplete information when firms do not explore the data after the merger. We analyze Nash bargaining on the final value of the M&A in Section 5.2 and consider the possibility of divestment after a M&A in Section 5.3.

## 5.1 Mergers Under Incomplete Information without Exploration

In the baseline model, we have focused on competitive profits  $\pi^0$  greater than those in the case of the merger without exploration. This situation arises whenever there is a negative brand image of Firm 2 or organizational inefficiencies post-merger, which may negatively impact profits for the merged entity.

Nevertheless, the usual effect of “avoidance of competition” suggests that even without further synergies, profits in a merger without exploration can be larger than under competition. In some cases, the literature on killer acquisitions has even highlighted the benefits for a firm to acquire a rival and shut down its activities (Cunningham, Ederer and Ma, 2021; Cabral, 2021).

In this case, the alternative to sharing information or merging and exploring is for firms to merge without examining the data. Considering this alternative outside option, the qualitative insights derived in the baseline model remain unchanged. While profits in case of merger without exploration (equal to  $\pi^M(0, \bar{\theta}) = \pi^M(0, \underline{\theta})$ ) are independent of the degree of uncertainty of the synergies before the merger, we have already shown how  $\mathbb{E}[\pi^M(1, \theta)] - C(1)$  and  $\Pi(s)$  depend on  $\alpha$ .

Thus, similarly to (6), a necessary condition for exploration to be profitable – either with information sharing or after a merger under incomplete information – is therefore

$$(18) \quad \pi^M(1, \bar{\theta}) - C(1) \geq \pi^M(0, \bar{\theta}) = \pi^M(0, \underline{\theta}).$$

Otherwise, firms always prefer to merge without exploring rather than exploring the data and benefiting from positive synergies.

Hence, under condition (6), there exist  $\hat{\alpha}_1$  and  $\hat{\alpha}_2$ , with  $0 < \hat{\alpha}_1 < \hat{\alpha}_2 < 1$  such that firms share information before the merger if and only if  $\alpha \leq \hat{\alpha}_2$ . For  $\alpha < \hat{\alpha}_1$ , sharing information dominates merging under incomplete information and exploring which constitutes the best outside option. In this case, information sharing allows firms to avoid mergers when low synergies exist. For

$\hat{\alpha}_1 < \alpha < \hat{\alpha}_2$ , sharing information dominates a merger under incomplete information without exploration. Information sharing makes it profitable for firms to explore the data and benefit from information synergies. For  $\alpha \geq \hat{\alpha}_2$ , firms merge under incomplete information and do not explore the data.

To conclude, firms' desire to compete or merge under incomplete information depends on industry characteristics, and so does their profit when merging without exploring. In our model, these characteristics impact the firms' desire to share information before the merger and the alternative to sharing, but they do not change the optimal amount of information shared before a merger if sharing occurs.

## 5.2 Nash Bargaining

The ability of firms to contract on  $s$  may be limited. For instance, if  $s$  is observable by the parties but not contractible, ex-ante transfers  $T(s)$  are not incentive-compatible. By contrast, M&A decisions are contractible, and the parties can make transfers contingent on the M&A. If Firm 2 has full bargaining power at the time of a M&A decision, Firm 1 will prefer not to share information rather than sharing and inducing Firm 2 to explore. Indeed, in the case of low synergies, Firm 1 will get  $\pi_1^C(s, \underline{\theta})$  while in case of high synergy, there is a merger but Firm 1 will get its outside option  $\pi_1^C(s, \bar{\theta})$ . By H2, the expected value of  $\pi_1^C(s, \theta)$  is inferior to  $\pi_1^0$ , and Firm 1 prefers not to share information. Hence, there can be information sharing when monetary contracts  $T(s)$  are not feasible only if Firm 1 has a stake in the returns of a M&A.

In this extension, we assume that the spoils of a M&A are shared following the cooperative Nash bargaining solution. Firm 1 has a bargaining power weighted by  $\mu \in [0, 1]$ , while Firm 2 has a power weighted by  $1 - \mu$ . To simplify the exposition we assume that  $C(1) = 0$  and that  $\alpha$  is large enough so that  $\mathbb{E}[\pi^M(1, \theta)] - \pi^0$  is negative. Hence, if Firm 2 does not explore, there is competition, and payoffs are  $\pi_i^0$ . In turn, anticipated payoffs following no exploration are independent of  $s$ :

$$\forall s, i = 1, 2, u_i(s; noexpl) := \pi_i^0.$$

By contrast, if there is exploration, Firm 2 bears a cost of  $C(s)$  before learning synergies. There

is competition with low synergies and accompanying payoffs  $\pi^C(s, \theta)$  and there is a merger following high synergies, the surplus from the merger  $\pi^M(1, \bar{\theta}) - \pi^C(s, \bar{\theta})$  being shared via Nash bargaining.

$$\begin{aligned} u_1(s; expl) &:= \mathbb{E}[\pi_1^C(s, \theta)] + (1 - \alpha)\mu(\pi^M(1, \bar{\theta}) - \pi^C(s, \bar{\theta})) \\ u_2(s; expl) &:= \mathbb{E}[\pi_2^C(s, \theta)] + (1 - \alpha)(1 - \mu)(\pi^M(1, \bar{\theta}) - \pi^C(s, \bar{\theta})) - C(s). \end{aligned}$$

By the Arrow condition [H2](#),  $u_1(s; expl)$  is a decreasing function of  $s$  while  $u_2(s; expl)$  is an increasing function of  $s$ . There is exploration only if  $u_2(s; expl) \geq u_2(s; noexpl)$ , or

$$(19) \quad C(s) \leq \mathbb{E}[\pi_2^C(s, \theta)] - \pi_2^0 + (1 - \alpha)(1 - \mu)(\pi^M(1, \bar{\theta}) - \pi^C(s, \bar{\theta})).$$

By the Arrow condition and the Inada condition [H1](#), the condition fails at  $s = 0$ . On the other hand, the condition is satisfied at  $s = 1$  by [H2](#) and [H4](#), and as we have assumed in this section,  $C(1) = 0$ . Moreover, as  $u_2(s; expl)$  increases with  $s$ , there exists a unique cutoff  $\underline{s} \in (0, 1)$  such that Firm 2 explores if, and only if,  $s$  is greater than  $\underline{s}$  (see section [B](#) in the appendix for an illustration of this possibility.)

Firm 1 will benefit from sharing  $s$  only if there is exploration by Firm 2 and if  $u_1(s; expl)$  is greater than  $\pi_1^0$ . Because  $u_1(s; expl)$  is a decreasing function of  $s$ , a necessary and sufficient condition for information sharing and exploration under Nash bargaining is that  $s$  is smaller than a cutoff value  $\bar{s} \in [0, 1]$ . There can be information sharing and exploration only if  $\bar{s} \geq \underline{s}$ .

By [H2](#) and the implicit function theorem, both cutoff values  $\bar{s}$  and  $\underline{s}$  in (19) are increasing functions of  $\mu$ : as Firm 2 has less bargaining power, it will be incentivized to explore for larger values of  $s$  to compensate for the lower payoff under exploration. As for Firm 1, a larger value of  $\mu$  will make it more willing to share information because Firm 1 can recoup the competition loss when there is a merger.

### 5.3 Possibility of Divestment After the M&A

Firms may engage in a M&A without sharing information and separate the merged entity if low synergies exist. The firms' profits in case of divestment depend on the amount of data that Firm

2 has integrated into its systems before separation.

Assume that Firm 2 has used  $s$  of information to explore the data and that if synergies are low, Firm 1 can buy back its company. In this case, firms compete. As Firm 2 has had access to  $s$  data, it develops a product using all the available data, and the competitive profits of the firms are equal to  $\pi_1^C(s, \underline{\theta})$  and  $\pi_2^C(s, \underline{\theta})$ .

Anticipating these profits, the former owners of Firm 1 can make a TIOLI offer to Firm 2 and repurchase their company for a value equal to  $\pi^M(1, \underline{\theta}) - \pi_2^C(s, \underline{\theta}) < \pi_1^C(s, \underline{\theta})$  (we assume that  $\pi^M(1, \underline{\theta}) > \pi_2^C(s, \underline{\theta})$  for simplicity). As a result, Firm 2 can acquire Firm 1 at a price  $p = \pi_1^0 - \alpha(\pi_1^C(s, \underline{\theta}) - \pi^M(1, \underline{\theta}) + \pi_2^C(s, \underline{\theta}))$ , and make an expected gain at the time of the acquisition equal to those when  $s$  information is shared and explored before the merger.

$$u_2(s) = (1 - \alpha)\pi^M(1, \bar{\theta}) + \alpha \pi^C(s, \underline{\theta}) - \pi^0 - C(s).$$

However, this reasoning assumes that M&As and divestitures are costless to realize, which is a far cry from reality, as illustrated by our Nokia/Withings example. When merging or separating entails a cost, information sharing will strictly dominate mergers under incomplete information, even when firms can divest and avoid mergers with low synergies.

## 6 Conclusion

We have analyzed an environment in which the motive for information sharing is to facilitate the discovery of synergies and improve merger decisions. To assess whether this motive for information sharing is at play, empirical researchers and regulators should identify an increase in the amount of data exchanged and used by competing firms before the merger process.

Firms can share information in different ways. Our analysis has shown that because of the risks of expropriation, information sharing may require a contract and a money transfer. Hence, a convenient way to share data is through data marketplaces, which enable contracts between sellers and buyers of large data sets. Information on the transactions on these data marketplaces helps assess whether digital firms are adopting pre-merger information-sharing practices.

But, as highlighted by our cooperative Nash bargaining analysis, firms may also share infor-

mation without contracting and money transfer. In this case, a simple way for firms to share data is to use the virtual data rooms mentioned earlier. Under Article 23 of the Digital Markets Act recently implemented in Europe,<sup>22</sup> members of the European Commission have a right of inspection under which they could request access to the information held by large gatekeepers such as Google and Facebook and, in particular, verify whether they owned data from firms they acquired before the acquisition occurred.

Finally, because learning the level of synergies yields more efficient M&As decisions, information sharing can impact firms' willingness to merge and thus market concentration, innovation, and social surplus. In particular, the number of merger failures should decrease if data-driven companies can better anticipate the efficiency of a M&A. The identification of these causal links is a topic for further research.

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<sup>22</sup>See [The Digital Markets Act: ensuring fair and open digital markets](#), European Commission, last accessed July 23, 2023.

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## A A Quality Competition Model

To illustrate our results, we analyze a simple model of information sharing and mergers when firms compete by selling products of different qualities.

Before information is shared, Firm 1 sells a product of quality  $q_1^0$  at a price  $p_1^0$ , and Firm 2 sells a product of quality  $q_2^0$  at a price  $p_2^0$ .

There is a mass 1 of consumers with quasi-linear utility functions  $u(q_i, p_i) = q_i - p_i$ . Firms compete à la Bertrand to sell their products, and the firm winning the market makes profits equal to  $\pi_i = p_i$ .

For simplicity, at the beginning of the game,  $q_1^0 > 0$ ,  $q_2^0 = 0$ , and Firm 1 is a monopolist in the market. Hence, the equilibrium prices and profits are  $\pi_1^0 = p_1^0 = q_1^0$  and  $\pi_2^0 = p_2^0 = 0$ .

**Information sharing.** Suppose that Firm 1 shares  $s > 0$ , and, for now, let us ignore the possibility of a M&A. If Firm 2 invests  $C(s)$  and learns  $\theta$ , it can develop a product of quality  $q_2(s, \theta) = s\theta$  while the product quality of Firm 1 does not change. We assume for simplicity that when a product is on the market, consumers know its valuation immediately. This holds even if firms do not know the quality of the product at the time they launch it. Indeed, the literature on the pricing of information goods ([Shapiro and Varian, 1998](#)) has long pointed out that consumers can quickly discover their product valuation before acquiring it through sampling, free downloading, freemium, ratings, and reviews.

To ensure that the main hypotheses of the baseline model hold in this framework, we assume that  $\bar{\theta} > u > 2\theta$ , and we discuss these conditions below. Consumers purchase the product that yields the highest utility, and Bertrand's competition implies that the equilibrium profits of the two firms are

$$\begin{aligned}\pi_1^C(s, \theta) &= 0, \quad \pi_2^C(s, \theta) = s\theta - u \text{ if } s\theta - u \geq 0, \\ \pi_1^C(s, \theta) &= u - s\theta, \quad \pi_2^C(s, \theta) = 0 \text{ if } s\theta - u \leq 0.\end{aligned}$$

The assumptions of our primary analysis are satisfied with this quality competition model.

$$(H2) \quad \begin{aligned}\frac{\partial \pi_2^C(s, \theta)}{\partial s} &= \theta \geq 0 \geq \frac{\partial \pi_1^C(s, \theta)}{\partial s} = 0 \text{ if } s\theta - u \geq 0, \\ \frac{\partial \pi_2^C(s, \theta)}{\partial s} &= 0 \geq 0 \geq \frac{\partial \pi_1^C(s, \theta)}{\partial s} = -\theta \text{ if } s\theta - u \leq 0.\end{aligned}$$

As we have assumed that  $u > \underline{\theta}$ , when synergies are low the competitive payoffs are equal to  $\pi_1^C(s, \underline{\theta}) = u - s\underline{\theta}$  and  $\pi_2^C(s, \underline{\theta}) = 0$ . This ensures that (H3) is satisfied:

$$(H3) \quad \frac{\partial \pi^C(s, \underline{\theta})}{\partial s} = -\underline{\theta} < 0.$$

**M&A.** When firms merge, the merged entity sells as a monopolist a product of quality equal to  $q_2(1, \bar{\theta}) = \bar{\theta}$  if synergies are high and to  $q_2(1, \underline{\theta}) = \underline{\theta}$  if synergies are low. As we have assumed that  $\bar{\theta} > u$  and  $u > 2\underline{\theta}$ , Firm 2 is willing to merge only when synergies are high and we recover the option value of the baseline model:

$$(H4) \quad \begin{aligned} \pi^M(1, \bar{\theta}) &= \bar{\theta} > \pi^C(s, \bar{\theta}) = \max[u - s\bar{\theta}, s\bar{\theta} - u], \\ \pi^M(1, \underline{\theta}) &= \underline{\theta} < u - s\underline{\theta}. \end{aligned}$$

**Information sharing.** The expected profit of Firm 2 purchasing  $s$  from Firm 1 is:

$$(1 - \alpha)(\bar{\theta} - u) - \alpha\underline{\theta}s - C(s).$$

By concavity of this expression, the equilibrium amount of information shared is unique and satisfies  $\alpha\underline{\theta} = -C'(s^*)$ .

**Consumer surplus.** The surplus of consumers is equal to zero if firms do not share information or if they merge. If firms share information and compete, consumer surplus equals  $\min\{u, \theta s\}$ . This weakly increases with  $s$  and (H6) is satisfied.

**Regulatory oversight.** Finally, a M&A is accepted by the regulator when  $s$  information is shared when  $\rho$  is smaller than

$$\rho^*(s^R) = \begin{cases} \frac{1+s-\frac{u}{\bar{\theta}}}{1+2s-\frac{u}{\bar{\theta}}} & \text{if } s \leq \frac{u}{\bar{\theta}}, \\ \frac{1-s+\frac{u}{\bar{\theta}}}{1-s+2\frac{u}{\bar{\theta}}} & \text{if } s \geq \frac{u}{\bar{\theta}}. \end{cases}$$

In turn, condition (Hazard), under which companies share more information in the presence of a regulator, can be written:

$$(Hazard) \quad \text{For } s^R \geq \frac{u}{\bar{\theta}}, \quad \frac{f(\rho^*(s^R))}{1 - F(\rho^*(s^R))} < \frac{(\bar{\theta}(1 - s^R) + 2u)^2}{u(\bar{\theta}(1 - s^R) + u)}.$$

Condition (Hazard) is satisfied for many distributions, such as when  $\rho$  is uniformly distributed for then the hazard rate is  $\frac{f(\rho^*(s^R))}{1 - F(\rho^*(s^R))} = \frac{\bar{\theta} - s^R \bar{\theta} + 2u}{u}$  which is clearly smaller than  $\frac{(\bar{\theta} - s^R \bar{\theta} + 2u)^2}{u(\bar{\theta} - s^R \bar{\theta} + u)}$ .

## B Nash Bargaining in the Quality Model

In the quality model, consider the following specification:

$$\bar{\theta} = 4, \quad \underline{\theta} = 0, \quad u = 1, \quad \alpha = \frac{3}{4}, \quad C(s) = \frac{1 - s}{10s}.$$

Moreover, assume that Firm 1 has smaller bargaining power than Firm 2, that is  $\mu \leq \frac{1}{2}$ .

In this case,  $\pi_1^0 = 1$ ,  $\pi_2^0 = 0$ , and if there is no exploration, merging under incomplete information yields an expected profit of  $\mathbb{E}[\theta] - C(1) = 1$ , which is equal to  $\pi^0 = 1$ .

If Firm 2 explores, there is competition with probability  $\alpha$ , and merger with probability  $1 - \alpha$ . Hence, the expected profits at the time Firm 2 does the exploration are:

$$u_1(s, expl) = \begin{cases} \frac{1}{4}(3\mu + 4(\mu - 1)s + 4) & \text{if } s \leq \frac{1}{4} \\ \frac{1}{4}(\mu(5 - 4s) + 3) & \text{if } s \geq \frac{1}{4} \end{cases}$$

$$u_2(s, expl) = \begin{cases} \frac{(3+4s)(1-\mu)}{4} - \frac{1-s}{10s} & \text{if } s \leq \frac{1}{4} \\ \frac{4s\mu + 4 - 5\mu}{4} - \frac{1-s}{10s} & \text{if } s \geq \frac{1}{4}. \end{cases}$$

The lower bound on  $s$  for exploration solves  $u_2(s, expl) = \pi_2^0 = 0$ , while the upper bound on  $s$  for Firm 1 to benefit from exploration solves  $u_1(s, expl) = \pi_1^0 = 1$ . Straightforward computations

show that Firm 1 benefits from sharing  $s$  and exploration when  $s$  is smaller than

$$\bar{s}(\mu) = \begin{cases} \frac{3\mu}{4(1-\mu)} & \text{if } 0 < \mu \leq \frac{1}{4} \\ \frac{5\mu-1}{4\mu} & \text{if } \frac{1}{4} < \mu < \frac{1}{2} \end{cases}$$

At  $s = \frac{1}{4}$ , Firm 2 has an expected payoff under exploration equal to  $\frac{7}{10} - \mu$  which is positive since  $\mu < \frac{1}{2}$ . Therefore, the lower bound on  $s$  must be in the region  $s \leq \frac{1}{4}$ , and

$$\underline{s}(\mu) = \frac{4}{17 - 15\mu + \sqrt{5\mu(45\mu - 134) + 449}}$$

There will be exploration only if  $\bar{s}(\mu)$  is greater than  $\underline{s}(\mu)$ . This requires that  $\mu$  is large enough (greater than 0.135). As the bargaining power of Firm 1 increases, we see in Figure 3 that the equilibrium shares of information  $\underline{s}(\mu)$  and  $\bar{s}(\mu)$  increase.

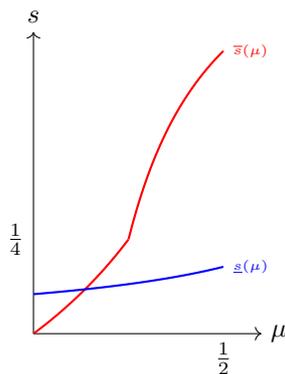


Figure 3: Incentive bounds with Nash bargaining

## C Hazard Condition

There are only three possible cases for the variations of the functions  $G(s) := \pi^M(1, \bar{\theta}) - \pi^C(s, \bar{\theta})$  and  $\rho^*(s)$ . Indeed, it is not possible that both functions have positive variations, as  $\rho^*(s) = \frac{G(s)}{G(s) - L(s)}$  and  $L'(s) < 0$  by (H6). Hence, a necessary condition for increasing  $\rho^*(s)$  is that  $G(s)$  decreases with  $s$ . We consider the three other cases below.

$G(s)'$  is positive and  $\rho^{*'}(s)$  is negative. In this case, (Hazard) does not hold, and firms share less information than without the regulator. Doing so increases the chances for the merger to be accepted and the competitive profits if the merger is blocked.

$G'(s)$  is negative and  $\rho^{*'}(s)$  is positive. In this case, (Hazard) holds, and firms share more information with than without regulatory oversight. By doing so, they increase the chances for the merger to be accepted and increase the competitive profits in case the merger is blocked.

$G(s)'$  and  $\rho^{*'}(s)$  are negative. In this case, if condition (Hazard) is satisfied, firms share more information in the presence of the regulator. Condition (Hazard) ensures that the loss from a reduced probability of merger is dominated by the gains from enhanced profits if the merger is blocked.

If condition (Hazard) is not satisfied, firms share less information in the presence of the regulator. By doing so, they reduce their profits in case the merger is blocked, but they increase the chance for the merger to be approved. The fact that (Hazard) is not satisfied implies that the profit loss in case of merger denial is dominated by the increase in chances that the merger will be approved.