Merger Failures*

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Abstract

This paper proposes an explanation as to why some mergers fail, based on the interaction between the pre- and post-merger processes. We argue that failure may stem from informational asymmetries arising from the pre-merger period, and problems of cooperation and coordination within recently merged firms. We show that a partner may optimally agree to merge and abstain from putting forth any post-merger effort, counting on the other partner to make the necessary efforts. If both follow the same course of action, the merger goes ahead but fails. Our unique equilibrium allows us to make predictions on which mergers are more likely to fail.

Keywords: mergers, synergies, asymmetric information, complementarities.

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1 Introduction

Despite observing consistently strong merger activity around the world, a vast number of these corporate unions seem to be unsuccessful. Indeed, over the last fifteen years, 43% of all merged firms worldwide reported lower profits than comparable non-merged firms (Gugler et al. [24]). Likewise, more than 50% of investigated U.S. mergers earned negative cumulative abnormal returns (Agrawal et al. [2]).[1] Given these disappointing outcomes, it is not surprising that more than half of the merged firms end up being divested (Porter [44]). Dessein et al. [17] confirm that "there are countless examples of failed mergers that were unable to achieve the synergies that motivated the deal".

This paper proposes a formal explanation of failure in mergers for synergies. Our setup takes explicitly into account the interactions between the pre- and post-merger processes. We argue that failure may stem from informational asymmetries arising from the pre-merger period, and problems of cooperation and coordination when recently merged. We shall show that, based on its pre-merger information, a firm might optimally agree on merging and abstain from exerting post-merger efforts. By hoping to free-ride on the efforts of the other partner, a firm might expect to obtain some merger gains that would compensate the costs of merging. But, if both partners follow the same course of action, the merger goes ahead and fails.

Our pre- and post-merger setups contain key features of a *merger for synergies*. Pre-merger, potential merger gains are uncertain. Indeed, the reaction of competitors, the evolution of the economic fundamentals and the strategic fit are unknown at the time of merging (Haspeslagh and Jemison [30]). Therefore, prospective partners collect information about the potential gains from merging by, for example, hiring investment banks (Servaes and Zenner [58]). However, although part of this information might be available to both firms, another part certainly remains private. This is because at this point it is not sure that the merger is going to materialize. If firms decide in the end not to merge, they could use the obtained information against each other when competing. In sum, it is assumed that prospective merging partners possess some private information on uncertain merger gains.

Postmerger, merging companies attempt to realize synergies by integrating specific hard-to-trade resources. These synergies can be obtained through the adaption and modification

[1] Practitioners' studies estimate merger failure to be even more frequent; their estimated failure rate lies well above 50%, and is sometimes believed to be even as high as 85% (Copeland et al. [15]).

of existing products and processes, leading to knowledge and capabilities that did not exist before the merger (Farrell and Shapiro [19]). Suppose, for example, that a firm specializing in basic programming merges with a firm that employs experts in system design. By combining their knowledge, partners might be able to produce a new and superior computer apparatus, both in calculus performance and usefulness for an organization. But, a more cost-effective and superior product can be developed, only if one partner writes the necessary programs *and* the other designs the adequate system. Synergies are thus by definition not achievable through the actions of a single merging party (Farrell and Shapiro [19]).[2]

But implementing the right post-merger actions –writing those programs and developing a system so that each fits one another– necessarily involves a private cost for each partner. Accordingly, synergies can only be attained through a relation-specific and privately costly effort.[3] These efforts are non-contractible, given that they are difficult to observe during the post-merger process. Actions in this phase are usually difficult to describe in sufficient detail (Mailath et al. [37]) and decisions are often plagued by ambiguity (Vaara [63]). Action interdependencies make it even more difficult to measure separate contributions (Simon [59]). In sum, the post-merger efforts of each partner are assumed to be (i) necessary to achieve synergies, but (ii) privately costly and (iii) non-contractible. As a result, they exhibit strategic complementarities, thereby potentially leading to coordination problems.[4]

Indeed, in the organizational literature poor merger performance has often been connected to post-merger coordination problems (see Larsson and Finkelstein [36] for an overview). Unlike internal development and growth, newly merged firms cannot rely on preexisting coordination mechanisms, such as standard operating procedures, routines, shared language and identification, which are all consequences of long-term relationships within the firm (see e.g. Kogut and Zander [34]). This poor post-merger coordination, organizational researchers argue, hinders the

[2] Synergy gains are akin to the indirect gains from interdependent activities in organizations, as defined by Milgrom and Roberts [38],[39].

[3] As Wickelgren [69] confirms: “Just because they [the merging partners] are part of one firm, however, does not mean they will now only act in their joint, as opposed to their individual, interest.” It is said that managers’ motivation to cooperate comes from team spirit and trust (Kandel and Lazear [33]). But, this is exactly what is lacking in a newly merged firm (Flynn [20], Seabright [56]). Further recent papers that model each merging partner deciding upon a privately costly effort include Dessein et al. [17] and Kretschmer and Puranam [35].

[4] Strategic complementarities are also consistent with the findings of a large literature in management that concludes that tasks are more valuable when they cluster together (see Dessein and Santos [18] for an overview).

optimal functioning of newly formed firms and therefore the ability to reap the projected synergy gains.

Arguably, a potential way out of these coordination problems could be to "structurally integrate" the merged firms. By grouping organizational units together, common authority, systems and processes can then be used to reduce coordination issues. But, as confirmed by Puranam and Srikanth [47] and Puranam et al. [48], although post-merger integration helps merging firms to leverage what the partners "know" by promoting coordination, it hinders their ability to leverage what they do or "explore" because of a reduction in autonomy.[5] In a merger for synergies, there is a strong need for exploration because significant effort on products and processes by each partner are required to reap synergies (Schilling [55]). As a result, merging partners are frequently kept as separately fully functioning (see Wickelgren [69] and references therein). Thus, despite the potential coordination problems, structural separation is the best setting in a merger for synergies.

This organizational structure, however needed, has the additional problem of potential free-riding by partners. Free-riding may occur because synergies are not the only obtainable merger gains. This means that if only one partner makes an effort, then other (non-synergetic) merger gains can still be obtained. Going back to our example, it may be that when one partner develops a better computer system, this still may lead to gains by selling the new system through the already existing warehousing and delivery operations from the other partner. Merger gains, thus, can be divided into non-synergetic gains achievable through the actions of a single partner, and synergies, which are the gains that exceed the return of individual actions (Agarwal et al. [1]). As a result, in a merger for synergies both issues of coordination and cooperation are potentially present (Gulati et al. [25]).

The presence of asymmetric information allows us to find a unique equilibrium in our setup. In this equilibrium, if a partner expects substantial gains, it agrees on merging and exerts a

[5] Integration implies a standardization of work practices and procedures between partner firms. These changes can cause disruption, independent of any improvements brought about by a new configuration of organizational attributes (Amburgey et al. [5], Hannan and Freeman [26]). Changes can also alter organizational routines, and in doing so can undermine creative and innovative capabilities (Benner and Tushman [9]). Ranft and Lord [50], building on seven detailed case studies of technology acquisitions, argue that autonomy for acquired firms -in terms of formal administrative structure and culture- simultaneously preserves tacit and socially embedded technologies and capabilities.

post-merger effort. As a result, if both partners expect substantial gains, all potential merger gains -including synergies- are obtained and the merger is successful. If one firm instead has low expectations, then the merger will not go through. More interestingly, we show that, if a partner has intermediate expectations, it might optimally agree on merging and abstain from exerting any post-merger effort. While by not making an effort one precludes the possibility of obtaining synergy gains, merging might still be profitable. By hoping to free-ride on the efforts of the other partner, a firm expects to obtain non-synergetic gains that would compensate the costs of merging. This can happen when the other partner expects higher potential merger gains and is thus willing to exert effort, in the belief that both partners will jointly realize synergy gains.

If both partners follow the same course of action, however, the merger goes ahead and fails, because both abstain from exerting any post-merger effort. Failure may thus occur even though the management of each firm takes the appropriate merger decision in expected terms. Provided that shareholders do not have more information than the managers of their own firm, they should also accept the agreement.[6] Failure could not have been avoided by post-merger communication either. Each partner has incentives to overstate its information, independently of its effort decisions. Indeed, it always prefers to let the other to exert an effort. Under these conditions, credible communication cannot be supported in equilibrium, as shown by Baliga and Morris [6].

Our explanation thus provides a formal rationale for why and how post-merger problems can be the cause of merger failure, as is often claimed by the organizational literature. It must be stressed that, although all the mergers in our setting have the potential for synergy gains, failure happens because the merger partners do *not* pursue synergy gains. Indeed, as pointed out in Banal-Estañol et al. [7] and Kretschmer and Puranam [35], synergy implementation is a strategic decision. It is further important to note that it is the very characteristics of post-merger efforts in a merger for synergies -leading to potential problems of both cooperation and coordination- that may lead to the explained course of actions. Indeed, for failure to occur, not exerting effort should not be the optimal decision for all levels of expectations. If this was the case, firms would not enter a merger. Solely pure post-merger coordination problems would not

[6] Although many mergers may fail through our mechanism, mergers should be profitable on average. Rhodes-kropf and Viswanathan [51] use a similar rationale to explain why targets may accept bids from overvalued bidders in periods of high market valuations.

lead to failure either, since firms would exert effort if they merged.

The approach we follow and consequently the unique equilibrium helps to make predictions on which mergers are more likely to suffer from organizational problems. First, mergers with higher expected potential gains suffer less from post-merger issues. In general, however, one should not just rely on the value of potential synergies, but must consider organizational variables as well. In particular, the lower the cost of post-merger efforts and the higher their degree of complementarity, the lower the probability of failure. On the contrary, the lower the opportunity costs of merging -i.e. what firms earn as stand-alone profits plus the (fixed) cost of merging- the higher the probability of failure. Firms merge then more often and, by taking this decision more easily, they transmit less positive information to their partners. As a result, partners exert effort less often in the post-merger process.

Of course, there are other reasons apart from organizational difficulties that may explain failure. Mergers might fail because of plain "bad luck", because the realization of the uncertainty falls short of the expectation. Managers can also be empire-builders and merge, not to increase shareholder's profits, but to belong to a larger firm (Jensen [32]). Unprofitable mergers may further occur because firms may merge to preempt their partners from merging with rivals (Fridolfsson and Stennek [21]). Finally, managers may irrationally overestimate the future performance of the merged entity, so-called "managerial hubris", due to the underestimation of internal conflicts (Banal-Estañol et al. [7]) or by not foreseeing problems derived from conflicting organizational cultures (Weber and Camerer [68]).

There are few papers in the economics literature that study post-merger problems in general and coordination issues in particular. Agarwal et al. [1] investigate experimentally how prior alliances between merger partners affect merger performance. Similar to our framework, they "focus on post-acquisition coordination problems, given prior [organizational] research highlighting its importance" (Agarwal et al. [1], p. 3). In their setup, managers need to allocate the resources they control to either individual activities, which generate private profits, or to combined production activities, which might generate additional benefits. These latter activities, however, require a minimum amount of combined resources. In equilibrium, a manager would contribute to the combined activities if and only if the other is contributing as well. Fulghieri and Hodrick [23] investigate the post-merger interactions between synergies and internal agency conflicts. Divisional managers may be able to reduce the likelihood of having their divisions divested by reducing the attractiveness for alternative use. As in our setup, strategic complementarities might generate multiple equilibria if information is complete. In their paper, expectations about the behaviors in other parts of the organization may determine which particular equilibrium will be selected.

Our model can be seen as a variant of a *global game* (Carlsson and van Damme [11]). In these type of games, agents' payoffs (realized merger gains in our model) depend on the action chosen by the other agents (the post-merger effort) and some unknown economic fundamental (the potential merger gains). Agents receive public and private signals that generate beliefs about the economic fundamental and about the actions and beliefs of the other agents. Morris and Shin [40] showed that this incomplete information game has a unique equilibrium as long as the public signal is noisy enough. If the public signal becomes too precise, coordination problems and multiple equilibria arise as in the complete information case. In our setting, prior to the global game (the post-merger stage), the decision of whether to participate (the merger decision) allows players to update their beliefs about the signals of the other players. Uniqueness in our setup is then only ensured when the private signals are noisy enough, which is a consequence of the fact that the decision to participate in the game makes part of the private information public.[7]

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 explains the equilibrium. Section 4 provides our explanation of merger failure. Section 5 performs comparative statics and Section 6 gives our empirical predictions. Section 7 concludes. In Appendix A we provide preliminaries for the proofs, which are assigned to Appendix B.

2 Model

2.1 Main Setting

Two firms examine the possibility to merge. If the merger does not occur, each will earn the stand-alone profits $\pi^s \in \mathbb{R}$. Merging profits, on the other hand, depend on the uncertain potential gains from merging and on the extent to which these gains will actually be obtained in the post-merger process. Accordingly, the profits for each merging firm can be written as $\pi^s + f\theta/2 - k$, where $\theta \in \mathbb{R}$ represents the potential gains from merging, $f \in [0, 1]$ the degree of

[7] Angeletos et al. [4] obtain a similar result to ours in a dynamic version of Morris and Shin's [40] model.

fulfillment and $k > 0$ a (net) fixed cost for merging.[8] We consider thus the case of two symmetric firms deciding upon a merger of equals, whereby profits are shared equally.

In line with Rajan and Zingales [49], we think it is realistic to claim that managers -and more specifically the top management- take the decisions within the firm. While it is reasonable to expect that employees at all levels impart their own influence on the post-merger process, the top management of each forming firm plays the crucial role in establishing and shaping the strategic direction of the whole group (Chatterjee et al. [13]). This allows us to concentrate on the managerial decisions. We will henceforth use the terms 'firm' or 'merger partner', bearing in mind that it is always the top management of these firms that takes the decisions.

The decision to merge, though, needs the approval of each firm's shareholders. However, assuming that the (risk-neutral) management of each firm is paid an exogenous and symmetric fraction of the merger surplus, managers will always obtain the consent of their (risk-neutral) shareholders if they decide to seek merger approval. Indeed, shareholders have access to the same information as their managers and will not bear the costs of post-merger actions, while also receiving a symmetric proportion of the surplus. Therefore, if a merger is profitable for the management, then it should also be profitable for the shareholders. For simplicity, we normalize the fraction of the profits that goes to the management of each partner to one half.[9]

We analyze the merger process by using the following game. In the pre-merger period, both firms collect information about the potential gains from merging. In the merger period, firms decide whether to merge. One firm, denoted as Firm 1, first decides whether to propose a

[8] There could be merger gains obtainable independent of the results of the post-merger process, e.g. through the elimination of fixed costs by having one headquarter instead of two. In our setup, these gains would be substracted from the costs k of merging. If they were so large that they compensate the costs of merging, then we would have $k \leq 0$. In this case, however, a merger would always be profitable and, as a consequence, no failure could occur. We limit ourselves for the remainder of the paper to the case of $k > 0$.

[9] Giving each manager of the merged firm an equal part will be the incentive scheme most conducive to synergies and therefore the most natural in a merger for synergies. It is true that in other types of mergers (e.g. a merger for market power), giving each manager an equal part might not always be optimal (see e.g. Banal-Estañol and Ottaviani [8]). Indeed, in Banal-Estañol et al. [7], using a related setup to our model here, we show that better effort incentives may be obtained by increasing the percentage of profits to one partner and compensating the other partner via a fixed fee. However, full synergies will never be obtained, since the partner receiving a fixed fee will not exert effort, and therefore is not suited to a setup where the intended primary goal of the merger is synergy realization. See also Dessein et al. [17], Kretschmer and Puranam [35] and Wickelgren [69], who analyze the use of optimal incentives to manage interdependence in multi-product firms.

merger to the other, Firm 2, which in turn decides whether to accept.[10] If both firms agree to merge, then in the post-merger period, merging partners attempt to realize the potential gains from merging. At the end of the post-merger process, firms evaluate whether the merger was successful. The timing of the game, described in more detail in the following subsections, is represented in Figure 1.

<<Insert Figure 1 about here>>

2.2 Pre-merger Period

In the pre-merger period, prospective partners collect information about the potential gains from merging by hiring, for example, investment banks (Servaes and Zenner [58]). Although part of this information might be available to both firms, another part is certainly private. Indeed, at this point it is not sure that the merger is going to materialize and firms could use the obtained information against each other when competing. Full information disclosure before the merger materializes may also violate competition laws.[11]

Formally, before any information gathering, the gains are completely uncertain and therefore θ is a priori randomly drawn from the real line, with each realization equally likely.[12] Obtained information can be classified into private or public. The information derived from non-shared research and knowledge is summarized into two noisy private signals of the true gains,

$$x_i = \theta + \varepsilon_i \quad \text{for } i = 1, 2. \tag{1}$$

Parameters ε_i represent the noise and are assumed to be independently identically distributed with $\varepsilon_i \sim U(-l, l)$ and independent from θ. The knowledge available to both firms is assumed

[10] Merger decisions are modeled as sequential decisions to avoid the equilibrium where both firms decide not to merge for any level of potential gains. This equilibrium appears only when firms take the merger decision at exactly the same point in time.

[11] The Federal Trade Commission articulates that the exchange of sensitive information prior to the clearance of the merger may amount to a breach of the United States competition legislation. Several successful legal actions have been brought on this basis (see for example *FTC Watch No. 265, at 3; 232-233*, and the Case *United States v. Input/Output, Inc. and Laitram Corp., 1999 WL 1425404, at *1*).

[12] The assumption that θ is uniformly distributed on the real line presents no technical difficulties as long as we are concerned only with conditional beliefs. As Morris and Shin [40] argue, such an improper prior is the same as assuming that the prior distribution of θ becomes diffuse.

to be summarized in a noisy public signal of the true gains,

$$y = \theta + \upsilon. \tag{2}$$

Parameter υ represents again the noise and we presume $\upsilon \sim U(-l, l)$, and υ, ε_i and θ to be independent. For simplicity, we set the three signals equally precise.

2.3 Merger Decisions

The merger period starts with Firm 1 deciding whether to make a merger proposal to Firm 2. Equivalently, Firm 1 is the first firm to publicly announce whether it agrees to merge.[13] In taking this decision, it uses its available information, $I_1^m \equiv \{x_1, y\}$, to update its beliefs about the potential gains, $(\theta \mid I_1^m)$, and its beliefs about the private signal received by Firm 2, $(x_2 \mid I_1^m)$. If Firm 1 decides not to propose, both firms obtain the stand-alone profits π^s and the game ends.[14] If it decides to propose, then it is Firm 2's turn to respond.

Subsequently, Firm 2 decides whether to accept or reject the proposal, based on its available information $I_2^m \equiv \{x_2, y, \text{ Firm 1 agreed to merge}\}$. It can reject and terminate the game, resulting in the stand-alone profits π^s for each firm. If on the other hand, Firm 2 accepts, the merger takes place. Each firm pays the merging costs k and becomes a partner in the new entity. The two partners then enter into the post-merger process.

2.4 Post-merger Process

Following the discussion in Farrell and Shapiro [19], we divide the potential gains from merging θ into synergy and non-synergy gains. From the "right" actions of a single partner, the merged entity can only obtain direct non-synergy gains $\frac{\theta}{d}$. Synergies, on the other hand, are the indirect gains that can be obtained from the *joint* actions of both partners, exceeding the direct return of the individual actions, $\theta - \frac{\theta}{d} - \frac{\theta}{d} = \theta(1 - \frac{2}{d})$, where $d > 2$. Hence, maximum obtainable merger gains θ are divided into $\frac{2\theta}{d}$ direct non-synergy gains and $\theta(1 - \frac{2}{d})$ synergy gains.

As explained in the introduction and consistent with empirical observations (see Wickelgren [69] and references therein), merging partners in our setup are kept as fully functioning, with

[13] We will show that the order in which firms announce their decision does not matter. It would be therefore equivalent to assume that only proposals or acceptances are observed.

[14] We assume that both the costs of merging and the stand-alone profits are certain. Results would not change if these parameters were random, as long as their expected values are the same for both firms.

the corresponding managers having the discretion to make decisions. Indeed, as argued by Puranam et al. (2009) and Farrell and Shapiro [19], for example, each partner brings –and potentially applies– specific and hard-to-trade knowledge and resources in a merger for synergies. Of course, implementing the right post-merger actions necessarily involves a relation-specific cost for each partner. For example, making the right use of the resources within the merged firm may imply foregoing a more market-oriented goal (Banal-Estañol et al. [7]). Accordingly, our model assumes that synergies can only be obtained through privately costly efforts; each partner's effort comes at a cost t.[15]

Post-merger efforts are assumed to be non-verifiable and also unobservable during the post-merger process and therefore chosen as if they were exerted simultaneously (as in Dessein et al. [17]). Indeed, actions in the post-merger phase are likely to be plagued by ambiguity about what the other is doing (Vaara [63]). Further, in the initial post-merger context it is intrinsically hard to describe the desired actions to distinguish them from seemingly similar actions which have very different consequences (Mailath et al. [37]). Additionally, interdependencies of actions may make it even more difficult to measure separate contributions of partners at this stage (Simon [59]).

In summary, based on the information available $I_i^p \equiv \{I_i^m, \text{Firm } j \text{ agreed to merge}\}$, each merging partner decides whether to exert an effort, $e_i \in \{0,1\}$. The fulfilled merger gains are $f(e_1, e_2)\theta$. When both partners exert effort, both synergy and non-synergy gains are obtained and the degree of fulfillment of potential merging gains is $f(1,1) = 1$, i.e. gains are not discounted. If only one partner makes an effort, no synergy gains are obtained and the fulfillment factor is $f(1,0) = f(0,1) = \frac{1}{d}$ where $d > 2$. If none of them makes an effort, we let the penalty to be extremely high, $f(0,0) = 0$, and zero merger gains are obtained.[16] The uncertain payoffs for (the management of) each partner, gross of merging costs and stand-alone profits, are summarized in Table (3).

[15] Scharfstein and Stein [53] attribute a similar setup to divisional rent-seeking, Fulghieri and Hodrick [23] to managerial entrenchment, and Agarwal et al. [1] to resource allocation towards combined activities. Further recent papers that model each merging partner deciding upon a privately costly effort include Dessein et al. [17] and Kretschmer and Puranam [35].

[16] To fully discount the potential gains if none makes any effort is just a normalization of k (see footnote 8).

	Effort ($e_2 = 1$)	No Effort ($e_2 = 0$)
Effort ($e_1 = 1$)	$\frac{\theta}{2} - t$, $\frac{\theta}{2} - t$	$\frac{\theta}{2d} - t$, $\frac{\theta}{2d}$
No Effort ($e_1 = 0$)	$\frac{\theta}{2d}$, $\frac{\theta}{2d} - t$	0 , 0

(3)

As one can easily check, post-merger actions to achieve positive gains are strategic complements;[17] that is, the marginal return of a partner's action is increasing in the level of action of the other partner (Vives [66]). A larger d implies that actions are more complementary; rewards from actions become larger when the partner has exerted effort and smaller when it has not.

In a complete information setting -for example if firms received a public signal y only- three scenarios would arise depending on the level of expected potential gains. If the gains were low, not making an effort would be a strictly dominant strategy for both firms. If the gains were high, merging partners would exert effort since this would be a strictly dominant strategy. Finally, in the intermediate case, there would be multiple equilibria. The two partners making an effort and none exerting effort would both be Nash equilibria. This indeterminacy is problematic when one goes backwards to the merger stage. At the moment of taking merger decisions, firms do not know in which equilibrium of the post-merger process they are going to coordinate.

Similar to the global games literature, the presence of asymmetric information enables us to find a unique equilibrium. The payoffs in our setup, however, are different from the basic global game as described in Morris and Shin [40], in which making no effort yields a fixed payoff. This difference will prove to be crucial for the occurrence of failure. If the payoffs of not making an effort were fixed (and lower than the fixed cost of merging), it would be impossible for a firm to agree to merge and to exert no effort later on. Here, the payoffs from not exerting effort while the partner exerts effort increase with the expected efficiency gains θ. In other words, a partner gains more from free-riding in the post-merger stage when the expected gains are higher.

3 Equilibrium Behavior

3.1 Definitions

To simplify our discussion, we first consider the case in which firms receive only a private signal. A strategy in this setting does not consist of two binary decisions as in the complete information

[17] In the case of negative gains, $\theta < 0$, not to make effort will be a dominant strategy.

case, but in a mapping from the range of possible signals to those two binary choices. Given that Firm 2's merger decision only needs to be taken if Firm 1 has proposed, and post-merger effort decisions need only be taken if both firms have agreed to merge, strategies are fully defined without specifying the action of the other.

Definition 1 *A strategy s_i for Firm i, $i = 1, 2$, is a function specifying, for each possible private signal $x_i \in \mathbb{R}$, an action*

$$\begin{aligned} s_1 &: \mathbb{R} \rightarrow [\{\textit{Propose, Not propose}\}, \{\textit{Effort } (e_1 = 1), \textit{ No Effort } (e_1 = 0)\}] \textit{ and} \\ s_2 &: \mathbb{R} \rightarrow [\{\textit{ Accept, Not accept }\}, \{\textit{Effort } (e_2 = 1), \textit{ No Effort } (e_2 = 0)\}]. \end{aligned}$$

We concentrate on monotonic strategies, which in binary choice settings is equivalent to the class of switching strategies. Depending on whether the signal is below or above a cutoff point, the player takes one action or the other. In our case, since we have two decisions, a strategy is uniquely defined by two cutoff points.

Definition 2 *A double switching strategy s_i for Firm i, $i = 1, 2$, with cutoffs $\widetilde{x}_i$ and $\widetilde{\widetilde{x}}_i$ for merging and making an effort respectively can be described as*

$$\begin{aligned} s_1(x_1) &= \begin{cases} \textit{Propose} & \textit{iff } x_1 > \widetilde{x}_1 \\ \textit{Effort } (e_1 = 1) & \textit{iff } x_1 > \widetilde{\widetilde{x}}_1 \end{cases} \\ \textit{and } s_2(x_2) &= \begin{cases} \textit{Accept} & \textit{iff } x_2 > \widetilde{x}_2 \\ \textit{Effort } (e_2 = 1) & \textit{iff } x_2 > \widetilde{\widetilde{x}}_2. \end{cases} \end{aligned}$$

The sequential ordering introduces another informational asymmetry (besides the private signals). The first-mover firm, Firm 1, has to take the proposing decision without knowing whether Firm 2 will accept or reject later on. The following lemma shows that in our setup this is *de facto* not the case.

LEMMA 1 *When deciding whether to propose, Firm 1 decides as if it knows that Firm 2 is going to accept. As a result, both firms take the merger decision based on the same information structure, $I_i \equiv \{x_i, x_j \geq \widetilde{x}_j\}$, for $i = 1, 2$ and $i \neq j$.*

Firm 1's decision is only relevant when Firm 2 accepts the merger because the stand-alone profits do not depend on who rejects the merger. Given this result, we denote from now on for expositional ease both the *Propose* and *Accept* decisions as *Merge*, and similarly *Not Propose* and *Not Accept* as *Not Merge*.

From Table (3), if Firm j chooses a double switching strategy around $(\widetilde{x}_j, \widetilde{\widetilde{x}}_j)$, Firm i exerts effort whenever

$$g(x_i, \widetilde{x}_j, \widetilde{\widetilde{x}}_j) \equiv (d-1)E(\theta \mid I_i^e) \Pr ob(x_j \geq \widetilde{\widetilde{x}}_j \mid I_i) + E(\theta \mid I_i^{ne}) \Pr ob(x_j \leq \widetilde{\widetilde{x}}_j \mid I_i) - 2dt \geq 0,$$

where $I_i^e \equiv \{I_i, x_j \geq \widetilde{\widetilde{x}}_j\}$ and $I_i^{ne} = \{I_i, x_j < \widetilde{\widetilde{x}}_j\}$ and recall that $I_i \equiv \{x_i, x_j \geq \widetilde{x}_j\}$. Intuitively, a higher private signal x_i raises the expected merger gains and the probability that the partner exerts effort. Hence, the function $g(\cdot)$ is increasing in x_i and the partner makes more easily an effort when it receives a higher signal. As a consequence, this condition uniquely defines a post-merger effort cutoff $\widetilde{\widetilde{x}}_i$ for each double switching strategy of the other firm $(\widetilde{x}_j, \widetilde{\widetilde{x}}_j)$. Firm i exerts effort if and only if $x_i \geq \widetilde{\widetilde{x}}_i$.

At the merger stage, therefore, Firm i knows whether it will make an effort later on. If Firm i knows that it would exert effort in the post-merger stage, $x_i \geq \widetilde{\widetilde{x}}_i$, it merges whenever

$$h(x_i, \widetilde{x}_j, \widetilde{\widetilde{x}}_j) \equiv dE(\theta \mid I_i^e) \Pr ob(x_j \geq \widetilde{\widetilde{x}}_j \mid I_i) + E(\theta \mid I_i^{ne}) \Pr ob(x_j \leq \widetilde{\widetilde{x}}_j \mid I_i) - 2d(t+k) \geq 0.$$

Similarly, if Firm i knows that it would not make an effort later on, $x_i < \widetilde{\widetilde{x}}_i$, it merges whenever

$$m(x_i, \widetilde{x}_j, \widetilde{\widetilde{x}}_j) \equiv E(\theta \mid I_i^e) \Pr ob(x_j \geq \widetilde{\widetilde{x}}_j \mid I_i) - 2dk \geq 0.$$

Intuitively again, a higher private signal x_i increases $h(\cdot)$ and $m(\cdot)$ and induces Firm i to merge more easily. Given that $h(\widetilde{\widetilde{x}}_i, \widetilde{x}_j, \widetilde{\widetilde{x}}_j) = m(\widetilde{\widetilde{x}}_i, \widetilde{x}_j, \widetilde{\widetilde{x}}_j)$, the previous conditions uniquely define a merger cutoff $\widetilde{x}_i$ for each $(\widetilde{x}_j, \widetilde{\widetilde{x}}_j)$ such that Firm i will decide to merge if and only if $x_i \geq \widetilde{x}_i$. In summary, Firm i's best response to a switching strategy is also a switching strategy.[18]

3.2 Equilibrium

Given that the model is (de facto) symmetric, we concentrate on equilibria in the class of symmetric strategies whereby partners i and j play the same double switching strategy, $\widetilde{x}_i = \widetilde{x}_j \equiv \widetilde{x}$ and $\widetilde{\widetilde{x}}_i = \widetilde{\widetilde{x}}_j \equiv \widetilde{\widetilde{x}}$. We proceed in three steps. In a first step, we provide necessary and

[18] This implies that when solving for equilibria within the class of switching strategies, we can restrict attention to potential deviations within that class. If there is no profitable deviation to a switching strategy, there will not be a profitable deviation to a non-switching strategy.

sufficient conditions for double symmetric switching strategies to be equilibria. In a second step it is shown that, provided that the information gathered carries some noise, a unique equilibrium exists for each combination of the exogenous parameters.[19] In a last step, we find the unique equilibrium in function of these parameters.

LEMMA 2 *: CHARACTERIZATION OF THE EQUILIBRIUM.*

A pair of cutoffs $(\widetilde{x}, \widetilde{\widetilde{x}})$ *is an equilibrium in symmetric switching strategies iff*
(a) $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0, h(\widetilde{x}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0$ *and* $\widetilde{x} \geq \widetilde{\widetilde{x}}$ *or*
(b) $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0, m(\widetilde{x}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0$ *and* $\widetilde{x} \leq \widetilde{\widetilde{x}}$.

An equilibrium is found by the intersection of the post-merger effort decision function, implicitly defined by $g(\cdot) = 0$, and *either* the "I-will-later-exert-efffort" merger decision function $(h(\cdot) = 0)$ *or* the "I-will-later-not-exert-effort" merger decision function $(m(\cdot) = 0)$. The first intersection is an equilibrium if and only if, in this intersection, firms exert effort for a larger range of private signals than they merge $(\widetilde{x} \geq \widetilde{\widetilde{x}})$. Indeed, in such intersections, if the private signal is higher than the effort cutoff $(x_i \geq \widetilde{\widetilde{x}})$, a firm merges when the private signal is higher than the merger cutoff defined by the "I-will-later-exert-effort" function $(x_i \geq \widetilde{x})$. If the private signal is lower than the effort cutoff $(x_i < \widetilde{\widetilde{x}})$, the firm would never merge. On the other hand, an intersection of $g(\cdot)$ and $h(\cdot)$ where $\widetilde{x} < \widetilde{\widetilde{x}}$ is not an equilibrium. When the private signal is below the effort cutoff $(x_i < \widetilde{\widetilde{x}})$, the "I-will-later-exert-effort" merger function does not apply. The same reasoning holds for the other intersection.

The next step is to show that when the private signal has enough noise there is a unique pair that satisfies (a) or (b) of the previous lemma, and therefore a unique equilibrium exists.

PROPOSITION 1 *: EXISTENCE AND UNIQUENESS OF THE EQUILIBRIUM.*

If $l \geq l^* \equiv \frac{6d(d-2)t}{(3d-4)(d-1)}$ *there is a unique equilibrium in symmetric switching strategies.*

The merger decision of each firm transforms part of its private information into public. This public information has a "multiplier effect" on all actions, because both firms know that the

[19] Uniqueness of equilibrium is not straightforward in our game. Although effort decisions are strategic complements with respect to each other, merger and effort decisions are not. For a comprehensive analysis of games with strategic complementarities, see Vives [66].

partner has received this information. Public information, therefore, exceeds its pure informational content and the problem of self-fulfilling beliefs arises again. This is a feature that keeps on returning in the global games literature: one needs the public signal to be noisy enough to reach a unique equilibrium (Morris and Shin [40]). The particular feature in our model, however, is that the *private* signal becomes partly public through the merger decision. Thus, in order to have uniqueness, we need the private signal to be noisy enough. Angeletos et al. [4] obtain a result in the same spirit as ours in a dynamic version of the game of Morris and Shin [40].

Assuming that this condition is satisfied, we are able to characterize the unique equilibrium in function of the parameters of our model.

Proposition 2 *: Equilibrium.*

Defining $x^* \equiv \frac{2dt}{d-1} - \frac{l}{3}$*, the symmetric switching equilibrium* $(\widetilde{x}, \widetilde{\widetilde{x}})$ *satisfies:*

(a) If $k = \frac{t}{d-1}$ *then* $\widetilde{x} = x^* = \widetilde{\widetilde{x}}$*.*

(b) If $k > \frac{t}{d-1}$ *then* $\widetilde{x} > x^* > \widetilde{\widetilde{x}}$*.*

(c) If $k < \frac{t}{d-1}$ *then* $\widetilde{x} < x^* < \widetilde{\widetilde{x}}$*.*

First, in (a) above, a special case of the exogenous parameters, merger and effort decisions are the same. Firms find it profitable to merge in the same cases where they optimally exert effort. Second, if the costs of merging are higher, then merging becomes more expensive. As a direct consequence, firms merge less and the cutoff from merging is higher than before. Indirectly, since the acceptance of merging transmits a more positive signal, firms exert effort more easily than before and the cutoff from making an effort is lower (part b). Finally, following the same reasoning, if the opportunity costs of merging are lower firms merge more and exert effort less often (part c).

3.3 Extension

We now briefly consider the case in which firms receive a private and a public signal before merging. The introduction of a public signal y along with the private signals x_i and x_j does not significantly alter the results. The proposition can be restated in terms of the two types of information, as shown in the following proposition. In particular, noisy enough signals are again sufficient to ensure uniqueness.

Proposition 3 *: Extension to private and public information.*

There exists a unique l^{**} such that if $l \geq l^{**}$ then there exists a unique symmetric equilibrium in switching strategies $(\widetilde{x}, \widetilde{\widetilde{x}})$. Defining $r \equiv \frac{3}{2}(\frac{2dt}{d-1} + \frac{l}{3} - y)$ and

$$x^{**} \equiv \begin{cases} \frac{6dt}{d-1} - l - 2y & \text{if } y \leq \frac{2dt}{d-1} - \frac{l}{3} \\ y + 2l + r - \sqrt{r^2 + 2(2l)^2} & \text{if } y > \frac{2dt}{d-1} - \frac{l}{3} \end{cases}$$

the equilibrium is such that

(a) If $k = \frac{t}{d-1}$ then $\widetilde{x} = x^{**} = \widetilde{\widetilde{x}}$.

(b) If $k > \frac{t}{d-1}$ then $\widetilde{x} > x^{**} > \widetilde{\widetilde{x}}$.

(c) If $k < \frac{t}{d-1}$ then $\widetilde{x} < x^{**} < \widetilde{\widetilde{x}}$.

4 Post-Merger Failures

We now give a formal definition of failure. Mergers are evaluated at the end of the post-merger process, once partners observe the equilibrium efforts, e_1^* and e_2^*.[20]

Definition 3 *A post-merger failure occurs when both firms agree to merge but, at the end of the post-merger process, the gains expected by each merging partner are lower than the stand-alone profits, i.e. for $i = 1, 2$, $i \neq j$*

$$\pi^s + f\left(e_i^*, e_j^*\right) E(\theta \mid I_i^p, e_i^*, e_j^*)/2 - k < \pi^s.$$

We define failure gross of the cost of effort. Indeed, to evaluate whether a merger is a failure in terms of profits (and share prices), the cost of effort of the management should not be included. Second, we define failure in expected terms. Failure can of course always occur when the realization of the uncertain gains θ is lower than expected, independent of the level of effort exerted by the partners. Third, we consider the merger a failure when it is considered a failure by each individual partner. This is done for notational ease, but our definition would be equivalent to each partner evaluating the sum of profits, given its information. Finally, each individual partner considers whether the merger is a failure using the information it has available. This is the strongest possible definition of failure. As we show in the following lemma, post-merger failures can then only occur when none of the partners exerts effort. As such, we establish a lower bound of the failure rates in function of our parameters.

[20] Even though partners can observe the post-merger effort level chosen by the other at the end of the process, these efforts are, as mentioned above, asssumed to be non-verifiable and therefore non-contractible.

Lemma 3 *A post-merger failure occurs if and only if both partners merge and exert no effort.*

The proof of this result is straightforward. First, if none of the partners makes any effort, this is a post-merger failure by definition. Second, if they merge and only one makes an effort, this is not a failure. The partner that made no effort merged because this was a profitable decision, even before knowing with certainty the effort choice of its partner. After observing that the partner has exerted effort, it should expect even higher profits. Third, if both exert effort, the same reasoning holds. Both entered the merger without knowing the action of the partner in the post-merger stage and should expect higher profits after observing it.

We are now ready to formally state our explanation of merger failures. In the next corollary, that follows directly from Proposition 2 and Lemma 3, we describe in which situations post-merger failures occur.

Corollary 1 : post-merger failures.

When all information about uncertain merger gains is private, post-merger failures occur when $k < \frac{t}{d-1}$ *and* $\widetilde{x} \leq x_i < \widetilde{\widetilde{x}}$ *for* $i = 1, 2$.

As shown in Lemma 3, a post-merger failure can only occur if both firms choose to merge but not to exert post-merger effort. For this to happen, it is necessary that the merger decision is taken more easily than the effort decision, i.e. in equilibrium one must have that $\widetilde{x} < \widetilde{\widetilde{x}}$. By Proposition 2, this occurs when the costs of merging (k) are low, the degree of complementarity of efforts (d) is low and the costs of effort (t) are high enough such that $k < \frac{t}{d-1}$. In order for a failure to *de facto* occur, it must be that the private signals received by both partners are intermediate, $\widetilde{x} \leq x_i < \widetilde{\widetilde{x}}$ for $i = 1, 2$. Both partners have gathered information about the merger gains, which are good enough to merge (merging costs are low) but not so good so as to exert effort (cost of effort is high). Indeed, each gives a reasonable probability that the other will exert effort and prefers to free-ride on it (the degree of complementarity is low). The merger then goes ahead but fails because both choose not to exert effort.

We have assumed that private signals remain private throughout. But failure could not be avoided even if communication was possible. As argued in the introduction, a potential partner does not want, or is not allowed, to give out all its information before merging. Failure could not be avoided by post-merger communication either. Each partner has incentives to overstate its private signal independently of its effort decisions. Indeed, one partner always prefers the other to exert effort. Under these conditions, credible communication cannot be supported in equilibrium, as shown by Baliga and Morris [6].

From Lemma 3 it is clear that if post-merger efforts were guaranteed, a post-merger failure would never occur. Notice that in that case, merging partner i would choose to merge whenever $E(\theta \mid x_i, x_j \geq \hat{x}_j) - 2(t+k) \geq 0$ and the symmetric equilibrium in switching strategies would be $\hat{x} = 2(t+k) - \frac{l}{3}$. Then, in our model, when x_i for $i = 1, 2$ is such that $\widetilde{x} < x_i < \widetilde{\widetilde{x}}$ and $x_i \geq \hat{x}$, a post-merger failure would have been avoided if both partners had merged and had exerted effort. On the other hand, if $x_i < \hat{x}$ or $x_j < \hat{x}$, and $\widetilde{x} < x_i < \widetilde{\widetilde{x}}$ for $i = 1, 2$ then the post-merger failure would not have occurred if the post-merger efforts were guaranteed since the merger would not have gone through.

5 Comparative statics

In Section 3, we showed that our game has a unique equilibrium in the class of symmetric switching strategies if the private signal is not very precise. Here, we exploit this property to analyze which situations should lead to more merger failures as defined in Section 4. We analyze how the probability of failure, given θ, varies with the exogenous parameters of the model. To avoid uninteresting situations, we analyze the cases where it is possible that firms merge ($\widetilde{x} \leq \theta + l$) and where it is possible that they do not exert effort ($\widetilde{\widetilde{x}} > \theta - l$). Further, we concentrate on the most natural case in which more post-merger effort leads to more incentives to merge, which corresponds to the case in which the sum of the thresholds is positive, $\widetilde{x} + \widetilde{\widetilde{x}} > 0$ (see the proof of Proposition 1). For simplicity, we restrict ourselves to the case with private information only.

The probability of failure is defined as the probability that the merger fails, given that both firms decided to merge. As shown in Lemma 3, failure is directly related to the probability that a firm i does not exert a post-merger effort when it has decided to merge.

Definition 4 *The "probability of failure" is the probability that the merger fails given that both firms have decided to merge, that is,* $Prob(x_1 < \widetilde{\widetilde{x}} \mid x_1 > \widetilde{x}, \theta) * Prob(x_2 < \widetilde{\widetilde{x}} \mid x_2 > \widetilde{x}, \theta)$*, where*

$$Prob(x_i < \widetilde{\widetilde{x}} \mid x_i > \widetilde{x}, \theta) = \begin{cases} \frac{\min\{\widetilde{\widetilde{x}}, \theta+l\} - \max\{\widetilde{x}, \theta-l\}}{\theta+l-\max\{\widetilde{x}, \theta-l\}} & \text{if } \widetilde{x} \leq \widetilde{\widetilde{x}} \\ 0 & \text{if } \widetilde{x} > \widetilde{\widetilde{x}}. \end{cases}$$

Costs of merging

Let us first consider comparative statics with respect to fixed costs of merging k. Similar to the intuition provided for Proposition 2, higher costs of merging lead firms to merge less easily. The acceptance of the merger by the other partner thus yields more positive information. Therefore, expected merger gains and the likelihood of the partner exerting post-merger effort become higher. Hence, the firm is more prone to exert effort. Thus, the distance between $\widetilde{\widetilde{x}}$ and $\widetilde{x}$ becomes smaller and that of between $\theta + l$ and $\widetilde{x}$ larger. Therefore, the probability of failure is lower.

COROLLARY 2 : COSTS OF MERGING.

Higher costs of merging (k greater) lead to less mergers ($\widetilde{x}$ greater) and more post-merger effort ($\widetilde{\widetilde{x}}$ lower) and therefore to a lower probability of failure.

The following figure shows as an example both cutoffs for the case in which $d = 3$, $l = 2$ and $t = 0.5$, with k varying from 0 to 0.5. For k going from 0 to 0.25, $\widetilde{x} < \widetilde{\widetilde{x}}$ and the possibility of failure exists. And, the lower k is, the bigger the range where failure might occur. The figure also depicts the merging cutoff if post-merger efforts were guaranteed. As argued in the previous section, this cutoff shows that the post-merger failure could have been avoided either by exerting effort (in the region above) or by not merging (in the region below).

<<Insert Figure 2 about here>>

Costs of post-merger effort

We now turn to the cost t of exerting post-merger effort. First, higher costs t lead partners to exert less effort. As a result, firms merge less since they also expect their partners to exert less effort. However, while the cost of effort t has a first-order effect on a firm's effort decisions, on the merger decision it has only a second-order effect. Cutoff $\widetilde{\widetilde{x}}$ rises therefore faster than cutoff $\widetilde{x}$ and the possibility of failure becomes higher.

Corollary 3 *:* Costs of post-merger efforts.

Higher costs of post-merger effort (t greater) lead to less mergers ($\widetilde{x}$ greater) and less effort ($\widetilde{\widetilde{x}}$ greater) and therefore to a higher probability of failure.

The following figure shows as an example both cutoffs for the case in which $d = 3$, $l = 2$ and $k = 0.25$, with t varying from 0.25 to 0.75. For t greater than 0.5, $\widetilde{x} < \widetilde{\widetilde{x}}$ and the possibility of failure exists. And, the greater t is, the bigger the range where failure might occur.

<<Insert Figure 3 about here>>

Complementarity of post-merger efforts

We now turn to the measure d of degree of complementarity of post-merger actions. The higher d is, the more complementary post-merger efforts are. More complementarity punishes "one-sided" effort more heavily as it discounts even more the non-synergistic merger gains in the case where only one partner exerts effort. Thus, if a firm accepts the merger, it will more easily exert post-merger efforts. Therefore, at the merger stage, each firm gives a higher probability that its partner will make an effort. This effect should induce firms to merge more often. There is, however, a second and opposite effect at the merger stage. Although one-sided effort occurs less often, the losses when this happens are larger for a higher complementarity. As a consequence, firms might merge less. In what follows, we show that this second effect is stronger and firms consequently merge less for a higher complementarity. Given that they also exert effort more often, the probability of failure therefore becomes smaller.

Unfortunately, because of the two opposite effects on merging explained above, it is not possible to derive the result analytically. As shown in Lemma 2, the merger and the post-merger effort equilibrium strategies are the unique solution of a complex non-linear system of equations: the intersection of an increasing function ($\widetilde{\widetilde{x}}(\widetilde{x})$, determined by $g(.)$), and a decreasing function ($\widetilde{x}(\widetilde{\widetilde{x}})$, determined by either $h(.)$ or $m(.)$, depending on the parameter region). Given that the costs of merging and the costs of effort shift only one of these curves, we have been able to derive implicit comparative statics results analytically. Unfortunately, in the case of the complementarity of the efforts, d, a change in the exogenous variable shifts *both* curves. On the one hand, a higher d shifts the curve $\widetilde{x}(\widetilde{\widetilde{x}})$ outwards. On the other hand, it shifts the curve $\widetilde{\widetilde{x}}(\widetilde{x})$ inwards. Although this unambiguously leads to more effort as $\widetilde{\widetilde{x}}$ decreases, showing wether this leads to more or less merers is not straightforward, as the net effect on $\widetilde{x}$ is not clear.

By making use of simulation techniques, however, we are able to show that a higher d indeed leads to a higher $\widetilde{x}$. In a spreadsheet available from the authors' webpages, it is possible to select an exogenous range for d, k, l and t, and the number of discrete points to analyze. The programme then shows the minimum of $\widetilde{x}(d) - \widetilde{x}(d-1)$ for all d and the maximum of $\widetilde{\widetilde{x}}(d) - \widetilde{\widetilde{x}}(d-1)$ for all d. For every combination of k, l and t, the minimum is positive and therefore $\widetilde{x}(d) - \widetilde{x}(d-1)$ is positive for any d and $\widetilde{x}(\cdot)$ is always increasing and mergers are thus less frequent. Similarly, given that the maximum is negative, $\widetilde{\widetilde{x}}(d) - \widetilde{\widetilde{x}}(d-1)$ is negative for any d and therefore $\widetilde{\widetilde{x}}(\cdot)$ is decreasing. We state these findings in the following result.

Result 5 *:* Complementarity of post-merger efforts.

A higher complementarity of efforts (d greater) leads to less mergers ($\widetilde{x}$ greater) and more post-merger effort ($\widetilde{\widetilde{x}}$ lower) and therefore to a lower probability of failure.

As an example, the next figure shows the cutoffs for the case $\{k, l, t\} = \{0.15, 2, 0.5\}$.

<<Insert Figure 4 about here>>

6 Empirical predictions

In this section we propose empirical operalizations of our comparative statics and indicate whether existing empirical evidence can be matched to our predictions.

Costs of merging

Prediction 1 *Higher costs of merging lead to less mergers and less failures.*

We propose three measures of costs of merging that have been used in the literature: **(i)** the firms' degree of cash-richness, **(ii)** the economy-wide capital liquidity, and **(iii)** for large firms, the strictness of merger policy in a jurisdiction.

(i) A first measure of the costs of merging can be the firms' degree of cash-richness. Harford [27] argues that the transaction costs of merging can be lowered by holding cash reserves. A firm can avoid the costs associated with external financing if it maintains sufficient internal financial flexibility. He shows indeed that firms that have built up large cash reserves are more active in the merger market, even when controlling for stock price performance and sales growth. A higher cash reserve can thus be linked to lower costs of merging.

Our prediction is in line with Harford's [27] results on merger performance. He finds that both operating performance and abnormal stock price reactions to acquisition bid announcements by cash-rich bidders are negative and decreasing in the amount of excess cash held by the bidder. He attributes these results to "agency-theories", where a cash stockpile insulates managers from monitoring by external markets. Our model shows that it might also be that higher cash piles -and therefore lower transaction costs- induce less effort and hence increase merger failure.

(ii) Costs of merging can be measured by the aggregate level of capital liquidity. Harford [29] shows that high aggregate capital liquidity, which reduces the costs of merging, is a necessary condition for mergers to occur in waves. Although economic, regulatory and technological shocks drive merger benefits, whether these shocks lead to a merger 'wave', he argues, depends on whether there is sufficient overall capital liquidity.[21]

Although there is no direct evidence linking aggregate cost of capital and merger performance, one can make indirect inferences. Since high capital liquidity is linked with the occurrence of merger waves, one can use the existing empirical evidence on the performance of wave-mergers as opposed to non-wave mergers. Consistent with our prediction, Gugler et al. [24] shows that wave-mergers perform significantly worse than non-wave mergers in the long term. The median abnormal return after three years is more than 11% lower for wave-mergers. Further, Harford's [28] wave-dummy is significantly negative for different regressions of long-run merger performance. Also Rosen [52] finds that long-run returns are significantly lower for mergers announced in periods when the merger market is booming. These papers explain this observation due to merger waves coinciding not only with high cash liquidity, but also overvalued stockmarkets. The reason offered by these so-called "misvaluation" theories goes as follows: during times

[21] This reasoning is remiscent to Shleifer and Vishny [54] who hypothesize that part of the reason why merger waves always occur in booms is because booms typically coincide with increases in cash flows and thus less financial constraints.

of high valuations over-valued acquirers prefer to finance deals with stocks, and targets accept these offers. Our model, thus, offers an alternative logic for these observations.

(iii) One could finally argue that the costs of merging are higher in regimes with stricter merger policies. Strictness of a merger policy in a given year can be defined as the number of merger prohibitions or the total number of merger policy actions (prohibitions and merger remedies). Seldeslachts et al. [57] confirm that a stricter merger policy is perceived by (large) firms as leading to a higher cost of merging. A test could be derived to assess not only the incentives to merge, but also a merger's subsequent performance.

In sum, we propose three measures that can be related to the cost of merging, which make them thus potentially useful measures to test our first prediction. While the first two measures -an individual firm's degree of cash-richness and the economy-wide capital liquidity- are related and empirical evidence on these is consistent with our model's predictions, the third measure -the strictness of merger policy- has so far not been connected to merger performance.

Costs of post-merger effort

Prediction 2 *Higher costs of post-merger effort lead to less mergers and more failures.*

To obtain a direct measure for cost of effort is hard.[22] One can, however, make a link between ability and cost of effort, where for more able agents it is less costly to exert effort.[23] Then, in the context of mergers, the ability of (managers in) firms during the post-merger stage has been linked to **(i)** the knowledge base of merging firms and **(ii)** the experience built in previous mergers. We explain each factor in turn and relate existing empirical evidence to our prediction.

(i) Ahuja and Katila [3] and Cloodt et al. [14] argue that a greater pre-merger knowledge base has a positive impact on the post-merger (innovation) performance. The underlying reasoning

[22] There are few papers that have tried to empirically measure cost of effort. Foster and Rosenzweig [22] provide a direct test for effort and cost of effort, using information on worker's health, consumption and work time. Delfgauw and Dur [16] test whether people differ in their disutility from work effort because they face different external constraints (e.g. the care for children). See Prendergast [45] for an overview of empirical tests of agency models in firms.

[23] In Spence's [62] signaling model, for example, clever people can signal their ability through education, given that their cost of studying is lower.

is that (innovation) outputs are often the result of recombining existing elements of knowledge into new syntheses (Kogut and Zander [34], Teece et al. [61]). Then, the number of post-merger direct combinations of existing elements increases exponentially with the size of its knowledge base.[24] Thus, one can argue that ability is higher -and costs of post-merger effort to realize synergies lower- for firms with larger pre-merger knowledge bases.

Given this operalization of post-merger costs of effort, our prediction is in line with empirical results. Both Ahuja and Katila [3] and Cloodt et al. [14] codify the size of the knowledge base by the pre-merger stock of patents. Ahuja and Katila [3] find that the pre-merger stock of patents has a positive impact on the post-merger innovation performance, measured as the number of successful patent applications 1-4 years after the merger. Cloodt et al. [14], using the same methodology, confirm this finding, although the positive effect disappears after two years in some industries.

(ii) One can relate the cost of post-merger effort to the merging experience of firms. Singh and Zollo [60] and Vermeulen and Barkema [64], for example, argue that knowledge accumulation through past mergers might have a positive impact on the performance of subsequent mergers. Thus, a more merger-experienced firm should have learnt from past mergers and should therefore have a lower cost in exerting post-merger effort.[25]

Given this operalization of post-merger costs of effort, our prediction is in line with empirical results. A measure of merger experience can be obtained by simply counting the number of previous mergers, which is one of the measures used by Singh and Zollo [60] and Vermeulen and Barkema [64]. Singh and Zollo [60] find a significant effect of past within-industry merger experience on post-merger return on assets. Vermeulen and Barkema [64] find an additional merger increases the probability that subsequent mergers will survive by 3.4 percent.

In sum, given that the cost of post-merger effort is difficult to observe directly, we propose using as proxies the knowledge base of merging firms -measurable through the pre-merger stock of

[24] For example, while a firm with five units of knowledge can generate ten combinations using two elements at a time, acquiring another firm with three units of knowledge increases the number of combinations that become available to twenty eight.

[25] To be more precise, the literature on how merger experience translates into learning may also be dependent on how well firms codify this knowledge, in which type of mergers firms were previously involved and whether these mergers were successes or failures. See e.g. Hayward [31] for a detailed investigation on how merger experience translates into learning and thus lower costs of post-merger effort in subsequent mergers.

patents- and the accumulated merger experience of merging partners -measurable through a count of previous merger participations. Existing evidence on the impact on post-merger R&D output or return on assets is consistent with our second prediction.

Complementarity of post-merger efforts

Prediction 3 *Higher complementarity of post-merger efforts leads to less mergers and less failures.*

There are several empirical papers that try to capture the degree of complementarities between merging firms, mostly in the context of technology and innovation. We shortly explain these papers, classified per methodology, and indicate again where and how one could relate their results to the predictions of our model.

(i) Cassiman et al. [12] look at mergers that differ in their degree of technological complementarities. Merging firms are classified as having more complementarities if they had R&D projects in different technological fields and/or had developed capabilities in the different stages of the R&D process (e.g. basic research from one side and development from the other). They find that mergers between partners coming from technologically more complementary fields lead to higher post-merger R&D effort, less organizational problems and more R&D output. These findings are consistent with our third prediction if one relates merger failure (or success) to R&D output.

(ii) Ahuja and Katila [3] and Ornaghi [41],[42] connect the degree of relatedness of the knowledge bases of the merging firms to their (innovative) performances, where relatedness is measured through the number of common patents and patent citations. Since each patent number uniquely identifies a distinct component of knowledge, they argue, the lower the number of patents that are common across two knowledge bases, the lower the relatedness between those knowledge bases. Therefore, the lower the number of common patents, the higher the degree of complementarity. Ornaghi [41] finds that a higher level of pre-merger technological relatedness between merged parties -and hence lower complementarities- is associated with both a lower post-merger R&D input and output, thus leading to poorer post-merger innovation performances. Furthermore, Ornaghi [42] finds a merger's stock value to be higher in subsequent years for a lower level of pre-merger technological relatedness.

(iii) Puranam et al. [46] argue that mergers might involve "component technologies", used as components of larger product systems, or "standalone technologies", used for creating standalone products. They claim that component technologies exhibit greater complementarities than standalone products. Indeed, the extent of effort interdependence is higher because component technologies cannot be used without significant adjustments to both components. They do not provide an empirical test of which type of merger is more successful.

In sum, there are various ways how one can capture the degree of complementarities between merging firms. Complementarities can be measured through the degree of relatedness in projects and processes (Cassiman et al. [12]), final products (Puranam et al. [46], Cassiman et al. [12]) or pre-merger knowledge bases (Ahuja and Katila [3], Ornaghi, [41],[42]). Some of the existing evidence (Cassiman et al. [12], and Ornaghi [41],[42]) can be related to our model and it is consistent with our third prediction.

7 Conclusion

This paper proposed a novel explanation as to why some mergers fail while others succeed based on pre-merger informational asymmetries, and problems of cooperation and coordination in the post-merger stage. We showed that each firm's management may optimally agree to merge and abstain from exerting post-merger efforts, expecting the merger partner to make the necessary efforts. We argued that, provided that they have the same information as their management, shareholders of each firm accept the merger agreement. The merger then goes ahead and fails.

Accordingly, these mergers are unprofitable. Share prices, on the other hand, can rise at the merger's announcement. Indeed, if the market has no more information than the firm, it should bid up the firm's price because the firm will take the appropriate merger decision in expected terms. Therefore, our setup may serve as an alternative to Fridolfsson and Stennek's [21] explanation for the empirical merger puzzle that unprofitable mergers often coincide with initially increasing share prices.

We identified under which conditions mergers are more likely to fail and explained how one can empirically test our predictions. First, lower merging costs, induced by, for example, a higher level of capital liquidity, induce firms not only to merge more but also to less often exert effort. As a result, failures occur with a higher probability. Second, higher costs of effort, which can for instance be related to firms having built less experience in previous mergers, lead to less mergers but still relatively more failures. Finally, higher complementarities between merging firms -in R&D for example- lead to less mergers but at the same time less failures. We further argued that the existing empirical evidence is consistent with these predictions.

Given the likelihood of failure, it is not surprising that firms go through great lengths in signaling to their prospective partners their commitment to the merger. Indeed, management's commitment has shown to be crucial in achieving merger success. Weber [67], for example, finds evidence for top managers' commitment -where commitment is defined as "[...] a willingness to exert considerable effort on behalf of the organization"- to have a significantly positive effect on mergers' financial performance in subsequent years.

Our framework focussed on a merger for synergies, where partners are kept as separately fully functioning. A simplified version of our framework could be extended by letting firms decide, as a function of the importance of synergy gains, between a merger of equals and a takeover. In a takeover, one firm buys out the other and gets rid of the strategic uncertainty in the post-merger stage. This forecloses the possibility of failure, but comes at the expense of the possibility of achieving synergy gains. In some cases, if the potential synergy gains are low, this might be optimal. More generally, one could allow for a sharing agreement which specifies the allocation of cash payments and shares of the profits of the new entity (as in Banal-Estañol and Ottaviani [8]). A particular case is where the merging firms split evenly the shares of the new company, i.e. a merger of equals. The other extreme is where firms opt for a pure takeover by assigning all the shares to one firm and transferring cash from this firm to the other.[26] A full investigation of this question is a challenging task for future research.

Finally, our insights may be suited for setups that go beyond mergers. In particular, co-authors writing a paper, businessmen setting up a new enterprise or firms entering an alliance may fail for the same reason. Failure may occur due to a lack of effort of the partners, despite both having voluntary entered the agreement. Consider for example the case of two co-authors undertaking a project. The paper will only have a chance of success if at least one author is sufficiently optimistic about the prospects of the undertaking, but each of them may enter the

[26] More generally, one could allow for a sharing agreement which specifies the allocation of cash payments and shares of the profits of the new entity (as in Banal-Estañol and Ottaviani [8]). Among possible agreements, the merging firms may evenly split the shares of the new company, i.e. a merger of equals. Alternatively, they may opt for a pure takeover by assigning all the shares to one firm and transferring cash from this firm to the other.

project if they believe that their co-author is more enthusiastic than they are.

Appendix A: Beliefs

If θ is a random variable with an improper distribution and firm i receives a private signal $x_i = \theta + \varepsilon_i$, where $\varepsilon_i \sim U(-l, l)$ with ε_i and θ independent, we have that $\theta \mid x_i \sim U(x_i - l, x_i + l)$.

Firm i does not observe firm j's private signal, x_j, but knows that $x_j = \theta + \varepsilon_j$ where $\varepsilon_j \sim U(-l, l)$ and ε_j and θ, ε_j and ε_i are independent. Since $\theta \mid x_i$ and ε_j are uniforms, we know that $x_j \mid x_i$ is a sum of uniforms, which results in a distribution function with density function,

$$f(x_j \mid x_i) = \begin{cases} \frac{x_j - x_i + 2l}{(2l)^2} & \text{if } x_j \in [x_i - 2l, x_i] \\ \frac{x_i + 2l - x_j}{(2l)^2} & \text{if } x_j \in [x_i, x_i + 2l], \end{cases}$$

and we can obtain

$$\Pr ob\left(x_j \geq \tilde{\tilde{x}}_j \mid x_i, x_j \geq \tilde{x}_j\right) = \frac{\Pr ob(x_j \geq \tilde{\tilde{x}}_j \mid x_i)}{\Pr ob(x_j \geq \tilde{x}_j \mid x_i)} = \begin{cases} \frac{\left(x_i + 2l - \tilde{\tilde{x}}_j\right)^2}{(x_i + 2l - \tilde{x}_j)^2} & \text{if } \ x_i \leq \tilde{x}_j \leq \tilde{\tilde{x}}_j \\ \frac{\left(x_i + 2l - \tilde{\tilde{x}}_j\right)^2}{2(2l)^2 - (\tilde{x}_j - x_i + 2l)^2} & \text{if } \ \tilde{x}_j \leq x_i \leq \tilde{\tilde{x}}_j \\ \frac{2(2l)^2 - \left(\tilde{\tilde{x}}_j - x_i + 2l\right)^2}{2(2l)^2 - (\tilde{x}_j - x_i + 2l)^2} & \text{if } \ \tilde{x}_j \leq \tilde{\tilde{x}}_j \leq x_i \\ 1 & \text{if } \ \tilde{x}_j > \tilde{\tilde{x}}_j. \end{cases}$$

We can find $\theta \mid x_i, x_j \sim (\theta \mid x_i) \mid (x_j \mid x_i)$ which is a uniform again, because $x_j \mid x_i$ is a sum of two uniform distributions and $(\theta \mid x_i)$ is a uniform. We have then $\theta \mid x_i, x_j \sim U[\min\{x_i, x_j\} + l, \max\{x_i, x_j\} - l\}]$. Given that

$$E(\theta \mid x_i, x_j \geq \tilde{x}_j, x_j \geq \tilde{\tilde{x}}_j) = \frac{\int_{x_j \geq \max\{\tilde{x}_j, \tilde{\tilde{x}}_j\},} [\int_\theta \theta f(\theta \mid x_i, x_j)] d\theta dx_j}{\Pr ob(x_j \geq \max\{\tilde{x}_j, \tilde{\tilde{x}}_j\} \mid x_i)}$$

we have that

$$E(\theta \mid x_i, x_j \geq \tilde{x}_j, x_j \geq \tilde{\tilde{x}}_j) = \begin{cases} \frac{2x_i + l + \tilde{x}_j}{3} & \text{if } \ x_i \leq \tilde{x}_j \text{ and } \tilde{\tilde{x}}_j \leq \tilde{x}_j \\ \frac{6x_i(2l)^2 - (\tilde{x}_j + 2x_i - l)(\tilde{x}_j - x_i + 2l)^2}{3\left[2(2l)^2 - (\tilde{x}_j - x_i + 2l)^2\right]} & \text{if } \ x_i > \tilde{x}_j \text{ and } \tilde{\tilde{x}}_j \leq \tilde{x}_j \\ \frac{2x_i + l + \tilde{\tilde{x}}_j}{3} & \text{if } \ x_i \leq \tilde{\tilde{x}}_j \text{ and } \tilde{\tilde{x}}_j > \tilde{x}_j \\ \frac{6x_i(2l)^2 - (\tilde{\tilde{x}}_j + 2x_i - l)(\tilde{\tilde{x}}_j - x_i + 2l)^2}{3\left[2(2l)^2 - \left(\tilde{\tilde{x}}_j - x_i + 2l\right)^2\right]} & \text{if } \ x_i > \tilde{\tilde{x}}_j \text{ and } \tilde{\tilde{x}}_j > \tilde{x}_j \end{cases}$$

and for $\tilde{x}_j \leq \tilde{\tilde{x}}_j$ we have that

$$E(\theta \mid x_i, x_j \geq \tilde{x}_j, x_j < \tilde{\tilde{x}}_j) = \frac{\int_{\tilde{x}_j \leq x_j \leq \tilde{\tilde{x}}_j} [\int_\theta \theta f(\theta \mid x_i, x_j) d\theta] f(x_j \mid x_i) dx_j}{\Pr ob(\tilde{x}_j \leq x_j \leq \tilde{\tilde{x}}_j \mid x_i)}$$

and analogous expressions can be obtained.

Appendix B: Proofs

Proof of Lemma 1

Firm 1's payoff from proposing the merger depends on the probability that Firm 2 agrees to merge. From the Law of Total Expectations, we can write Firm 1's payoff by proposing the merger as $[\pi^s + E(f\theta \mid I_1^m, x_2 \geq \widetilde{x}_2) - 2k - 2e_1t] \Pr ob(x_2 \geq \widetilde{x}_2 \mid I_1^m) + \pi^s \Pr ob(x_2 < \widetilde{x}_2 \mid I_1^m)$. Firm 1 agrees to propose as long as this expression is greater than π^s which, simplifying, amounts to the condition $E(f\theta \mid I_1^m, x_2 \geq \widetilde{x}_2) - 2k - 2e_1t \geq 0$.

Proof of Lemma 2

First take a pair $(\widetilde{x}, \widetilde{\widetilde{x}})$ that satisfies part (a). Suppose that firm j is using this switching strategy with cutoffs $(\widetilde{x}, \widetilde{\widetilde{x}})$. As argued in footnote 23, we only need to consider deviations within the class of switching strategies. By definition of $(\widetilde{x}, \widetilde{\widetilde{x}})$, Firm's i best response is to use, in the post-merger stage, a switching strategy with cutoff $\widetilde{\widetilde{x}}$. Now consider two cases. Suppose first that Firm i receives a private signal x_i below $\widetilde{\widetilde{x}}$. Knowing that it is not going to integrate, we can show that it is not going to merge, that is $m(x_i, \widetilde{x}, \widetilde{\widetilde{x}}) < 0$. Since $m()$ is an increasing function of x_i we have that $m(x_i, \widetilde{x}, \widetilde{\widetilde{x}}) < m(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}})$. By definition of g, h and m, we have that $m(\cdot) = h(\cdot) - g(\cdot)$ and also $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0$. Since $h(\cdot)$ is an increasing function in x_i and $h(\widetilde{x}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0$ and $\widetilde{x} \geq \widetilde{\widetilde{x}}$ then $h(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) < 0$. Hence, $m(x_i, \widetilde{x}, \widetilde{\widetilde{x}}) < 0$ and Firm i does not want to merge. Suppose secondly that Firm i receives a private signal x_i above $\widetilde{\widetilde{x}}$. Then it is going to merge, knowing that it is going to exert effort, whenever $x_i \geq \widetilde{x}$ by definition of $h(\cdot)$. We have shown that Firm i will merge whenever its private signal is above $\widetilde{x}$.

We now show that a pair $(\widetilde{x}', \widetilde{\widetilde{x}}')$ that satisfies $g(\widetilde{\widetilde{x}}', \widetilde{x}', \widetilde{\widetilde{x}}') = 0$ and $h(\widetilde{x}', \widetilde{x}', \widetilde{\widetilde{x}}') = 0$ but $\widetilde{\widetilde{x}}' > \widetilde{x}'$ is not an equilibrium. Suppose that Firm j uses a switching strategy with cutoffs $(\widetilde{x}', \widetilde{\widetilde{x}}')$. Firm's i best response is to use a switching strategy with cutoff $\widetilde{\widetilde{x}}'$ in the post-merger stage. Suppose that Firm i receives a private signal $x_i = \widetilde{x}' - \varepsilon$. Knowing that it does not exert effort, it will merge whenever $m(x_i, \widetilde{x}', \widetilde{\widetilde{x}}') \geq 0$. But since $m(x_i, \widetilde{x}', \widetilde{\widetilde{x}}') = h(x_i, \widetilde{x}', \widetilde{\widetilde{x}}') - g(x_i, \widetilde{x}', \widetilde{\widetilde{x}}')$ and $g(x_i, \widetilde{x}', \widetilde{\widetilde{x}}') < 0$ and $h(x_i, \widetilde{x}', \widetilde{\widetilde{x}}')$ is arbitrarily close to 0 when ε tends to 0, $m(x_i, \widetilde{x}', \widetilde{\widetilde{x}}') > 0$ and it will merge. Then $\widetilde{x}'$ cannot be a cutoff point.

The same arguments apply for (b).

Proof of Proposition 1

From the definition of $g()$, we have that

$$g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) \equiv (d-1)E(\theta \mid I_i^e) \Pr ob(x_j \geq \widetilde{\widetilde{x}} \mid I_i) + E(\theta \mid I_i^{ne}) \Pr ob(x_j \leq \widetilde{\widetilde{x}} \mid I_i) - 2dt \geq 0,$$

where abusing of the notation $I_i^e = \{I_i, x_j \geq \widetilde{\widetilde{x}}\}$, $I_i^{ne} = \{I_i, x_j < \widetilde{\widetilde{x}}\}$ and $I_i \equiv \{\widetilde{\widetilde{x}}, x_j \geq \widetilde{x}\}$. This expression is increasing in $\widetilde{x}$. As shown in Appendix A, we can obtain for the uniform distribution that if $\widetilde{\widetilde{x}} \geq \widetilde{x}$,

$$g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = \frac{(d-1)(3\widetilde{\widetilde{x}} + l)(2l)^2 + (\widetilde{\widetilde{x}} - \widetilde{x})\left[\widetilde{\widetilde{x}}(6l - \widetilde{x} - 3\widetilde{\widetilde{x}}) + (\widetilde{\widetilde{x}} + \widetilde{x})(3l + \widetilde{x} + \widetilde{\widetilde{x}})\right]}{6(2l)^2 - 3(\widetilde{x} - \widetilde{\widetilde{x}} + 2l)^2} - 2dt,$$

whereas if $\widetilde{\widetilde{x}} < \widetilde{x}$,

$$g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = \frac{(d-1)(2\widetilde{\widetilde{x}} + l + \widetilde{x})}{3} - 2dt.$$

We can show that when $l \geq \frac{6d(d-2)t}{(3d-4)(d-1)}$, then $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}})$ is also increasing in $\widetilde{\widetilde{x}}$. Then, by the implicit function theorem, we get that $\widetilde{\widetilde{x}}$, such that $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0$ is a decreasing function of $\widetilde{x}$.

Using the implicit function theorem again we can show that $\widetilde{x}''$ such that $m(\widetilde{x}'', \widetilde{x}'', \widetilde{\widetilde{x}}'') = 0$ is an increasing function of $\widetilde{\widetilde{x}}''$ except when $\widetilde{x}'' - \widetilde{\widetilde{x}}'' < 0$ and $\widetilde{x}'' + \widetilde{\widetilde{x}}'' < 0$. Outside this region more effort implies more incentives to merge. Therefore, if $\widetilde{x}''$ such that $m(\widetilde{x}'', \widetilde{x}'', \widetilde{\widetilde{x}}'') = 0$ is never in this region, there is a unique pair $(\widehat{x}', \widetilde{\widehat{x}}')$ such that $g(\widetilde{\widehat{x}}', \widehat{x}', \widetilde{\widehat{x}}') = 0$ and $m(\widehat{x}', \widehat{x}', \widetilde{\widehat{x}}') = 0$. In the case in which it is (and more effort implies less incentives to merge), we can also show that there is a unique pair $(\widehat{x}', \widetilde{\widehat{x}}')$ because the two curves could never cross twice. This can never happen because the derivative of $\widetilde{x}''(\widetilde{\widetilde{x}}'')$ is increasing and that of $\widetilde{\widetilde{x}}(\widetilde{x})$ is decreasing and the derivative of the first function at $\widetilde{x}'$ is larger than the derivative of the second at $\widetilde{\widetilde{x}}$. Similarly, we can show that there is a unique pair $(\widehat{x}, \widehat{\widehat{x}})$ such that $g(\widehat{\widehat{x}}, \widehat{x}, \widehat{\widehat{x}}) = 0$ and $h(\widehat{x}, \widehat{x}, \widehat{\widehat{x}}) = 0$.

Suppose first that $\widehat{x} \leq \widehat{\widehat{x}}$. This is, by the previous lemma, an equilibrium. Now we need to show that $(\widehat{x}', \widetilde{\widehat{x}}')$ such that $g(\widetilde{\widehat{x}}', \widehat{x}', \widetilde{\widehat{x}}') = 0$ and $m(\widehat{x}', \widehat{x}', \widetilde{\widehat{x}}') = 0$ is not, i.e. that $\widehat{x}' \leq \widetilde{\widehat{x}}'$. Since $g(\widehat{\widehat{x}}, \widehat{x}, \widehat{\widehat{x}}) = 0$ and $h(\widehat{\widehat{x}}, \widehat{x}, \widehat{\widehat{x}}) \geq h(\widehat{x}, \widehat{x}, \widehat{\widehat{x}}) = 0$, we have that $m(\widehat{\widehat{x}}, \widehat{x}, \widehat{\widehat{x}}) = h(\widehat{\widehat{x}}, \widehat{x}, \widehat{\widehat{x}}) - g(\widehat{\widehat{x}}, \widehat{x}, \widehat{\widehat{x}}) \geq 0$. Since $\widehat{\widehat{x}}(\widehat{x})$ such that $g(\widehat{\widehat{x}}, \widehat{x}, \widehat{\widehat{x}}) = 0$ is a decreasing function, the combination $(\widehat{x}', \widetilde{\widehat{x}}')$ such that $g(\widetilde{\widehat{x}}', \widehat{x}', \widetilde{\widehat{x}}') = 0$ and $m(\widehat{x}', \widehat{x}', \widetilde{\widehat{x}}') = 0$ should satisfy $\widehat{x}' \leq \widehat{x}$ and $\widetilde{\widehat{x}}' \geq \widehat{\widehat{x}}$. But then, since $\widehat{x} \leq \widehat{\widehat{x}}$, then $\widehat{x}' \leq \widetilde{\widehat{x}}'$ and therefore, from the previous lemma $(\widehat{x}', \widetilde{\widehat{x}}')$ cannot be an equilibrium. If, secondly, $\widehat{x} > \widehat{\widehat{x}}$ then $(\widehat{x}, \widehat{\widehat{x}})$ is not an equilibrium by the previous lemma. However, following a similar reasoning as above we can show that $\widehat{x}' > \widehat{\widehat{x}}'$ and therefore $(\widehat{x}', \widehat{\widehat{x}}')$ is an equilibrium.

Proof of Proposition 2

(a) Suppose first that $k = \frac{t}{d-1}$. If $\widetilde{x} = \widetilde{\widetilde{x}} = \frac{2dt}{d-1} - \frac{l}{3} \equiv x^*$ then $E(\theta \mid \widetilde{x}, x_j \geq \widetilde{x}, x_j \geq \widetilde{\widetilde{x}}) = \frac{2dt}{d-1}$ and $\Pr ob(x_j \geq \widetilde{\widetilde{x}} \mid \widetilde{x}, x_j \geq \widetilde{x}) = 1$ and $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = h(\widetilde{x}, \widetilde{x}, \widetilde{\widetilde{x}}) = m(\widetilde{x}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0$. This is an equilibrium because parts (a) and (b) of Lemma 2 are satisfied. Moreover this equilibrium is unique by Proposition 1.

(b) Second, it $k > \frac{t}{d-1}$ then $h(x^*, x^*, x^*) = m(x^*, x^*, x^*) < 0$ and following an argument similar to the one presented in the proof of the previous proposition, the equilibrium satisfies part (a) in Lemma 2.

(c) When $k < \frac{t}{d-1}$ then $h(x^*, x^*, x^*) = m(x^*, x^*, x^*) > 0$ and then the equilibrium satisfies part (b) in Lemma 2.

Proof of Proposition 3

Following the same procedure as in Section 3, we are going to obtain $g(x_i, \widetilde{x}_j, \widetilde{\widetilde{x}}_j, y)$, $h(x_i, \widetilde{x}_j, \widetilde{\widetilde{x}}_j, y)$ and $m(x_i, \widetilde{x}_j, \widetilde{\widetilde{x}}_j, y)$. The same arguments of the proof of Lemma 2 apply here and we need again to look for intersections of $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}, y)$ and $h(\widetilde{x}, \widetilde{x}, \widetilde{\widetilde{x}}, y)$ when $\widetilde{\widetilde{x}} \leq \widetilde{x}$ and of $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}, y)$ and $m(\widetilde{x}, \widetilde{x}, \widetilde{\widetilde{x}}, y)$ when $\widetilde{\widetilde{x}} \geq \widetilde{x}$. As in Proposition 1, there exists l^{**} such that $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}, y)$ is an increasing function of $\widetilde{\widetilde{x}}$ and therefore the equilibrium is unique. Similar to Proposition 2, we have that when $k = \frac{t}{d-1}$, an equal cutoff for the merging and effort decisions, $x^{**} = \widetilde{x} = \widetilde{\widetilde{x}}$ satisfies $g(x^*, x^*, x^*, y) = m(x^*, x^*, x^*, y) = h(x^*, x^*, x^*, y) = 0$ and is therefore an equilibrium. The expression, in function of y and the exogenous variables, is stated in the text. And, similarly, if $k > \frac{t}{d-1}$ or $k < \frac{t}{d-1}$ we have the orderings in (b) and (c), respectively.

Proof of Corollary 2

Given that $m(\cdot)$ is decreasing in k and increasing in $\widetilde{x}$, $\widetilde{x}(\widetilde{\widetilde{x}}, k)$ such that $m(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}, k) = 0$ is increasing in k. On the other hand, $g(\cdot)$ is an independent function of k. Given that $\widetilde{\widetilde{x}}(\widetilde{x})$ such that $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0$ is a decreasing function of $\widetilde{x}$, we have that if $(\widetilde{x}, \widetilde{\widetilde{x}})$ satisfy $g(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}) = 0$ and $m(\widetilde{\widetilde{x}}, \widetilde{x}, \widetilde{\widetilde{x}}, k) = 0$ and $(\widetilde{x}', \widetilde{\widetilde{x}}')$ satisfy $g(\widetilde{\widetilde{x}}', \widetilde{x}', \widetilde{\widetilde{x}}') = 0$ and $m(\widetilde{\widetilde{x}}', \widetilde{x}', \widetilde{\widetilde{x}}', k') = 0$ for $k' > k$ then $\widetilde{x} < \widetilde{x}'$ and $\widetilde{\widetilde{x}} > \widetilde{\widetilde{x}}'$. The same arguments apply for the intersections of $g(\cdot)$ and $h(\cdot)$.

Proof of Corollary 3

Given that $g(\cdot)$ is decreasing in t and increasing in $\widetilde{\widetilde{x}}$, $\widetilde{\widetilde{x}}(\widetilde{x},t)$ such that $g(\widetilde{x},\widetilde{x},\widetilde{\widetilde{x}},t)=0$ is increasing in t. On the other hand, $m(\cdot)$ is an independent function of t. Hence, given that $\widetilde{x}(\widetilde{\widetilde{x}})$ such that $m(\widetilde{\widetilde{x}},\widetilde{x},\widetilde{\widetilde{x}})=0$ is an increasing function of $\widetilde{\widetilde{x}}$, we have that if $(\widetilde{x},\widetilde{\widetilde{x}})$ satisfy $g(\widetilde{\widetilde{x}},\widetilde{x},\widetilde{\widetilde{x}})=0$ and $m(\widetilde{\widetilde{x}},\widetilde{x},\widetilde{\widetilde{x}},t)=0$ and $(\widetilde{x}',\widetilde{\widetilde{x}}')$ satisfy $g(\widetilde{\widetilde{x}}',\widetilde{x}',\widetilde{\widetilde{x}}')=0$ and $m(\widetilde{\widetilde{x}}',\widetilde{x}',\widetilde{\widetilde{x}}',t')=0$ for $t'>t$ then $\widetilde{x}<\widetilde{x}'$ and $\widetilde{\widetilde{x}}<\widetilde{\widetilde{x}}'$. Therefore, higher costs of integrating lead to less mergers and less integration.

In order to show that it also leads to lower probability of failure, we also need to show that $\widetilde{\widetilde{x}}-\widetilde{x}<\widetilde{\widetilde{x}}'-\widetilde{x}'$. But this is true given that $\widetilde{x}(\widetilde{\widetilde{x}})$ such that $m(\widetilde{\widetilde{x}},\widetilde{x},\widetilde{\widetilde{x}})=0$ satisfies $\frac{\partial\widetilde{x}(\widetilde{\widetilde{x}})}{\partial\widetilde{\widetilde{x}}}=\frac{\widetilde{x}+\widetilde{\widetilde{x}}}{2(\widetilde{x}+l)}<1$.

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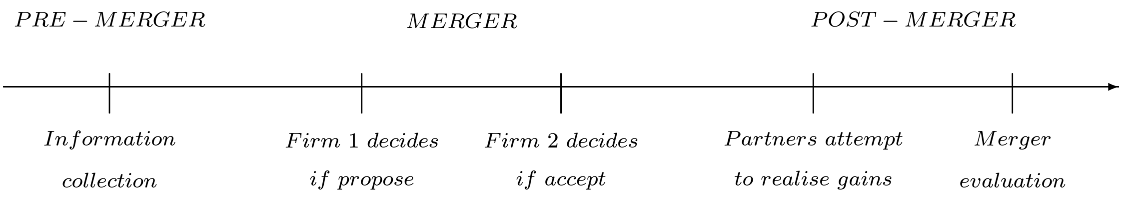

Figure 1: Timing of the Game.

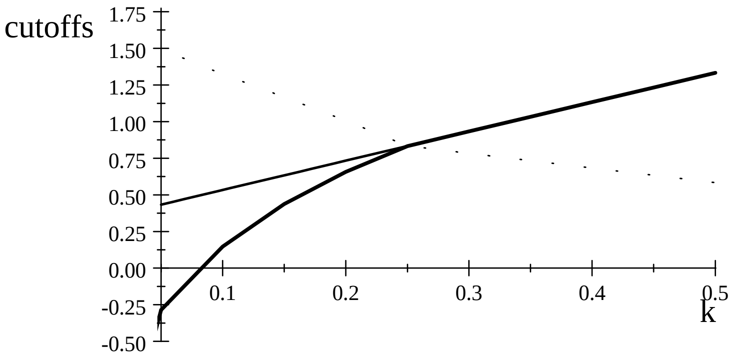

Figure 2: Merging cutoff $\widetilde{x}$ (thick line), post-merger effort cutoff $\widetilde{\widetilde{x}}$ (dotted line) and merging cutoff when the post-merger efforts are guaranteed $\widehat{x}$ (thin line) as a function of the costs of merging k.

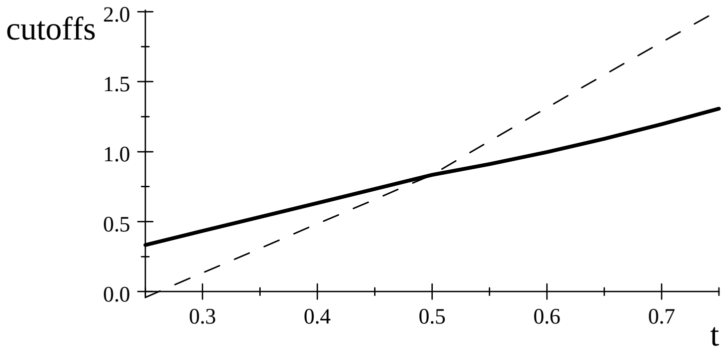

Figure 3: Merging cutoff $\widetilde{x}$ (thick line) and post-merger effort cutoff $\widetilde{\widetilde{x}}$ (dotted line) as a function of the costs of effort t.

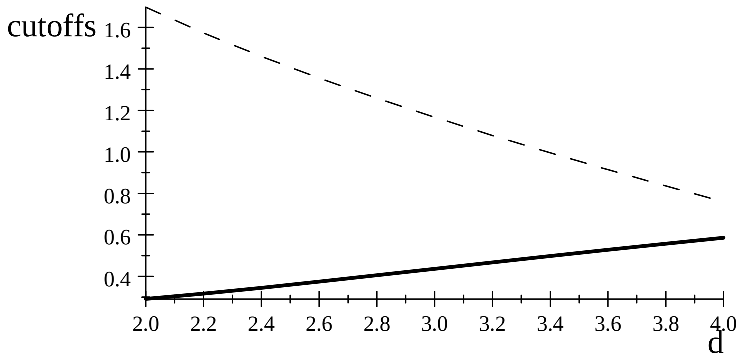

Figure 4: Merging cutoff $\widetilde{x}$ (thick line) and post-merger effort cutoff $\widetilde{\widetilde{x}}$ (dotted line) as a function of the complementarity d of post-merger efforts.