Shelving or developing? The acquisition of potential competitors under financial constraints*

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Abstract

We analyse the optimal policy of an antitrust authority towards the acquisitions of potential competitors in a model with financial constraints and asymmetric information. With respect to traditional mergers, these acquisitions trigger a new trade-off. On the one hand, the acquirer may decide to shelve the project of the potential entrant. On the other hand, the acquisition may allow for the development of a project that would otherwise never reach the market. We show that a merger policy does not need to be lenient towards acquisitions of potential competitors to take advantage of their pro-competitive effects on project development. This purpose is achieved by a strict merger policy that pushes the incumbent towards the acquisition of potential competitors lacking the financial resources to develop their project independently. An equivalent rule would consist in blocking takeovers whose acquisition price is above a certain threshold. We also show that, if the anticipation of a takeover relaxes the target firm's financial constraints, a more lenient policy rule, which always allows for the acquisition of firms that have already committed to enter the market, may be optimal. The cumulative conditions necessary for this to be the case include the presence of pronounced financial imperfections. Hence, the more developed financial markets, the more likely that a stringent merger policy will be optimal.

Keywords: Merger policy, potential competition, conglomerate mergers

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1 Introduction

The acquisition of *potential competitors* is a widespread phenomenon. In the digital economy alone, hundreds of start-ups have been bought in the last few years by incumbents such as Alphabet, Amazon, Apple, Facebook and Microsoft (The Economist, 2018; The Wall Street Journal, 2019; The New York Times, 2020). These issues also arise in other industries. Cunningham et al. (forthcoming) and Eliason et al. (2020) show that similar patterns are prevalent in the pharmaceutical and in the healthcare industries, respectively.[1] In the vast majority of cases, such acquisitions are not large enough to trigger mandatory pre-merger notification requirements, leading to stealth consolidation (see Wollmann, 2019).[2] As a result, many have asked for stricter antitrust action, alarmed by the possible anti-competitive consequences arising from the elimination of future competition (see, e.g., Crémer et al., 2019; Furman et al., 2019; Scott Morton et al., 2019; Motta and Peitz, forthcoming).

The traditional approach to the analysis of horizontal mergers trades off the costs of market power and the benefits of cost efficiencies (see, among many others, Williamson, 1968; Farrell and Shapiro, 1990; McAfee and Williams, 1992). The acquisition of potential competitors triggers an additional trade-off. On the one hand, the incumbent may acquire the start-up to then shelve the start-up's project. This would be a "killer acquisition" as documented by Cunningham et al. (forthcoming) in the pharma industry. On the other hand, the acquisition may allow for the development of a project that would otherwise never reach the market. This may happen because the incumbent has availability of resources – managerial skills, market opportunities, capital – that the target firm lacks. Erel et al. (2015), for instance, show empirically that acquisitions can relieve financial frictions, especially when the target is relatively small. To our knowledge, the effect of this brighter side produced by the acquisition of potential competitors has been overlooked by the theoretical literature. In this paper, we then ask: what are the conditions under which the acquisition of a start-up is anti-competitive in the presence of financial constraints? What policy should the antitrust authority follow when faced with such acquisitions?

In our model, while the incumbent has sufficient funds to invest, the start-up possibly lacks the assets needed to obtain external funding and develop its project further. Specifically, we build on Holmström and Tirole (1997) moral-hazard model to derive situations in which inefficient credit rationing arises in equilibrium. We nest this financial contracting game within a game in which the incumbent can take-over the start-up. We assume that the start-up acquisition market exhibits asymmetric information. The existence of information asymmetries in the market for

[1]Acquisitions have become the most widespread exit method for start-ups in all sectors, while IPOs have been declining. Of course, not all the acquired young firms constitute threatening potential competitors for the incumbents.

[2]Cunningham et al. (forthcoming) also document empirically that, in the pharmaceutical sector, incumbents conduct acquisitions that do not trigger the Federal Trade Commission reporting requirements. Similarly, Eliason et al. (2020) show that most of the acquisitions of small dialysis facilities conducted by large national chains fall outside the scope of current antitrust laws.

innovations is not controversial (see, e.g., Gans et al., 2008 and the ensuing literature). We assume that the incumbent does not know the exact value of the start-up's assets (whereas financial investors and the start-up itself do), but only its probability distribution. This approach is consistent with the empirical literature documenting the presence of informational frictions between acquirer and target, especially when the latter is a knowledge-based or R&D intensive firm, and thus more difficult to value (Officer et al., 2009).[3] (In an extension, we also analyse the case of perfect information and show that — while less rich — the main qualitative insights are confirmed.)

The incumbent can submit a takeover bid in two moments. One moment is prior to project development, before the start-up asks for funding. We will denote these acquisitions, that involve potential competitors, as *early takeovers*. The other moment is after the start-up secures funding and successfully develops, i.e. when it is committed to enter the market. We will denote these acquisitions, involving committed entrants, as *late acquisitions*.[4] If the start-up is acquired at the early stage, the acquirer may decide to develop the project or shelve it. Whatever the stage at which the acquisition proposal is made, an Antitrust Authority (AA) will decide whether to approve or block it on the basis of a standard of review that is established before the acquisition game takes place.[5]

Although they have a project with positive net present value, moral hazard implies that only start-ups with sufficient assets, and therefore with sufficient skin in the game, will receive funding. Otherwise, the entrepreneur will lack incentives to put effort, and the project is bound to failure. This gives rise to two types of start-ups, depending on whether they will be credit rationed or not. The incumbent knows this, but because of asymmetric information on the value of the start-up's assets, it can only formulate two types of offers at the early stage: either it makes a pooling bid, i.e. it offers a high takeover price such that a start-up would always accept, irrespective of the amount of own assets; or it makes a separating bid, i.e. offers a low takeover price targeting only the credit-rationed start-ups.[6] A separating bid is more profitable for the incumbent than a pooling bid when financial imperfections are severe: the probability that the start-up is financially constrained is high enough and, therefore, the risk that the start-up will reject a low takeover price is worth taking.

[3] One may think that an incumbent will inspect the start-up's books as part of due diligence. However, due diligence takes place after the acquisition price is decided and the offer accepted – no target firm would accept disclosing the content of its books under the risk that the takeover does not happen. For example, the Corporate Finance Institute's Guide on "Mergers Acquisitions M&A Process" states: "Due diligence is an exhaustive process that begins when the offer has been accepted" (see `http://corporatefinanceinstitute.com/resources/knowledge/deals/mergers-acquisitions-ma-process/`).

[4] The US Horizontal Merger Guidelines distinguish between the *potential entrants*, which are "likely [to] provide [...] supply response" in the event the conditions allow them to compete on the market, and the *committed entrants*, which are "not currently earning revenues in the relevant market, but that have committed to entering the market in the near future." In the paper we refer to this distinction.

[5] We follow the literature and assume that the AA can commit to a merger policy (see, e.g., Sørgard, 2009; Nocke and Whinston, 2010 and 2013). Given that AAs may take hundreds of merger decisions every year, and that precedents matter in competition law, the credibility of the commitment in this context is not an issue.

[6] In what follows, with a slight abuse of terminology, we use "separating" and "pooling" to distinguish between the offers made by the incumbent firm, which is the uninformed party in the game.

Our paper derives the optimal merger policy within this setting. One may think that, in order to take advantage of the pro-competitive effect of *early takeovers*, a merger policy should be lenient towards acquisitions of potential competitors. Our analysis shows that this purpose is, instead, achieved by a strict merger policy, i.e. a policy that commits to block any late takeover, and to be stringent vis à vis early takeovers unless the incumbent formulates a separating bid. Such a policy pushes the incumbent towards early takeovers targeted to financially constrained start-ups. This allows society to benefit from innovations that would never reach the market otherwise, while avoiding both the suppression of ex-post competition – that occurs whenever early takeovers involve financially unconstrained start-ups, and the incumbent has an incentive to invest; or whenever takeovers occur at a later stage, once start-ups have successfully developed – and the suppression of efficient projects – that occurs whenever killer acquisitions occur, i.e. whenever early takeovers involve financially unconstrained start-ups, and the incumbent shelves. This strict policy, that authorises acquisitions where the incumbent makes separating bids, effectively amounts to a policy whereby the AA screens mergers according to the value of the transaction, authorising those that are below a certain threshold. In this respect, our paper may contribute to a discussion about takeover prices possibly signalling anti-competitive mergers.

We then consider the merits of alternative, more lenient policies. First, we show that it is never optimal to be lenient with early acquisitions only. That is, it never optimal for the AA to commit to never approve late takeovers, and instead approve only the early takeovers that increase expected welfare. The reason is that this policy would boil down to accept more pooling-bid offers when the strict merger policy would have forced a separating bid. Therefore, such a policy is dominated by the strict merger policy. Relatedly, our analysis also shows that by adopting a strict merger policy and prohibiting *late takeovers*, the AA precludes another pro-competitive effect. If investors anticipate that a takeover will occur after the project is developed, they might be willing to finance a start-up they would have otherwise not funded. This happens because the investors rely on the incumbent (whose pledgeable income is higher) taking over the start-up's debt obligations. In other words, the prospect of late takeovers alleviates financial constraints and increases the chance that the innovation reaches the market also through this channel. This is welfare beneficial, even though the innovation eventually ends in the hands of the incumbent.[7]

Because of the latter effect a more lenient merger policy, which allows for the acquisition of committed entrants, may be optimal. For this to be the case, the following cumulative conditions must be satisfied:

1. Financial imperfections need to be severe, so that late takeovers have a pronounced ex-ante effect on financial constraints and on the chance that the innovation materialises.

[7]In Section 8.4, we discuss the features of the optimal funding contract depending on the policy chosen by the AA.

2. At equilibrium the incumbent must choose not to make an early takeover, which happens only when it has an incentive to shelve the project. Rather than making a separating bid to acquire a financially constrained start-up, and then terminate the project, the incumbent decides to let the project die naturally because of financial constraints and later acquire only those start-ups that successfully develop the project. Such a late takeover increases the start-up's pleadgeable income, and thus weakens ex-ante credit constraints, at the cost of increasing the incumbent's market power ex post.

3. The allocative inefficiencies caused by the ex-post increase in market power are mild, for instance because the innovation translates into a new product that is a weak substitute of the incumbent's existing product.

When all these conditions do not simultaneously apply, the optimal policy is a strict merger policy.

The paper continues as follows. After reviewing the related literature, we set up the model in Section 2. In the following sections we solve it by backward induction. It is convenient to divide the analysis for given policy rules chosen at the beginning of the game by the AA. Section 3 studies the continuation equilibrium given the AA has chosen a strict rule whereby it would not tolerate any (expected) welfare harm from the merger. Section 4 studies the other extreme policy rule whereby any merger would be allowed (laissez-faire). Section 5 looks at intermediate policy rules. Drawing on those analyses, Section 6 studies the optimal policy that the AA should adopt at the beginning of the game. Section 7 looks at a parametric model within which we can characterize the equilibria of the game and perform some comparative statics. Section 8 relaxes some assumptions and discusses some extensions of our model. Section 9 concludes.

Literature review The link between market structure and innovation incentives was pioneered by Arrow (1962). In Arrow (1962), a monopolist has much less to gain from innovating than a firm in a competitive market. The latter, thanks to the innovation, can take over the entire market at a margin reflecting its cost advantage, whereas the former cannibalises some of its current profits. This is Arrow's replacement effect. Gilbert and Newbery (1982) build on this effect by allowing for the possibility of entry by a potential competitor. They show that the monopolist has strong incentives to acquire the intellectual property rights that are necessary to preempt entry, and in this way preserve its monopoly profits.[8] More recently, Cunningham et al. (forthcoming) combine the Arrow's replacement effect and the entry-preempting patenting effect in Gilbert and Newbery to show that, after acquiring the potential entrant, the incumbent has strong incentives to shelve the entrant's new product. In this way, the monopoly avoids the cannibalisation of own existing products' sales. We add financial imperfections to the picture.

[8]Vickers (1985) shows that these incentives weaken when there are multiple incumbents in the market (a prediction that is in line with the results in Cunningham et al., forthcoming). Chen (2000) finds that the monopoly persistence result fails to hold when considering the bidding competition for a new product between a potential entrant and the monopolist of a related product.

By doing this, we first show that takeovers of potential competitors may not always give rise to killer acquisitions. In fact, they may also increase the chance that the innovation reaches the market, by allowing the incumbent to develop a project that the start-up would not because of financial constraints. We derive the optimal policy in this context and we show that a merger policy does not need to be lenient towards early takeovers to take advantage of their beneficial effects. Second, we show that, under the presence of financial imperfections, there exists another channel through which takeovers may affect innovation: the anticipation that a late takeover will occur alleviates the start-up's financial constraints and may enable the start-up to finance a project that would not be funded otherwise. This other pro-competitive effect is exclusively due to the authorisation of late takeovers, a counter-intuitive result, which contrasts with conventional practice: an AA would typically be more likely to block a takeover of a committed entrant, rather than that of a potential entrant.

Lately, the literature has explored the impact of takeovers on the innovation decisions of incumbents and start-ups (see, among others, Norbäck and Persson, 2009 and 2012; Bryan and Hovenkamp, 2020; Letina et al., 2020; Norbäck et al., 2020). Norbäck and Persson (2009) study an incumbent's choice between acquiring a start-up's innovation at an early stage, or wait and acquire the innovation after the start-up has received financial support by venture capitalists.[9] Similarly, Norbäck et al. (2020) show the conditions under which shelving arises in equilibrium. However, both papers abstract from the competitive effects of these takeovers or the design of optimal merger policies. The impact of merger policies on innovation activities is instead the focus of Letina et al. (2020). They show that a strict merger policy reduces the probability of discovering innovations and leads to the duplication of the entrant's innovation activity by the incumbent.[10] We instead show that a strict policy can be beneficial because it pushes the incumbent towards early takeovers of credit-constrained start-ups, thereby alleviating the inefficiency caused by financial constraints and making the development of the innovation more likely.[11]

We also contribute to the theoretical literature in industrial organisation and finance that explores how corporate financing affects competition, in the spirit of Brander and Lewis (1986) and Maksimovic (1988). Later, this literature has studied the role of financial contracting in models of predation (Bolton and Scharfstein, 1990), vertical relationships (Cestone and White, 2003; Nocke and Thanassoulis, 2014) and group affiliation (Cestone and Fumagalli, 2005). To the best of our knowledge, we are the first to explore the role of credit constraints in the context

[9]See Arora et al. (2019) for a model where takeovers' timing depends on the start-up's entrepreneur decision to sell out at an early stage, or rather focus her scarce time and resources to develop the potential of the project. In our model, the timing is relevant to formulate optimal policies.

[10]See also e.g., Cabral (2020) for a cautious view about stricter merger control in digital industries. Norbäck and Persson (2012) develop a model with an AA, but shelving never arises in their framework. Finally, Bryan and Hovenkamp (2020) analyse the relationship between merger policy and innovation efforts, but with a focus on the start-ups that produce inputs for competing incumbents.

[11]Katz (2020) shows that the acquisitions of potential competitors are a means to limit competition *for* the market, thus providing another rationale for heightened scrutiny of acquisitions by incumbents.

of optimal merger policies. By doing this, we also contribute to the vast literature on horizontal mergers. An important message of this literature is that mergers between suppliers of substitute products should be prohibited (e.g., among others, Farrell and Shapiro, 1990) and that, in a dynamic setting, adopting a myopic approach is optimal (e.g., Nocke and Whinston, 2010). We contribute to this literature by studying the optimal merger policy when not only committed entrants but also potential competitors are involved in the acquisition.

2 The base model

There are three players in our game: an Antitrust Authority (AA), which at the beginning of the game decides its merger policy;[12] a monopolist Incumbent; and a Start-up. The start-up owns a "prototype" (or project) that, if developed, can give rise to an innovation: for instance a substitute/higher quality product to the incumbent's existing product, or a more efficient production process. The start-up does not have enough own resources to develop the project. It has two options: it can either obtain additional funds from competitive capital markets, or sell out to the incumbent. The incumbent will have to decide whether and when it wants to acquire the start-up (and if it does so before product development, it has to decide whether to develop the prototype or shelve it), conditional on the AA's approval of the acquisition. We assume that the takeover involves a negligible but positive transaction cost.[13]

The AA commits at the beginning of the game to a merger policy, in the form of a maximum threshold of "harm", $\overline{H} \geq 0$, that it is ready to tolerate. Harm from a proposed merger consists of the difference between the expected welfare levels if the merger goes ahead, and in the counterfactual where it does not take place (derived of course by correctly anticipating the continuation equilibrium of the game).[14] A proposed merger will be prohibited only if the tolerated harm level $\overline{H}$ is lower than the expected harm from the merger, if any.[15]

Product market payoffs We now describe the payoffs that firms and consumers obtain depending on whether the innovation is taken to the market and on which firm has developed the project successfully. In Section 7, we provide a micro-foundation to these payoffs within a model that satisfies the following parametric assumptions.

[12]It would be equivalent if it was Parliament or Government who decides the merger policy, and then the AA who implements it at a later stage.

[13]This assumption serves as a tie-breaking rule when the incumbent's profits are the same with and without the takeover (gross of the transaction costs).

[14]Our analysis would not qualitatively change if the AA used consumer surplus instead of welfare as a benchmark. For a discussion of the merits of consumer surplus v. total surplus in antitrust, see Farrell and Katz (2006).

[15]In the real world $\overline{H}$ is typically strictly positive for several reasons: the law prescribes that only mergers which significantly affect competition can be prohibited; some mergers may not even be reviewed because they do not meet notification criteria (e.g., in most jurisdictions the merger has to be notified only if the combined turnover goes beyond certain thresholds); in many jurisdictions competition law does not oblige firms to notify mergers; the law (or the courts) assigns the burden of proving that the merger is anti-competitive to the AA, and sets a high standard of proof.

If either the investment in the development of the project has not been undertaken, or it was undertaken but it failed, the incumbent is a monopolist with its existing product. Total welfare (gross of the investment cost K, if any) is $W^m = CS^m + \pi_I^m$. If the development of the prototype has been successful and S markets the innovation, the start-up competes with the incumbent I. They will make duopoly profits, π_S^d and π_I^d, respectively, with $\pi_I^d < \pi_I^m$. The associated (gross) welfare level will be $W^d = CS^d + \pi_S^d + \pi_I^d$. If I markets the innovation, it will obtain monopoly profits $\pi_I^M > \pi_I^m$.[16] Gross welfare is $W^M = CS^M + \pi_I^M$.

We assume that the ranking of total welfare is $W^m < W^M < W^d$. This ranking reflects the role of market competition (so that $W^M < W^d$). Moreover, $W^m < W^M$: for instance, industry profits are higher with a multi-product monopolist than a single product monopolist ($\pi_I^M > \pi_I^m$) and consumers (weakly) love variety (i.e. $CS^M \geq CS^m$); alternatively, both consumers and the monopolist benefit from a more efficient production process.

We assume throughout the paper that:

$$\pi_I^M > \pi_I^d + \pi_S^d, \tag{A1}$$

which amounts to saying that industry profits are higher under monopoly than under duopoly. If this assumption did not hold, the takeover would not take place. We also assume that:

$$\pi_S^d > \pi_I^M - \pi_I^m, \tag{A2}$$

which corresponds to the well-known Arrow's replacement effect: an incumbent has less incentive to innovate (in a new/better product or a more efficient production process) than a potential entrant because the innovation would cannibalise the incumbent's current profits. If this condition did not hold, then not only shelving would not take place, but also the incumbent might develop projects that even a sufficiently endowed outsider would not consider.

Funding and development of the project The development of the prototype requires a fixed investment K, which can be undertaken either by the start-up or by the incumbent, if the latter acquires the start-up at the beginning of the game.

The start-up and the incumbent differ in their ability to fund the investment. Whereas I is endowed with sufficient own assets to pay the fixed cost K if it wanted to, S does not hold sufficient assets A to cover this initial outlay: $A < K$. Thus, S will search for funding in perfectly competitive capital markets.

Following Holmström and Tirole (1997),[17] we assume that the probability that the prototype is developed successfully depends on the non-contractible effort exerted by the entrepreneur of

[16] Since the investment is costly, this assumption represents a necessary (but not sufficient) condition for the incumbent to invest. If $\pi_I^M < \pi_I^m$, the incumbent would always shelve the project after an acquisition.

[17] Similarly, Cestone and Fumagalli (2005) and Nocke and Thanassoulis (2014) use Holmström-Tirole moral hazard framework to study the role of financial constraints in models with product market competition.

the firm that owns the project. In case of effort the probability of success is $p \in (0,1]$, whereas in case of no effort the project fails for sure, but the entrepreneur obtains private benefits $B > 0$. In case of failure the project yields no profit.

In case of effort it is efficient to develop the prototype, i.e., development has a positive net present value (NPV) for the start-up:

$$p\pi_S^d > K. \tag{A3}$$

We also assume that the development of the project is not only privately beneficial for the start-up, but also for society as a whole, whether undertaken by the incumbent or the start-up:

$$p(W^M - W^m) > K. \tag{A4}$$

Assumption A4 implies that *a fortiori* expected welfare increases when the start-up invests: $p(W^d - W^m) > K$. Finally, we assume that:

$$B - K < 0 < B - (p\pi_S^d - K). \tag{A5}$$

The first inequality implies that if S shirks the project has negative value; thus, no financial contract could be signed unless S makes effort. The second implies that the start-up may be financially constrained, that is, it may hold insufficient assets to fund the development of the prototype even though the project has a positive NPV.

As in Holmström-Tirole, the financial contract signed by the start-up and the investors takes the form of a sharing rule that specifies the income transferred to the start-up in the case of success (R_S^s) and failure (R_S^f). Due to perfectly competitive financial markets, the share offered to the investors is set so that they can break-even. Finally, since the incumbent owns the assets to fund the project, the development of the project is not affected by moral hazard if the takeover takes place at the beginning of the game.

Information Before the game starts, A, the amount of the assets owned by S is drawn from a continuous CDF $F(A)$ with $A \in (0, K)$. The incumbent knows $F(A)$, but does not observe the specific value of A, while the investors do (as well as S itself), e.g. because they can inspect the accounts of S and know its financial and banking records and history of debt repayment.[18] Likewise, the AA does not observe A when it decides whether to authorise or block the takeover, but knows $F(A)$.[19] All the rest is common knowledge, so that when the AA establishes the merger policy and when it decides on a takeover proposal, it knows the probability of success p, the investment cost and can anticipate the product market payoffs in the different configurations. Finally, all agents are risk neutral, the borrowing firm S is protected from liability and the risk-

[18]We relax this assumption in Section 8.5.

[19]Typically AAs lack the expertise to assess correctly the state of finance of the start-up. However, see Section 8.5 for a treatment under perfect information.

free rate is zero.

Timing Next, we describe the timing of the game.

- At time $t = 0$, the AA commits to the standard for merger approval, $\overline{H}$.
- At $t = 1(a)$, I can make a takeover offer to S, which can accept or reject.
- At $t = 1(b)$, the AA approves or blocks the takeover proposal.
- At $t = 1(c)$, the firm that owns the prototype decides whether to develop or shelve it.
- At $t = 1(d)$ the owner of the prototype engages in financial contracting (if needed). After that, uncertainty about the success or failure of the project resolves.
- At $t = 2(a)$, I can make a take-it-or-leave-it offer to S (if it did not already buy it at $t = 1$, and if the development of the project was successful).
- At $t = 2(b)$, the AA approves or blocks the takeover proposal.
- At time $t = 3$, active firms sell in the product market, payoffs are realised and contracts are honored.

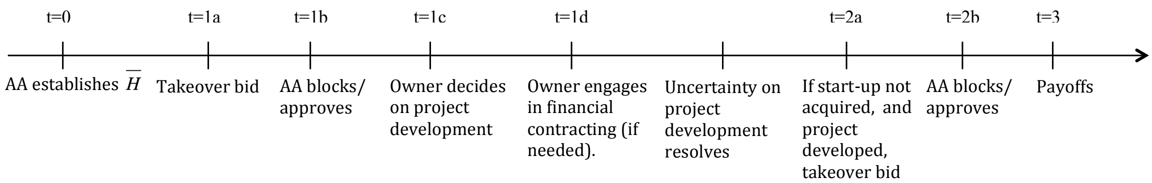

Figure 1. Timeline

We solve the game by backward induction. We will start considering two extreme policies: a strict merger policy and a laissez-faire merger policy. We will then consider intermediate policies. Finally, we will derive the optimal policy.

3 Strict merger policy

Let us analyse first the case in which $\overline{H} = 0$, so that the AA authorises only takeovers that, in the moment in which they are reviewed, are expected to increase total welfare.

3.1 Ex-post takeover game (t=2)

At $t = 2$ there exists scope for a takeover if a start-up that has not been acquired at $t = 1$ managed to invest and innovation has been successful. Therefore, absent the takeover there is a duopoly, whereas the takeover reinforces a monopoly.[20] Since $W^d > W^M$, the takeover would be ex-post welfare detrimental and, at $t = 2(b)$, it would be blocked. Anticipating this, the incumbent would not make any bid at $t = 2(a)$.

3.2 Financial contracting

If no takeover took place at $t = 1(b)$, a start-up that decided to develop the project searches for funding at $t = 1(d)$. Lemma 1 illustrates the outcome of the contracting game.

LEMMA 1 (Financial contracting under the strict merger policy)**.**
There exists a threshold level $\overline{A} \equiv B - (p\pi_S^d - K)$ of the start-up's own resources such that:

- *If $A < \overline{A}$, the start-up is credit-rationed and cannot invest in development.*
- *If $A \geq \overline{A}$, the start-up obtains external funding. Its expected profits from the investment are $p\pi_S^d - K$.*

Proof. The proof directly follows from Tirole (2006 Chapter 3). The start-up and the outside investors correctly anticipate that, if funded and if effort is made, the project will be successful with probability p and in this case it will give rise to duopoly profits π_S^d (because no takeover will be authorised at $t = 2$). With probability $1-p$ the project will fail and generate zero profits.

Consider a financial contract such that S obtains R_S^s in case of success (s) and R_S^f in case of failure (f) of the project. The start-up will exert effort if (and only if) the following condition is satisfied:

$$pR_S^s + (1-p)R_S^f \geq B + R_S^f. \tag{IC}$$

In order to elicit effort, the optimal contract establishes $R_S^f = 0$, i.e. it leaves rents to S only when the project is successful. S's incentive compatibility constraint becomes:

$$pR_S^s \geq B. \tag{IC'}$$

As for the investors, they are willing to lend $K - A$ if they expect to break even:

$$p(\pi_S^d - R_S^s) \geq K - A. \tag{IP}$$

Substituting in the investor's participation constraint (IP) the minimum amount of resources that must be attributed to the start-up to elicit effort (i.e. $R_S^s = B/p$ from a binding Condition

[20]Once the innovation has been developed, the incumbent will always market it: $\pi_I^M > \pi_I^m$.

(IC')), and rearranging, one obtains that (IP) holds if (and only if):

$$A \geq \overline{A} \equiv B - (p\pi_S^d - K),$$

where $\overline{A} > 0$ by Assumption A5. Hence, when $A < \overline{A}$, the start-up is credit rationed and cannot develop the prototype even though the NPV of the project is positive. If, instead, $A \geq \overline{A}$, the start-up obtains external funding. Perfect competition between investors implies that (IP) is binding: $pR_S^s = p\pi_S^d - (K - A)$. Hence, the expected payoff of the start-up when it receives funding is $pR_S^s - A$, which gives $p\pi_S^d - K$. Q.E.D.

If, instead, the start-up has been acquired by I at $t = 1(b)$, no financial contracting takes place because I has enough own resources to invest.

3.3 The investment decision

A start-up that expects external investors to deny financing will not undertake the investment. Conversely, the incumbent has the financial ability to invest, but it does not always have the incentive to do so. Indeed, the innovation increases the incumbent's profits less than the (unconstrained) start-up's. (This result follows directly from the Arrow's replacement effect, i.e. Assumption A2.) Then, as shown by Lemma 2, the increase in the incumbent's profits may not be large enough to cover the investment cost. When this is the case, the incumbent will shelve the project and the acquisition turns out to be a killer acquisition.

LEMMA 2 (Investment decision under the strict merger policy)**.**

- *An unconstrained start-up always invests in the development of the prototype.*
- *The incumbent invests if (and only if):*

$$p(\pi_I^M - \pi_I^m) \geq K. \tag{1}$$

Proof. If the incumbent did not acquire the start-up at $t = 1(b)$, and the start-up is credit-constrained, i.e. if $A < \overline{A}$, then the investment cannot be undertaken and the payoff of the start-up is nil. If, instead, $A \geq \overline{A}$, the start-up anticipates that by developing the project it will obtain the expected payoff $p\pi_S^d - K$. By Assumption A3 $p\pi_S^d \geq K$, and the unconstrained start-up always invests.

If the start-up has been acquired at $t = 1(b)$, the incumbent obtains π_I^m by not investing and the expected payoff $p\pi_I^M + (1-p)\pi_I^m - K$ by investing. The increase in expected profits is $p(\pi_I^M - \pi_I^m)$. By Assumption A2, $\pi_I^M - \pi_I^m < \pi_S^d$. Then, the incumbent benefits less than the unconstrained start-up from the investment, and it does not necessarily want to develop the project. It does so if (and only if) Condition 1 is satisfied. Q.E.D.

3.4 Ex-ante takeover game ($t = 1$)

At $t = 1$, the incumbent's takeover bid depends on the decision that it expects from the AA. Section 3.4.1 analyses the AA's decision at $t = 1(b)$, while Section 3.4.2 studies the incumbent's decision at $t = 1(a)$ and describes the overall equilibrium of the game.

3.4.1 Decision of the AA

At $t = 1(b)$ the AA observes the takeover bid made by the incumbent and the start-up's acceptance decision, and decides whether to authorise or block the merger.

The AA may observe that at $t = 1(a)$ the incumbent offered a high takeover price such that a start-up always accepts, irrespective of the own resources (*pooling bid*); alternatively, it may observe that the incumbent offered a low takeover price that only a constrained start-up is willing to accept (*separating bid*).

If it observes a separating bid, the AA authorises the takeover. The reason is the following. If the incumbent is expected to invest (i.e. if Condition 1 is satisfied), the takeover is welfare beneficial: the start-up will not be able to obtain external funding as an independent entity, whereas the incumbent will invest. Therefore the takeover avoids the inefficiency caused by financial constraints and allows society to enjoy the innovation, even though under monopoly conditions. If the incumbent is expected to shelve the project, the acquisition leaves total welfare unchanged because the start-up would not be able to bring the innovation to the market as a stand-alone entity.

Conversely, if it observes a pooling bid and the incumbent is expected to shelve, the AA blocks the takeover. In this case a start-up will always accept the offer: when the start-up is constrained the takeover is welfare neutral but when it is unconstrained – which occurs with probability $1 - F(\overline{A})$ – by authorising the merger the AA would allow for a killer acquisition and would deprive society of both the innovation and intensified competition.

Finally, a trade-off arises when the AA observes that the incumbent made a pooling bid and is expected to invest. When the start-up is unconstrained the takeover reduces welfare because, when the prototype is successfully developed, it weakens ex-post competition. However, when the start-up is constrained – which occurs with probability $F(\overline{A})$ – the takeover is welfare beneficial because it avoids financial constraints. As stated by Lemma 3, the AA authorises the takeover if (and only if) the probability that the start-up is constrained is sufficiently high.

LEMMA 3 (Decision of the AA under the strict merger policy)**.**
Under a strict merger policy:

- *If the incumbent made a separating bid at $t = 1(a)$, the AA authorises the takeover.*
- *If the incumbent made a pooling bid at $t = 1(a)$, the AA authorises the takeover if (and only if) the incumbent will develop the project (i.e. Condition 1 is satisfied) and the probability*

that the start-up is credit-constrained is sufficiently high:

$$F(\overline{A}) \geq \frac{p(W^d - W^M)}{p(W^d - W^m) - K} \equiv \Gamma(\cdot) \in (0,1). \tag{2}$$

Proof. See Appendix A.1. Q.E.D.

3.4.2 Takeover bid of the incumbent

When the incumbent plans to shelve (i.e. when Condition 1 is not satisfied), at $t = 1(a)$ it anticipates that, if it makes a pooling bid, the takeover will be blocked, and if it makes a separating bid the takeover will be approved (by indifference). However, in the latter case, the takeover leads to the suppression of a project that would die anyway. From the assumption that the takeover involves a transaction cost, though negligible, it follows that the incumbent does not make any bid.

When, instead, the incumbent plans to invest, it makes a separating bid at $t = 1(a)$ unless the probability that the start-up will be constrained is $F(\overline{A}) \in [\Gamma(\cdot), \Phi(\cdot))$, where $\Phi(\cdot)$ will be defined in Proposition 1. The incumbent finds it more profitable to make a pooling bid rather than a separating bid if (and only if) the probability that the start-up will be credit-constrained is low enough, i.e. $F(\overline{A}) < \Phi(\cdot)$. Intuitively, under a high probability that the start-up will not be funded, the incumbent does not want to make a high takeover offer (which is costly), since it is likely that S would accept to sell out at 0. With a separating bid it is of course possible that an unconstrained start-up rejects the offer and becomes a competitor, but when $F(\overline{A})$ is high enough, the risk is worth taking. If, instead, the probability the start-up will be constrained is low, then it is very likely that a low bid will not be accepted, and the incumbent chooses to offer a high price. Of course, this pooling bid may overpay the start-up, but this is a relatively low probability event.

However, as established by Lemma 3, the AA will authorise a takeover with a pooling bid only if the probability that the start-up is credit-constrained is high enough, i.e. $F(\overline{A}) \geq \Gamma(\cdot)$, because only in that case the welfare beneficial effect dominates. It is only when those two conditions are simultaneously satisfied that a takeover with a pooling bid will arise at the equilibrium. In fact, it might be the case that whenever the incumbent wants to make a pooling offer the AA will block the takeover (i.e. it might be that $\Phi(\cdot) \leq \Gamma(\cdot)$). If so, under a strict merger policy any equilibrium takeover would involve a separating bid.

Proposition 1 summarises the equilibrium of the game:

PROPOSITION 1 (Equilibrium of the game under the strict merger policy).
Under a strict merger policy:

- *If* $p(\pi_I^M - \pi_I^m) < K$*, no takeover takes place (either at* $t = 1$ *or at* $t = 2$*).*
- *If* $p(\pi_I^M - \pi_I^m) \geq K$*:*

– *And* $F(\overline{A}) \in [\Gamma(\cdot), \max\{\Phi(\cdot), \Gamma(\cdot)\})$*, the incumbent makes a pooling bid. Any start-up accepts it. The AA approves the takeover.*

– *And otherwise, the incumbent makes a separating bid. A credit-constrained start-up accepts the offer. The AA approves the takeover. No takeover occurs at* $t = 2$*.*

The threshold $\Gamma(\cdot)$ *is defined by Lemma 3, while*

$$\Phi(\cdot) \equiv \frac{p(\pi_I^M - \pi_S^d - \pi_I^d)}{p(\pi_I^M - \pi_I^d) - K} \in (0,1). \tag{3}$$

Proof. See Appendix A.2. Q.E.D.

4 High $\overline{H}$ (laissez-faire policy): Acquisitions are always allowed

In this section, we study the case where the intervention threshold is so high that any acquisition would be allowed (see the appendix for the exact identification of the tolerated level of harm such that this is the case).

4.1 The ex-post takeover game ($t = 2$)

At time $t = 2$ there exists scope for a takeover if a start-up (that has not been acquired at $t = 1(b)$) managed to invest and the project has been successful. Since the AA follows a laissez-faire policy here, any proposal will be approved.

The start-up accepts any takeover offer weakly higher than $\pi_S^d - F_s$, where π_S^d is the anticipated profit if it turns down the offer and F_s is the amount that S has to pay back to external investors in case of success, as established by the financial contract. With the acquisition the incumbent avoids competition vis à vis the start-up, but it has to honor the start-up financial obligations. The incumbent's increase in profits, if the takeover occurs, is therefore $\pi_I^M - \pi_I^d - F_s$. From Assumption A1 it follows that $\pi_I^M - \pi_I^d - F_s \geq \pi_S^d - F_s$: at $t = 2(a)$ the incumbent always wants to make the minimal offer that the start-up accepts and its $t = 3$ profits will be $\pi_I^M - \pi_S^d$.

4.2 Financial contracting and investment decision

Financial contracting When no acquisition occurred at $t = 1(b)$ and the start-up decided to develop the project, financial contracting at $t = 1(d)$ is similar to the one in Section 3.2. The main difference is that the start-up and the investors anticipate that, if effort is exerted and the project is successful, at a later stage the start-up will be acquired by the incumbent, which will also take over the financial obligations of the start-up. Since the incumbent makes profits π_I^M at $t = 3$, whereas the start-up would earn $\pi_S^d < \pi_I^M$, financiers expect the pledgeable income to be higher when the incumbent takes over the start-up at a later stage and are more willing to provide funds. As a consequence, the minimal amount of internal resources for the start-up to be unconstrained is lower with a laissez-faire policy than with a strict policy: a start-up whose assets A are such that $\overline{A}^T \leq A < \overline{A}$ is credit constrained under a strict merger policy whereas it manages to obtain financing under a laissez-faire policy. This result, summarised in Lemma 4, highlights a possible *pro-competitive* effect of takeovers.

LEMMA 4 (Financial contracting under the laissez-faire policy).
The prospect that the start-up will be acquired at $t = 2$ alleviates financial constraints: there exists a threshold level $\overline{A}^T \equiv B - (p\pi_I^M - K) \leq \overline{A}$ of the start-up's own resources such that:

- *If $A < \overline{A}^T$, the start-up is credit-rationed and cannot invest.*
- *If $A \geq \overline{A}^T$, the start-up obtains external funding. Its expected profits from the investment are $p\pi_S^d - K$.*

Proof. Investors anticipate that the highest income that can be pledged to them in case of success without jeopardising the borrower's incentives is $\pi_I^M - B/p \geq \pi_S^d - B/p$ from Assumption A1. Hence, following the same reasoning as in Section 3.2, the investors' participation constraint is satisfied if (and only if) $p(\pi_I^M - B/p) \geq K - A$, or:

$$A \geq \overline{A}^T \equiv B - (p\pi_I^M - K),$$

with $\overline{A}^T \leq \overline{A}$ because $\pi_I^M > \pi_S^d$. The rest of the proof proceeds as in Lemma 1. Q.E.D.

As we already discussed in Section 3.2, if the start-up has been taken over by I at $t = 1(b)$, no financial contracting takes place because I has enough own resources to fund the investment, should it want to undertake it.

Investment decision The investment decision is the same as in Section 3.3. An unconstrained start-up always invests in the development of the prototype, whereas the incumbent invests if (and only if) Condition 1 is satisfied.

4.3 Ex-ante takeover game ($t = 1$)

Under a laissez-faire policy the AA authorises any takeover. Therefore the incumbent chooses whether to make a separating bid or a pooling bid simply based on the relative profitability of the two options.

The incumbent anticipates that, under a laissez-faire policy, at $t = 2$ it will have the chance to acquire an unconstrained start-up which rejects a separating offer at $t = 1$. Therefore, differently from the case of a strict merger policy, when it plans to invest (i.e. when $p(\pi_I^M - \pi_I^m) \geq K$), the incumbent finds a separating bid always more profitable than a pooling bid. Intuitively, by making a low takeover bid the incumbent acquires the prototype when the start-up would not be able to invest. There is no point for it to offer a higher price at which also an unconstrained start-up would accept, because in that case it can "delegate" the start-up to invest, and then suppress competition by acquiring it at a later stage if the investment is successful.

Instead, a trade-off arises when the incumbent plans to shelve: as shown by Proposition 2, it makes a pooling bid when the probability that the start-up is constrained is low enough. If so, it is optimal for the incumbent to pay a high takeover price because it avoids what, from its perspective, is an inefficient investment. Proposition 2 summarises the equilibrium of the game:

PROPOSITION 2 (Equilibrium of the game under the laissez-faire policy)**.**
Under a laissez-faire policy that authorises any takeover both at $t = 1$ and $t = 2$:

- *If $p(\pi_I^M - \pi_I^m) < K$:*
  - *And $F(\overline{A}^T) \geq \Phi^T(\cdot)$, no takeover takes place at $t = 1$. An unconstrained start-up is acquired at $t = 2$ if the investment is successful.*
  - *And $F(\overline{A}^T) < \Phi^T(\cdot)$, the incumbent makes a pooling bid at $t = 1$. Any start-up accepts the offer. The incumbent shelves the project.*
- *If $p(\pi_I^M - \pi_I^m) \geq K$, the incumbent makes a separating bid at $t = 1$. A credit-constrained start-up accepts the offer. The incumbent invests. An unconstrained start-up rejects the offer, but is acquired at $t = 2$ if the investment is successful.*

The threshold level of the probability that the start-up is credit-constrained $\Phi^T(\cdot)$ is

$$\Phi^T(\cdot) \equiv \frac{p(\pi_I^m - \pi_I^M) + K}{p(\pi_I^m + \pi_S^d - \pi_I^M)} \in (0, 1), \tag{4}$$

when $p(\pi_I^M - \pi_I^m) < K$.

Proof. See Appendix A.3 Q.E.D.

5 Intermediate cases

We have so far studied two extreme cases. The strict merger policy, which approves only the acquisitions that increase expected welfare, tolerates a level of harm $\overline{H} = 0$. The laissez-faire policy, which approves any acquisition, tolerates a level of harm $\overline{H}$ that is larger than maximum between the welfare loss from authorising $t = 2$ takeovers ($W^d - W^M$) and the welfare loss from authorising $t = 1$ takeovers that kill all start-ups.

We now consider merger policies that are between these two extremes. We provide a discussion here, and relegate the proofs to Appendix A.4. In the same appendix, we derive the thresholds of tolerated harm that characterise each policy.

5.1 Policy that blocks mergers at t=2, but is more lenient at t=1

As long as late takeovers are blocked, a policy that is more lenient with respect to early acquisitions is always dominated by a strict merger policy.

Let $\overline{H}$ increase from zero: the AA approves more often a takeover in which the incumbent makes a pooling bid and is expected to develop. Indeed, when the tolerated harm is large enough (i.e. $\overline{H} \geq H^0$ as shown in Appendix A.4.1), any early takeover in which the incumbent makes a pooling bid and is expected to develop is approved. Therefore the increase in $\overline{H}$ allows the incumbent to engage in an early takeover with a pooling offer in situations in which a strict merger policy would have forced it to make a separating bid. In those cases this more lenient merger policy reduces expected welfare: both under a pooling and a separating offer the inefficiency caused by financial constraints is eliminated, but under a pooling offer competition at $t = 2$ is weakened.

As $\overline{H}$ increases further (and exceeds the threshold H^1 derived in Appendix A.4.1), early takeovers with a pooling offer are approved also when the incumbent is expected to shelve. When a pooling offer is more profitable for the incumbent than a separating offer such a change in the merger policy would authorise a killer acquisition when a strict merger policy would lead to no takeover, thereby reducing expected welfare.

5.2 Policy that authorises late takeovers, but is more strict at t=1 (intermediate merger policy)

Let us analyse the decision of the AA at $t = 1$ given that late takeovers are authorised, i.e. that the tolerated harm is $\overline{H} > W^d - W^M$.

If the AA observes that the incumbent at $t = 1(a)$ made a separating bid it authorises the takeover, both when the incumbent is expected to shelve (because total welfare remains the same) and when it is expected to invest (because the change in expected welfare is strictly positive).[21]

If the incumbent made a pooling bid and is expected to develop, differently from the case in which late takeovers are blocked under the strict policy, now the AA always authorises the early takeover because it increases the welfare expected at $t = 1$:

$$F(\overline{A}^T)[p(W^M - W^m) - K] > 0$$

from Assumption A4. When the start-up is unconstrained (which occurs with probability $1 - F(\overline{A}^T)$), the early takeover leaves welfare unchanged. Absent the takeover, the start-up would develop the project and, if successful, would be acquired at $t = 2$; thus, expected welfare would be $pW^M + (1 - p)W^m - K$. With the takeover, the investment would be undertaken by the

[21]See the proof of Lemma 3.

incumbent and total welfare would still be $pW^M + (1-p)W^m - K$.[22] When the start-up is constrained, the early takeover is welfare beneficial because it avoids the inefficiency caused by financial constraints and, when the investment is successful, leads to the development of the innovation, even though in a monopolistic market.

In all the above cases, when $\overline{H} > W^d - W^M$, early takeovers are approved. It remains to understand the decision of the AA if the incumbent made a pooling bid and is expected to shelve. If so, the early takeover decreases the welfare expected at $t = 1$:

$$-(1 - F(\overline{A}^T)[p(W^M - W^m) - K] \equiv -H^2 < 0.$$

Intuitively, if the early takeover is authorised welfare will be W^m because the incumbent shelves. Welfare is the same, when the early takeover is blocked, if the start-up is constrained. Instead, when the start-up is unconstrained, blocking the early takeover would allow the start-up to invest and possibly develop the innovation. Competition in the market would be softened by the takeover at $t = 2$, but the development of the innovation is anyway beneficial for welfare.

Therefore, if the harm to welfare, H^2, caused by an early takeover is lower than the one, $W^d - W^M$, caused by a late takeover, then also early takeovers must be approved, even in the case of a pooling offer followed by shelving. Such a scenario occurs if (and only if):

$$F(\overline{A}^T) \geq \frac{p(W^M - W^m) - K - (W^d - W^M)}{p(W^M - W^m) - K} \equiv \Lambda(\cdot) \tag{5}$$

because a higher probability that the start-up is constrained reduces the harm to welfare expected at $t = 1$. If Condition (5) holds, a merger policy that authorises late takeovers but is stricter towards early takeovers cannot arise. That is, if Condition (5) is satisfied,[23] in order to identify the optimal policy we have to compare a strict merger policy with a laissez-faire policy that authorises any takeover. We do this in Section 6.1.

If, instead, Condition (5) is not satisfied, blocking early takeovers (in the case of a pooling bid followed by shelving) can coexist with an authorisation of late takeovers. This intermediate merger policy corresponds to a tolerated level of harm $\overline{H} \in (W^d - W^M, H^2]$.

Lemma 5 describes the decision of the AA at $t = 1(b)$ under the intermediate policy:

LEMMA 5 (Decision of the AA with the intermediate merger policy)**.**
Let condition Condition (5) *be violated. There exists an intermediate merger policy that authorises any late takeover and:*

- *If the incumbent made a separating bid at $t = 1(a)$, then the AA authorises the early takeover.*

[22] If mergers at $t = 2$ are blocked, absent the takeover the successful start-up would compete with the incumbent and the takeover would decrease expected welfare.

[23] The RHS in Condition 5 might be negative and such a condition always satisfied.

- *If the incumbent made a pooling bid at $t = 1(a)$, the AA authorises the early takeover when the incumbent is expected to invest, whereas it blocks the early takeover when the incumbent is expected to shelve.*

Proof. See the discussion above and Appendix A.4.2. Q.E.D.

Let us analyse the takeover decision at $t = 1(a)$ under this intermediate merger policy. The incumbent anticipates the decision of the AA concerning the takeover. When the incumbent plans to shelve, it anticipates that, if it makes a pooling bid, the takeover will be blocked. If it makes a separating bid the takeover will be approved (by indifference). Under the assumption that the takeover involves a cost, though negligible, it is profitable for the incumbent not to make any bid.

Instead, when the incumbent plans to invest, it anticipates that the early takeover will be approved both under a pooling and a separating bid. As shown by Proposition 2, the incumbent always finds it more profitable to make a separating bid, because it will be able to acquire an unconstrained start-up at $t = 2$, if successful in the project development.

The equilibrium of the game is summarised by the following proposition:

PROPOSITION 3 (Equilibrium of the game under the intermediate merger policy)**.**
Under an intermediate merger policy which authorises any late takeover and prohibits early takeovers that involve a pooling bid and the suppression of the project:

- *If $p(\pi_I^M - \pi_I^m) < K$ no takeover takes place at $t = 1$. An unconstrained start-up will be acquired at $t = 2$ if the investment is successful.*
- *If $p(\pi_I^M - \pi_I^m) \geq K$, the incumbent makes a separating bid at $t = 1$. A credit-constrained start-up accepts the offer. An unconstrained start-up rejects the offer but will be acquired at $t = 2$ if the investment is successful.*

Comparing Propositions 2 and 3, it is easy to see that the laissez-faire policy is dominated by the intermediate policy, as long as this policy is feasible – i.e., Condition 5 is not satisfied. Such a policy avoids the worst-case scenario in which the incumbent acquires any type of start-up and then shelves, and in which expected welfare is W^m. This is the policy that must be compared to a strict merger policy to identify the optimal policy when Condition 5 is not satisfied, as we do in Section 6.2.

6 Optimal Policy

6.1 Comparison between a strict merger policy and a laissez-faire policy

At $t = 0$ the AA chooses the merger policy by committing to a tolerated harm $\overline{H}$. When Condition 5 is satisfied, the optimal policy is identified comparing a strict merger policy with a laissez-faire policy.

By comparing Propositions 1 and 2, one can see that a strict merger policy dominates a laissez-faire policy when the incumbent is expected to develop the project. Under a laissez-faire policy the incumbent always makes a separating offer at $t = 1$, thereby engaging in the takeover at an early stage if the start-up is constrained, and at a later stage when the start-up is unconstrained and successfully develops the prototype. Overall, a monopoly incorporating the innovation arises when the investment succeeds, whereas a monopoly without innovation when the investment fails. Under a strict merger policy expected welfare is exactly the same if the incumbent makes a pooling offer, $EW^{strict} = EW^{laissez-faire} = pW^M + (1-p)W^m - K$, which occurs if $F(\overline{A}) \in [\Gamma(\cdot), \max\{\Phi(\cdot), \Gamma(\cdot)\})$, i.e. when the AA authorises a pooling offer and the incumbent finds it more profitable than a separating offer. Otherwise, the incumbent makes a separating offer, and expected welfare is strictly higher than under a laissez-faire policy:

$$\begin{aligned} EW^{strict} &= p[F(\overline{A})W^M + (1-\overline{A})W^d](1-p)W^m - K \\ &> pW^M + (1-p)W^m - K = EW^{laissez-faire}. \end{aligned}$$

Indeed, a strict merger policy still allows to avoid the inefficiency caused by credit rationing (because early takeovers which exhibit a separating offer are authorised) but by blocking takeovers at the later stage, it benefits society by avoiding the suppression of competition.

A strict merger policy dominates a laissez-faire policy also when the incumbent is expected to shelve and financial imperfections are not severe, i.e. when $F(\overline{A}^T) < \Phi^T(\cdot)$:

$$EW^{strict} = W^m + (1 - F(\overline{A}))[p(W^d - W^m) - K] > W^m = EW^{laissez-faire}.$$

In that case, under the laissez-faire policy the incumbent engages in an early takeover and makes a pooling offer, which leads to the suppression of the project with certainty. Instead, no take-over would occur under a strict merger policy (either ex-ante and ex-post), and expected welfare would be higher because if the start-up is unconstrained and the project succeeds, society benefits from the innovation and from competition in the product market.

However, when financial imperfections are severe, a trade-off arises. Both under a strict and a laissez-faire policy no takeover would occur at $t = 1$. However, under a laissez-faire policy an unconstrained start-up that manages to successfully develop the project is acquired ex-post. This is welfare detrimental, because a monopoly arises instead of a duopoly; however it is precisely the expectation of the future acquisition that relaxes financial constraints ex-ante, and benefits welfare by allowing a start-up, that would be denied funds under a strict merger policy, to invest. A strict merger policy is better for welfare, i.e.

$$\begin{aligned} EW^{strict} &= W^m + (1 - F(\overline{A}))[p(W^d - W^m) - K] \\ &\geq W^m + (1 - F(\overline{A}^T))[p(W^M - W^m) - K] = EW^{laissez-faire}, \end{aligned}$$

when the following condition is satisfied:

$$\frac{p(W^d - W^m) - K}{p(W^M - W^m) - K} \geq \frac{1 - F(\overline{A}^T)}{1 - F(\overline{A})}. \tag{6}$$

If so, the beneficial effect of intensifying product market competition is big enough to dominate the detrimental effect of failing to relax financial constraints and of making it more likely that the innovation reaches the market.

6.2 Comparison between the strict policy and the intermediate policy

Comparing Propositions 1 and 3, one can conclude that, for the same reasons discussed in Section 6.1, the optimal policy is the strict one, i.e. $\overline{H} = 0$, when the incumbent is expected to develop. When the incumbent is expected to shelve, an equilibrium with a pooling bid never arises, because now the AA would block the takeover also under the more lenient policy. Then, the same trade-off described above between diminished allocative efficiency in the product market and higher probability to have the new product developed arises, irrespective of the severity of financial constraints. A strict policy is optimal when Condition 6 is satisfied.

6.3 The optimal policy

In sum, a strict merger policy is always optimal when the incumbent is expected to invest. When the incumbent is expected to shelve, a more lenient policy (that either authorises any type of takeover, or that blocks early takeovers when the incumbent makes a pooling bid and plans to shelve, and authorises late takeovers) may be optimal, but under the cumulative conditions indicated in the following proposition:

PROPOSITION 4 (Optimal policy)**.**

- *A laissez-faire policy (that authorises any takeover) is optimal when it holds simultaneously that: (i) the incumbent is expected to shelve, i.e.* $p(\pi_I^M - \pi_I^m) < K$*; (ii) financial imperfections are severe, i.e.* $F(\overline{A}^T) \geq \{\Phi^T(\cdot)$*; (iii) approving early takeovers followed by shelving is optimal, i.e.* $F(\overline{A}^T) \geq \Lambda(\cdot)$*; (iv) and the detrimental effect of less intense product market competition is dominated by the benefit of making it more likely that the innovation is commercialised, i.e., Condition 6 is not satisfied.*

- *An intermediate merger policy (that blocks early takeovers, when the incumbent makes a pooling bid and plans to shelve, and authorises late takeovers) is optimal when it holds simultaneously that: (i) the incumbent is expected to shelve, i.e.* $p(\pi_I^M - \pi_I^m) < K$*; (ii) approving early takeovers followed by shelving is not optimal, i.e.* $F(\overline{A}^T) < \Lambda(\cdot)$*; (iii) and Condition 6 is not satisfied.*

- *Otherwise, a strict merger policy is optimal.*

7 Micro-foundation of the general model

In this section we solve the model assuming that the development of the project leads to a new product which is an imperfect substitute of the incumbent's existing product, as described by the standard demand functions $p_i = 1 - q_i - \gamma q_j$, with $i, j = I, S; i \neq j$, and $\gamma \in (0, 1)$ (see Singh and Vives, 1984). Both the start-up and the incumbent have zero marginal production costs. Competition in the market is à la Cournot.

Appendix A.5 reports the payoffs of the firms and of consumers in the various market structures and identifies the restrictions on the feasible parameters' values that ensure that all the assumptions of the model are satisfied. In particular, an upper bound has to be imposed on the investment cost and on the degree of substitutability to ensure that duopoly profits are large enough to make the NPV of the project positive (Assumption A3) and that the incumbent's development of the new product is beneficial for society (Assumption A4):

$$K < \frac{p}{4}, \quad \gamma < \min\left\{\sqrt{\frac{p}{K}} - 2, \frac{3p - 8K}{8K + 3p}\right\} \equiv \overline{\gamma}.$$

Finally, Assumption A5 translates into:

$$B_{A5} \equiv \frac{p}{(2+\gamma)^2} - K < B < K.$$

Appendix A.5 also derives the building blocks of the model and characterises the optimal policy, that we describe in what follows.

7.1 The optimal merger policy

Appendix A.5 shows that, in this parametric model, under a laissez-faire policy the start-up is not credit constrained: $\overline{A}^T < 0$. From Proposition 2 it follows that, under a laissez-faire policy, at $t = 1$ the incumbent always makes a pooling bid when it plans to shelve. (Recall that a separating bid is profitable for the incumbent only if the probability that the start-up is constrained is sufficiently high, but in this case, $\overline{A}^T < 0$ implies that $F(\overline{A}^T) = 0$.) As a consequence, as shown in Section 6.1, a strict merger policy always dominates a laissez-faire policy: when the incumbent is expected to develop, a strict merger policy allows to take advantage of the beneficial effects of takeovers, i.e. the removal of the inefficiencies caused by financial constraints, without harming ex-post competition; when the incumbent is expected to shelve, a strict merger policy prevents killer acquisitions.

While a laissez-faire policy cannot be optimal, the next proposition characterises under which conditions an intermediate merger policy (i.e. a policy that blocks takeovers at $t = 1$, when the incumbent makes a pooling bid and plans to shelve, and authorises all other takeovers) may be so. In particular, it must simultaneously hold that: (i) the investment cost is high enough, so that there is more scope for the incumbent to shelve the project; (ii) the degree of substitutability is intermediate, so that authorising mergers at $t = 2$ does not produce too much allocative inefficiency; (iii) and financial imperfections are severe, so that relaxing financial constraints by authorising mergers at $t = 2$ is very beneficial.

PROPOSITION 5 (Optimal policy under Cournot with differentiated products)**.**
There exists a threshold level of the investment cost $\hat{K} \in (0, p/4)$ and a threshold level of the degree of substitutability $\hat{\gamma} \in (\gamma_{Inv}, \overline{\gamma}]$, such that:

- *The intermediate merger policy is optimal if (and only if) it holds simultaneously that:*
  - *(i) The investment cost is sufficiently large, i.e. $K > \hat{K}$,*
  - *(ii) The degree of substitutability is moderate, i.e. $\gamma \in (\gamma_{Inv}, \hat{\gamma})$,*
  - *(iii) Financial imperfections are severe:*

$$F(\overline{A}) > 1 - \frac{p(W^M - W^m) - K}{p(W^d - W^m) - K}.$$

- *Otherwise, a strict merger policy is optimal.*

Proof. See Appendix A.5.3. Q.E.D.

Figure 2 displays the optimal policy depending on the feasible values of the parameters $\gamma \in (0, \overline{\gamma})$ and $B \in (p/[(2+\gamma)^2] - K, K)$. We have set $K = 1/9$ and $p = 3/4$ for illustration. We have also assumed that the start-up's assets are distributed uniformly over $(0, K)$.

When the degree of substitutability is sufficiently low, i.e. $\gamma \leq \gamma_{Inv}$ (with γ_{Inv} defined in the Appendix), the incumbent finds it profitable to develop the project. In that case, as discussed in Section 6, a strict merger policy is always optimal. When the degree of substitutability is high, i.e. $\gamma \geq \hat{\gamma}$, the strict merger policy is also optimal. In this case, the intermediate merger policy cannot arise: allocative inefficiencies are pronounced and the harm to welfare caused by late takeovers $W^d - W^M$ is higher than the one caused by killer acquisitions at $t = 1$, $p(W^M - W^m) - K$; then, when the standard for merger policy is such that late takeovers are authorised, all early takeovers are also authorised. Therefore, the choice is between a laissez-faire policy and a strict merger policy. However, in this case, as discussed above, a strict merger policy dominates a laissez-faire policy also when the incumbent is expected to shelve: since $F(\overline{A}^T) = 0$, under a laissez-faire policy the incumbent would always make a pooling bid, thereby engaging in a killer acquisition with certainty. Such takeovers would be blocked, instead, under a strict merger policy.

For intermediate values of γ, there is scope for the intermediate policy and the incumbent finds it profitable to shelve. As discussed in Section 5, the intermediate merger policy dominates the laissez-faire policy. Therefore, the choice is between the intermediate merger policy and the strict merger policy. The former is optimal when Condition 6 is not satisfied (which, in this application, translates into the condition in point (iii) of Proposition 5). As we show in the

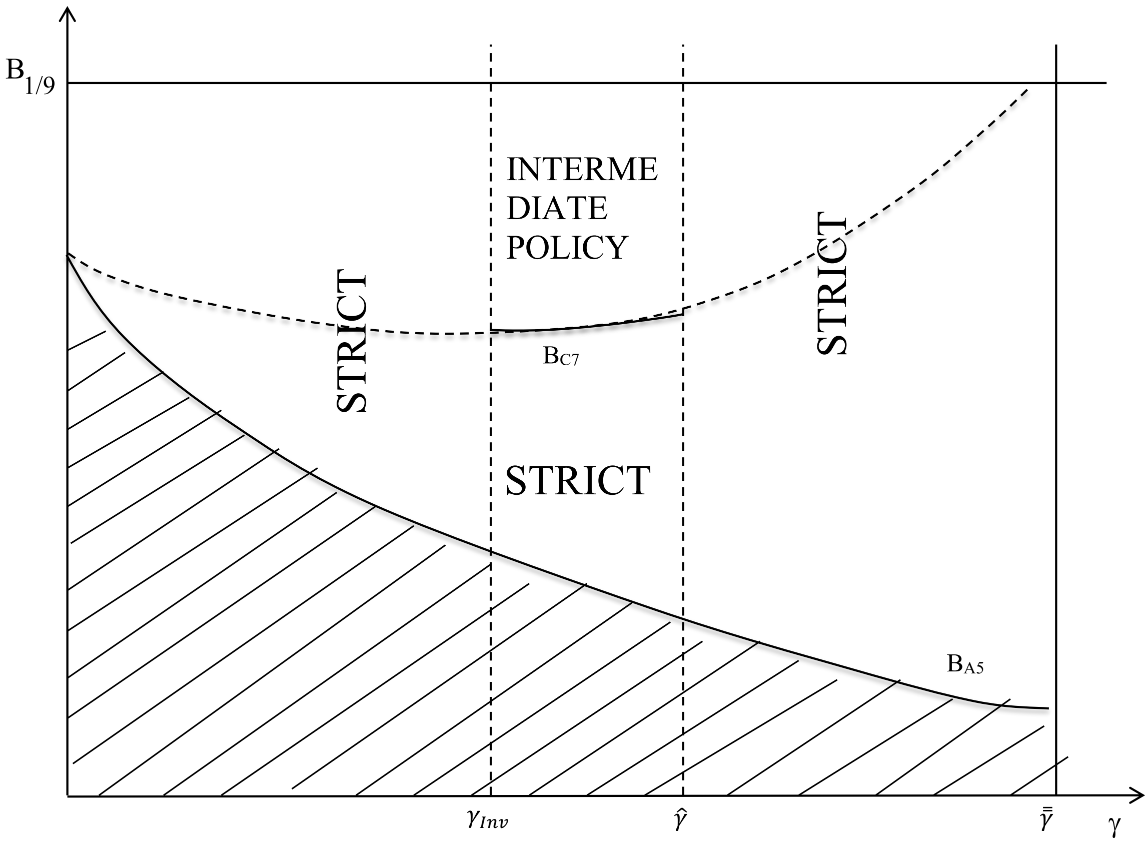

Figure 2. The Optimal Policy

appendix, under the assumption of uniform distribution, the condition in point (iii) requires $B > B_{C7}$ (with B_{C7} defined in the appendix): the private benefit that the owner of the project enjoys in the case of no effort can be considered a proxy for financial imperfections; the higher B, the higher $\overline{A}$ and the higher the probability that the start-up is financially constrained when late takeovers are not authorised. Therefore, when B is high enough, a merger policy that authorises ex-post takeover relaxes significantly financial constraints. This is so beneficial to dominate allocative inefficiencies and makes the intermediate policy optimal. Otherwise, the strict merger policy is optimal.

8 Discussion of assumptions and extensions

In this section we briefly discuss how relaxing some of our assumptions may impact upon the analysis and the results of the model.

8.1 Financial constraints

Assumption (A5) states that $B > p\pi_S^d + (1-p)v_0 - K$ and ensures that the moral hazard problem is strong enough for the start-up to possibly be financially constrained. If this assumption did not hold, the possible pro-competitive effects of early takeovers would vanish, and a strict merger policy that prohibits any takeover would always be optimal. Since S always has the chance to develop, a takeover would either kill the project or suppress competition, or both.

8.2 The AA uses contingent levels of tolerated harm

We have assumed the AA chooses the same policy criterion, namely $\overline{H}$, independently of whether the takeover takes place before or after the financial contracting stage – that is, before the innovation is developed or when entry is about to take place. Although it makes sense to think that the AA cannot change its standard of review, one may wonder what happens if the AA had two different standards, namely $\overline{H}_1$ and $\overline{H}_2$, depending on the timing of the takeover proposal. We would obtain the same qualitative result in that case: if the incumbent plans to develop, the optimal policy would be also in this case to set $\overline{H} = 0$. If the incumbent plans to shelve, the optimal policy is to authorise late takeovers and to block ex-ante takeovers under a pooling bid.

Relatedly, it is worth noting that the AA's decisions in the first stage are based on the takeover price (a pooling bid is one at which the takeover price is high enough for start-ups which are not financially constrained to accept the offer). This is relevant because it is often mentioned in policy discussions that the price of the transaction should be seen as a signal that the merger is likely anti-competitive (the idea being that the incumbent would be ready to share part of its profits in order to protect its market power).

8.3 Welfare efficiency of the investment

Assumption (A4) ($p(W^M - W^m) > K$) guarantees that the development of the project is beneficial for society if undertaken by the incumbent, and a fortiori by the start-up: $p(W^d - W^m) > p(W^M - W^m) > K$. Relaxing this assumption would lead to two meaningful cases.

If $p(W^M - W^m) < K < p(W^d - W^m)$, the project will be good for society only if it leads to competition. As a result, the strict merger policy, which prohibits any takeover, is optimal. In our model there could be two sources of pro-competitive effects: (i) takeovers involving potential competitors could be beneficial because the incumbent develops the project when the start-up would not be able to because of financial constraints; (ii) late takeovers involving committed entrant could be beneficial because the anticipation of future acquisitions relaxes financial constraints and allows the start-up to develop projects that would not be carried out otherwise. Both effects are muted if having the innovation in the hands of the incumbent does not raise welfare.

If $p(W^d - W^m) < K$, the project would always be welfare-reducing. Provided there is a private incentive for carrying it out, we would be in a situation similar to the "excess entry" result of Mankiw-Whinston. Killer acquisitions would be good: since project development wastes resources, the AA would like takeovers to go ahead whenever the incumbent would stop development. If the incumbent had a private incentive to develop as well, the AA would block such a merger: conditional on the project going ahead, the AA would prefer to have more intense ex-post competition, since $W^d > W^M$.

8.4 Debt, equity and convertible debt

Under the strict merger policy studied in Section 3, the investors' claim can be thought of as being either debt or equity. In other words, there is no difference between risky debt and equity. As shown in Tirole (2006), under the debt interpretation, the borrower must repay $\pi_S^d - R_S^s$ to the investors or else go bankrupt. In the case of project success, then, the start-up keeps R_S^s. Alternatively, investors and start-up can agree on an equity contract. In that case, the start-up holds a fraction R_S^s/π_S^d and the investors hold a fraction $(\pi_S^d - R_S^s)/\pi_S^d$ of equity.

This equivalence, which is a well-known feature of Holmström-Tirole moral-hazard setting, is broken under the more lenient merger policies studied in Sections 4 and Section 5. Specifically, the sharing rule considered in those sections can still be interpreted as a debt contract. However, an equity contract gives rise to different results in the financial contracting game. With equity, when the incumbent acquires the start-up in $t = 2$, it pays a total of π_S^d to the investors and the entrepreneur. Going backwards, the investors do not expect an increase in the pledgeable income, and there is no relaxation of financial constraints – that is, funding happens if (and only if) $A \geq \overline{A}$, as much as under the strict merger policy (see Appendix A.6 for the formal analysis). It follows that under the laissez-faire or the intermediate policy the start-up will prefer debt to equity.

Finally, we obtain the same results as with debt across merger policies if the start-up uses a convertible debt contract to negotiate funding with investors.[24] Under a convertible debt contract, parties negotiate a sharing rule that requires the payment of R_S^s and R_S^f (as in our main model) to the start-up in case of success and failure absent a takeover in $t = 2$ (and a complementary contingent share of the profits to make the investors break even). However, if a late-takeover offer is formulated by the incumbent, the arrangement prescribes that entrepreneur and investors will obtain shares x_S^j and $1 - x_S^j$, with $j = s, f$, of product-market profits π_I^M. By this, funding happens for all $A \geq \overline{A}^T$ and the same results as in the main analysis apply across merger policies.

8.5 Informational assumptions

The main effects of takeovers (avoidance of financial constraints vs. killer acquisitions; relaxation of financial constraints vs. increase of market power) and their implications for the choice of

[24]The use of convertible securities is widespread in venture capital finance (Schmidt, 2003; Tirole, 2006).

merger policies are still valid if we relax the assumption of imperfect information. There are some differences though.

Assume the incumbent knows the realisation of the start-up's resources when it bids at $t = 1(a)$ and the AA also knows it when it reviews the merger proposal. We maintain the assumption that, when it establishes the standard for merger policy at t = 0, the AA only knows the distribution of A (see Appendix A.7 for the proofs of this case).

Since the AA observes whether the start-up is constrained, it does not need to infer it from the takeover bid; likewise for the incumbent, who will not have to choose between a pooling and a separating bid. A first implication is that there is no reason to formulate a merger policy contingent on the takeover price. A second implication is that a laissez-faire policy is always dominated by a strict merger policy and cannot be optimal, as stated by Proposition 6 below. The reason is that, even though the authorisation of late takeovers relaxes financial constraints (it reduces the cut-off level of own resources necessary to obtain external funding from $\overline{A}$ to $\overline{A}^T$), under perfect information a laissez-faire policy does not produce any pro-competitive effect. The comparison of the outcomes under the two policies clarifies why this is the case.

Under a strict merger policy the early takeover will never take place unless the start-up is constrained ($A < \overline{A}$) and the incumbent has an incentive to develop (so that it finds it profitable to engage in the early takeover). By contrast, under a laissez-faire policy, the early takeover always occurs unless the start-up is constrained (i.e. $A < \overline{A}^T$) and the incumbent has an incentive to shelve, because in such a case it is more profitable for I to let the project die because of financial constraints. Therefore, when $A \geq \overline{A}$, the start-up is unconstrained under either policy. The strict policy dominates, because it avoids killer acquisitions (when I has an incentive to shelve) and the lessening of competition (when I has an incentive to develop). In all the other cases the two policies are equivalent. Namely, when $A < \overline{A}^T$, the start-up is constrained under either policy; the early takeover occurs under neither of them when the incumbent has an incentive to shelve (because, as said above, I prefers to let the project die naturally), whereas it occurs under either of them when the incumbent has an incentive to develop (because the AA authorises it even under a strict policy). When $A \in (\overline{A}^T, \overline{A}]$, the start-up is constrained under a strict merger policy, and unconstrained under a laissez-faire policy. Also in this case the outcome is the same under either policy: the project will not be developed when I plans to shelve (under a laissez-faire policy the project will be terminated by the incumbent, once acquired the start-up; under a strict merger policy it will be terminated by financial constraints); the early takeover will occur under either policy when I plans to develop (it will be authorised under a strict policy; the AA does not bound the choice of the incumbent under a laissez-faire policy).

The key point is that the pro-competitive effect produced by the authorisation of late takeovers manifests itself when no early takeover takes place under either policy and the start-up manages to invest under a laissez-faire policy, because the relaxation of financial constraints makes it unconstrained, whereas it would not be able to obtain funding under a strict merger policy. However, since the incumbent observes the realisation of A before deciding on the early takeover, under a laissez-faire policy the takeover always occurs when the start-up is unconstrained, and that scenario does not arise. By contrast, that scenario would arise and the pro-competitive effect produced under the intermediate policy, precisely because it authorises late takeovers, but blocks early takeovers when the start-up is unconstrained and the incumbent is expected to shelve. Indeed, as shown in Proposition 6, under perfect information the conditions that need to be satisfied for the intermediate policy to be optimal are similar to the ones derived with imperfect information.[25]

PROPOSITION 6. *(Optimal policy under perfect information.)*
When information is perfect,

- *A laissez-faire policy (that authorises any takeover) is never optimal.*
- *An intermediate policy (that blocks early takeovers when $A \geq \overline{A}^T$ and the incumbent is expected to shelve, and authorises late takeovers) is optimal when it holds simultaneously that: (i) the incumbent is expected to shelve; (ii) $p(W^M - W^m) - K \geq W^d - W^M$; (iii) Condition 6 is not satisfied.*
- *Otherwise, a strict merger policy is optimal.*

Proof. See Appendix A.7. Q.E.D.

8.6 Ex-ante effect of the acquisition

One could extend the game so as to have an initial stage where the start-up decides on the effort to make, and such effort determines the probability that innovation exists in the first place. If the innovation materialises, the game continues as we have described, and otherwise it will never be played. To the extent that effort is a non-decreasing function of the expected future revenue, one would have that the higher the expected acquisition price the higher the production of innovation. As a result, a strict policy would have a possible negative effect: since it blocks takeovers involving pooling bids (that is, with high prices), it might also decrease the incentives to produce innovation.

8.7 Other potential acquirers of the start-up

We have assumed that the incumbent is the only potential buyer of the start-up. In line with Vickers (1985) and Cunningham et al. (forthcoming), considering several competing incumbent

[25] Since the AA observes A when it evaluates the merger proposal, the condition for the intermediate policy to be feasible, $p(W^M - W^m) - K \geq W^d - W^M$, is less demanding than the one with imperfect information ($[1 - F(\overline{A}^T)]p(W^M - W^m) - K \geq W^d - W^M$).

firms would likely show that the incentive to take-over the start-up reduces with the number of incumbent firms, but we would not expect it to give rise to qualitative changes.[26]

Another possible extension (and one we formally analysed in a previous version of the paper) is to consider a potential acquirer which is an "outsider" to the industry, so as to capture the idea that, say, not only Google (which, with Google Maps, was the dominant firm in the market for turn-by-turn digital navigation), but also Facebook and Apple were interested in taking-over Waze. Intuitively, the acquisition by an outsider which is – like the incumbent – endowed with sufficient financial assets would be better for welfare, because it would avoid the inefficiency caused by financial constraints without suppressing competition. However, precisely because the acquisition may allow the incumbent to preserve its monopoly position, the outsiders would be less likely than the incumbent to acquire the start-up at equilibrium. Banning the incumbent from taking over the start-up would be the obvious policy, provided one knows that there are financially strong outsiders willing to acquire the target of the takeover. However, reduced competition in the takeover market would decrease the expected profits for the start-up, which could possibly reduce innovation effort, as discussed in the previous sub-section.

9 Concluding remarks

We have analysed the optimal merger policy of an Antitrust Authority which first commits to a merger standard, and then approves or blocks acquisitions of potential competitors on the basis of that standard. In our model, a start-up may be financially constrained and may thus fail to obtain the external funding needed to develop a project which (if successful) might disrupt the incumbent's monopoly. A takeover by the incumbent may be anti-competitive because (i) it could eliminate a potential competitor and/or because (ii) it could suppress project development. But it may also be pro-competitive, if (iii) the incumbent has an incentive to develop a project that an independent start-up would have not been able to pay for. Further, (iv) a takeover may relax financial constraints: the expectation that the start-up may be acquired in the future and that the incumbent will take over its obligations may make external investors more willing to provide external funds.

The identification of the optimal policy requires to compare three policy rules: a strict merger policy, that commits to prohibit any late takeovers and authorises early takeovers only when they involve a separating bid; a laissez-faire merger policy that authorises any early and late takeover; an intermediate policy that authorises late takeovers but is stricter towards early takeovers, blocking those that involve a pooling bid and in which the incumbent is expected to shelve. A commitment to approve late acquisitions – which ex post decrease welfare – will relax the financial constraint and promote investment (effect (iv) above), and explains why lenient

[26] Specifically, this is the case under the assumption that product-market profits do not depend on the identity of the firm owning the prototype. Under the alternative assumption that the profits depend on the prototype's owner, the willingness to pay for the start-up may increase in the presence of competitors (see Nörback and Persson, 2009).

merger policies may in some circumstances be optimal. We have showed that the more efficient the financial markets, the more likely a strict merger policy rule is optimal. Under such a rule, not all mergers would be blocked, but only those which would consist in the acquisition of a start-up that is likely to receive funding for its project. An equivalent rule would consist in blocking takeovers whose acquisition price is above a certain threshold: a pooling bid is one at which the takeover price is high enough for start-ups which are not financially constrained to accept the offer. Our results may therefore inform the current policy proposals suggesting that the price of the transaction might signal an anti-competitive merger (intuitively, the incumbent would be ready to pay more when the threat to its market power is higher).

Finally, we are well aware that our optimal policy has been derived within a particular model. To allow the reader to better assess the relevance of our results policy implications, we have discussed several extensions and showed the role played by the most important assumptions.

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A Appendix

A.1 Proof of Lemma 3

Proof. **Separating bid.** If the incumbent at $t = 1(a)$ made a low takeover bid, i.e. $P = P_L = 0$, and the start-up accepted the bid, then the AA infers that the start-up is credit-rationed, i.e. that $A < \overline{A}$. An unconstrained start-up would obtain $p\pi_S^d - K$ by investing and would reject the takeover offer since $p\pi_S^d - K > 0$ (from Assumption A3).

By blocking the takeover, total welfare will be W^m, because the start-up would not develop the project. If Condition 1 is not satisfied, total welfare will be W^m also when the AA authorises the takeover, because the incumbent is expected to shelve. If, instead, Condition 1 is satisfied, total welfare will be W^M if development succeeds (which occurs with probability p), while it will be W^m if the investment fails (which occurs with probability $1-p$). Total expected welfare when the takeover is authorised is given by:

$$EW_{dev}^{auth} = pW^M + (1-p)W^m - K. \tag{A-1}$$

The change in expected welfare, if the takeover is authorised, is therefore:

$$\Delta EW_{dev}^{sep} = p(W^M - W^m) - K = p(CS^M + \pi_I^M - CS^m - \pi_I^m) - K > 0. \tag{A-2}$$

The change in expected welfare is positive because the investment is profitable (i.e. Condition 1 is satisfied) and benefits consumers ($CS^M \geq CS^m$). Therefore, the AA authorises the merger when it observes that the takeover bid $P = P_L = 0$ has been accepted.

Pooling bid. If the AA observes that the incumbent at $t = 1(a)$ made a high takeover bid, i.e. $P = P_H = p\pi_S^d - K$, then it cannot infer whether the start-up is constrained or not, since any start-up will accept it.

If the AA blocks the merger and the start-up is constrained – which occurs with probability $F(\overline{A})$ – the investment will not be done and total welfare will be W^m; if it is not constrained – which occurs with probability $1 - F(\overline{A})$ – the start-up will invest. If the investment is successful, which occurs with probability p, the start-up will market the innovation and compete with the incumbent at $t = 3$ (recall that at $t = 2$ the merger will be blocked), giving rise to total welfare W^d; if the investment fails, total welfare will be again W^m. Therefore, expected welfare is given by:

$$EW^{block} = F(\overline{A})W^m + (1 - F(\overline{A}))[pW^d + (1-p)W^m - K].$$

If the AA authorises the merger and the incumbent shelves (i.e. if Condition 1 is not satisfied), welfare is W^m. The change in expected welfare is:

$$\Delta EW_{shelve}^{pooling} = -(1 - F(\overline{A})[p(W^d - W^m) - K] < 0$$

by Assumption A4. In this case the AA blocks the merger.

If the AA authorises the merger and the incumbent invests (i.e. if Condition 1 is satisfied), expected welfare is as in Equation A-1.

Authorising the takeover causes a change in expected welfare equal to:

$$\Delta EW_{dev}^{pooling} = -(1 - F(\overline{A})[p(W^d - W^M)] + F(\overline{A})[p(W^M - W^m) - K].$$

In this case authorising the takeover exerts two opposite effects. When the start-up is unconstrained, which occurs with probability $1-F(\overline{A})$, the takeover lowers welfare because $W^M < W^d$. However, when the start-up is constrained, the takeover increases welfare because we know from the analysis of Condition A-2 that $p(W^M - W^m) - K > 0$. Hence, when the incumbent makes a pooling bid and it is expected to invest, $\Delta EW_{dev}^{pooling} \geq 0$ and the takeover is authorised if (and only if):

$$F(\overline{A}) \geq \frac{p(W^d - W^M)}{p(W^d - W^m) - K} \equiv \Gamma(\cdot) \in (0, 1)$$

where $\Gamma(\cdot) < 1$ from Condition A-2. Q.E.D.

A.2 Proof of Proposition 1

Proof. We first show that, when the incumbent plans to develop, making a separating bid is profitable. By bidding $P_L = 0$ the incumbent anticipates that the offer will be accepted only by a constrained start-up (i.e. with probability $F(\overline{A})$). In that case the incumbent will earn π_I^M when the investment succeeds; and π_I^m otherwise. It also anticipates that, when the start-up is unconstrained and the offer is turned down, the AA will not authorise the merger at $t = 2(b)$. Then, the incumbent will earn the duopoly profits when the investment of the start-up succeeds, and π^m otherwise. Its expected payoff, net of the bid, is:

$$\pi_I^{sep} = F(\overline{A})[p\pi_I^M + (1-p)(\pi_I^m) - K] + (1 - F(\overline{A}))[p\pi_I^d + (1-p)\pi_I^m].$$

If the incumbent does not make any bid, it will obtain the same payoff as in the case of a separating bid when the start-up is unconstrained. It will obtain π^m when the start-up is constrained. In expected terms it will obtain:

$$\pi_I^{no} = F(\overline{A})\pi_I^m + (1 - F(\overline{A}))[p\pi_I^d + (1-p)\pi_I^m],$$

since $p(\pi_I^M - \pi_I^m) \geq K$, then $\pi_I^{sep} \geq \pi_I^{no}$.

We now show under which conditions a separating bid is more profitable for the incumbent than a pooling bid. In the latter case the start-up will accept the offer irrespective of its assets and the expected profit of the incumbent (net of the bid) is:

$$\pi_I^{pool} = p\pi_I^M + (1-p)\pi_I^m - K - (p\pi_S^d - K),$$

where $p\pi_S^d - K = P_H$ is the expected payoff of the start-up when it manages to obtain funding and, therefore, is the minimum offer that any start-up will accept. We find that $\pi_I^{sep} \geq \pi_I^{pool}$ if (and only if):

$$F(\overline{A}) \geq \frac{p(\pi_I^M - \pi_S^d - \pi_I^d)}{p(\pi_I^M - \pi_I^d) - K} \equiv \Phi(\cdot) \in (0,1)$$

where $\Phi(\cdot) > 0$ follows from Assumption A1 and $\Phi(\cdot) < 1$ from Assumption A3. Q.E.D.

A.3 Proof of Proposition 2

Proof. Consider $p(\pi_I^M - \pi_I^m) \geq K$. By bidding $P_L = 0$ the incumbent anticipates that the offer will be accepted only by a constrained start-up (i.e. with probability $F(\overline{A})$). It will earn π_I^M, when the investment succeeds; and π_I^m otherwise. The incumbent also anticipates that, when the start-up is unconstrained and the offer is turned down, the AA will authorise the merger at $t = 2(b)$. From Section 4.1 we know that, when the investment of the start-up succeeds, the incumbent will earn $\pi_I^M - \pi_S^d$ net of the takeover offer, and π_I^m otherwise. The expected payoff of the incumbent, is:

$$\pi_{I,dev}^{sep,T} = F(\overline{A}^T)[p\pi_I^M + (1-p)\pi_I^m - K] + (1 - F(\overline{A}^T))[p(\pi_I^M - \pi_S^d) + (1-p)\pi_I^m].$$

Under a laissez-faire merger policy making a separating offer is more profitable than under a strict policy: in the former case the start-up that manages to develop the project will be acquired at $t = 2$ and the incumbent will make net profits $\pi_I^M - \pi_S^d$, while in the latter case such an acquisition would not be authorised and the incumbent would earn $\pi_I^d < \pi_I^M - \pi_S^d$ from Assumption A1.

By bidding $P_H = p\pi_S^d - K$ the start-up will accept the offer irrespective of its assets and the expected profit of the incumbent (net of the bid) is:

$$\pi_{I,dev}^{pool,T} = p\pi_I^M + (1-p)\pi_I^m - K - (p\pi_S^d - K),$$

with $\pi_{I,dev}^{sep,T} > \pi_{I,dev}^{pool,T}$ if (and only if) $p\pi_S^d > K$, which is always satisfied by Assumption A3.

If the incumbent does not make any bid, it will obtain the same payoff as in the case of a separating bid, when the start-up is unconstrained. Instead, it will obtain π_I^m when the start-up is constrained. In expected terms it will obtain:

$$\pi_I^{no,T} = F(\overline{A}^T)\pi_I^m + (1 - F(\overline{A}^T))[p(\pi_I^M - \pi_S^d) + (1-p)\pi_I^m].$$

Since $p(\pi_I^M - \pi_I^m) \geq K$, then $\pi_{I,dev}^{sep,T} \geq \pi_I^{no,T}$. Therefore, if $p(\pi_I^M - \pi_I^m) \geq K$, the incumbent makes a separating offer at the equilibrium.

Consider now the case in which the incumbent plans to shelve (i.e. $p(\pi_I^M - \pi_I^m) < K$). Making a separating bid is equivalent to not making any bid because the project would not be developed by a constrained start-up. Under the assumption that the takeover involves a transaction cost, though negligible, the incumbent chooses not to make any bid. Its expected profit is:

$$\pi_I^{no,T} = \pi_{I,shelve}^{sep,T} = F(\overline{A}^T)\pi_I^m + (1 - F(\overline{A}^T))[p(\pi_I^M - \pi_S^d) + (1-p)\pi_I^m].$$

By bidding $P_H = p\pi_S^d - K$ the start-up will accept the offer irrespective of its assets. Since the incumbent decides to shelve, its expected profit, net of the bid, is:

$$\pi_{I,shelve}^{pool,T} = \pi_I^m - (p\pi_S^d - K),$$

with $\pi_{I,shelve}^{pool,T} > \pi_I^{no,T}$ if (and only if):

$$F(\overline{A}^T) < \frac{p(\pi_I^m - \pi_I^M) + K}{p(\pi_I^m + \pi_S^d - \pi_I^M)} \equiv \Phi^T(\cdot) \in (0,1),$$

where $\Phi^T(\cdot) > 0$ from $p(\pi_I^M - \pi_I^m) < K$ when the incumbent shelves and $\Phi^T(\cdot) < 1$ from Assumption A3.

Q.E.D.

A.4 Definitions of threshold levels of welfare harm

In this appendix, we first define the threshold of harm associated to the policies we describe in the main text, and then derive the formal results in Section 5.

To begin with, H^0 is the harm to welfare expected at $t = 1$ when the incumbent makes a pooling offer, it develops and takeovers at $t = 2$ are prohibited:

$$H^0 \equiv \max\{(1 - F(\overline{A}))[p(W^d - W^M)] - F(\overline{A})[p(W^M - W^m) - K], 0\}.$$

H^1 is the takeover's harm to welfare expected at $t = 1$ when the incumbent makes a pooling offer, it is expected to shelve and takeovers at $t = 2$ are prohibited:

$$H^1 \equiv (1 - F(\overline{A}))[p(W^d - W^m) - K].$$

From $p(W^M - W^m) > K$ (i.e. Assumption A4) it follows that

$$H^0 < H^1,$$

and

$$H^0 < W^d - W^M,$$

where the RHS is the harm to welfare caused by the approval of a takeover at $t = 2$.

Finally, H^2 is the takeover's harm on welfare expected at $t = 1$ when the incumbent makes a pooling bid, plans to shelve and takeovers at $t = 2$ are authorised:

$$H^2 \equiv (1 - F(\overline{A}^T))[p(W^M - W^m) - K]).$$

We can then define the threshold associated to each policy. The strict merger policy authorises only the takeovers that increase expected welfare; thus, $\overline{H} = 0$. The laissez-faire policy, by accepting any takeover, tolerates a level of harm that is strictly larger than (the maximum between) the welfare loss from market monopolisation in $t = 2$ ($W^d - W^M$) and loss produced by the combination of pooling-bid early acquisitions followed by shelving and late acquisitions, which is equal to H^2 – that is, $\overline{H} > \max\{W^d - W^M, H^2\}$ under a laissez-faire policy. An intermediate policy corresponds to the case in which $\overline{H} \in (W^d - W^M, H^2]$, as long as $H^2 > W^d - W^M$.

In what follows, we prove the results discussed in Section 5.

A.4.1 Merger policy that blocks mergers at t=2, but is more lenient at t=1

We start with the policy described in Section 5.1.

Consider first a level of harm $\overline{H} \in (0, H^0]$. If the incumbent shelves the equilibrium is the same as in Proposition 1 and no takeover takes place. The incumbent anticipates that a pooling bid would be blocked (since, as shown above, $H^0 < H^1$), whereas a separating bid would be approved (by indifference). However, it is more profitable for the incumbent not to engage in a takeover. In this case the merger policy that tolerates a level of $\overline{H} \in (0, H^0]$ leaves welfare unchanged relative to a strict merger policy.

If the incumbent develops, a level of harm $\overline{H} > 0$ makes the AA approve a pooling-bid takeover more often than if $\overline{H} = 0$. The condition for the AA to authorise is:

$$(1 - F(\overline{A}))[p(W^d - W^M)] - F(\overline{A})[p(W^M - W^m) - K] \leq \overline{H}$$

which is satisfied if (and only if)

$$F(\overline{A}) \geq \Gamma(\overline{H}) \equiv \frac{p(W^d - W^M) - \overline{H}}{p(W^d - W^m) - K}.$$

Note that $\Gamma(\overline{H})$ decreases in $\overline{H}$. At one extreme, if $\overline{H} = 0$, the threshold $\Gamma(0)$ is the one defined in Lemma 3; at the other extreme, if $\overline{H} = H^0$, the above condition is always satisfied and the AA always approves a pooling-bid takeover. When $F(\overline{A}) \in [\Gamma(\overline{H}), \Gamma(0))$, the AA approves a pooling-bid takeover that it would have blocked under a strict merger policy.

If a separating bid is more profitable for the incumbent than a pooling bid (i.e., if $F(\overline{A}) \geq \Phi(\cdot)$), the merger policy with $\overline{H} > 0$ does not affect the incumbent's equilibrium behaviour and leaves welfare unchanged relative to the strict merger policy. However, if $F(\overline{A}) \in [\Gamma(\overline{H}), \min\{\Phi(\cdot), \Gamma(0)\})$, the incumbent makes a pooling offer at the equilibrium whereas the strict merger policy would have forced it to make a separating bid. In this case a policy with $\overline{H} \in (0, H^0]$ decreases expected welfare relative to a strict merger policy:

$$\begin{aligned}\Delta EW &= (1-p)W^m + pW^M - K - [(1-p)W^m + p(F(\overline{A})W^M + (1-F(\overline{A}))W^d) - K] \\ &= p(1-F(\overline{A}))(W^M - W^d) < 0.\end{aligned}$$

Consider now $\overline{H} > H^0$. As long as $\overline{H} \in (H^0, H^1)$, no further effect is exerted on expected welfare because the incumbent's equilibrium behaviour does not change relative to the case in which $\overline{H} = H^0$: if the incumbent is expected to develop, any takeover is approved because, by continuity, $\Gamma(\overline{H}) < 0$) and the incumbent will engage in a pooling or separating offer depending on profitability. If the incumbent is expected to shelve, a takeover with a pooling bid is blocked whereas a takeover with a separating offer is approved, but the incumbent prefers not to formulate such an offer.

If $\overline{H} \geq H^1$, then the AA authorises a takeover with a pooling offer also when the incumbent is expected to shelve. We are focusing on the case in which mergers at $t = 2$ are blocked. Hence, it must also be that $\overline{H} < W^d - W^M$. The two conditions on $\overline{H}$ are compatible if (and only if) $H^1 < W^d - W^M$, i.e. if (and only if):

$$F(\overline{A}) > \frac{p(W^d - W^m) - K - (W^d - W^M)}{p(W^d - W^m) - K}.$$

The following lemma describes the outcome of the takeover game at $t = 1$ when $H^1 \leq \overline{H} < W^d - W^M$.

LEMMA A-1. *Under a policy that authorises any takeover at $t = 1$ and blocks takeovers at $t = 2$, there exist two thresholds levels of the probability that the start-up is credit-constrained, $\Phi(\cdot)$ and $\Phi'(\cdot)$ such that:*

- *If $p(\pi_I^M - \pi_I^m) < K$ and:*
  - $F(\overline{A}) \geq \Phi'(\cdot)$, *no takeover takes place (either at $t = 1$ or at $t = 2$).*
  - $F(\overline{A}) < \Phi'(\cdot)$, *the incumbent makes a pooling offer. Any start-up accepts the offer. The AA authorises the takeover. The incumbent shelves.*
- *If $p(\pi_I^M - \pi_I^m) \geq K$ and:*
  - $F(\overline{A}) \geq \Phi(\cdot)$, *the incumbent makes a separating bid. A credit-constrained start-up accepts the offer. The AA approves the takeover.*
  - $F(\overline{A}) < \Phi(\cdot)$, *the incumbent makes a pooling bid. Any start-up accepts the offer. The AA approves the takeover.*

The threshold $\Phi(\cdot)$ is defined in Proposition 1, and

$$\Phi^{'}(\cdot) \equiv \frac{p(\pi_I^m - \pi_I^d) - p(\pi_S^d) + K}{p(\pi_I^m - \pi_I^d)} \in [0, 1). \tag{A-3}$$

Proof. Proposition 1 shows that, if the incumbent plans to develop and the merger policy blocks mergers at $t = 2$, a separating bid is more profitable for the incumbent than a pooling bid if (and only if):

$$F(\overline{A}) \geq \frac{p(\pi_I^M - \pi_S^d - \pi_I^d)}{p(\pi_I^M - \pi_I^d) - K} \equiv \Phi(.) \in [0, 1).$$

It has also shown that making a separating bid is profitable for the incumbent.

If the incumbent plans to shelve, making a separating bid is equivalent to not making any bid: in both cases the project would not be developed. Under the assumption that the takeover involves a cost, though negligible, the incumbent chooses not to make any bid. Its expected profit is:

$$\pi_I^{no} = \pi_{I,shelve}^{sep} = F(\overline{A})\pi_I^m + (1 - F(\overline{A}))[p\pi_I^d + (1-p)\pi_I^m].$$

By bidding $P_H = p\pi_S^d - K$ the start-up will accept the offer irrespective of the amount of own assets. Since the incumbent decides to shelve, its expected profit, net of the bid, is:

$$\pi_{I,shelve}^{pool} = \pi_I^m - (p\pi_S^d - K).$$

$\pi_{I,shelve}^{pool} > \pi_I^{no}$ if (and only if):

$$F(\overline{A}) \leq \frac{p(\pi_I^m - \pi_I^d) - p(\pi_S^d) + K}{p(\pi_I^m - \pi_I^d)} \equiv \Phi^{'}(\cdot) \in [0, 1)$$

where $\Phi^{'}(\cdot) \geq 0$ follows from $K > p(\pi_I^M - \pi_I^m)$ and from Assumption A1 and $\Phi^{'}(\cdot) < 1$ from Assumption A3. Q.E.D.

Comparison with the strict merger policy By comparing the outcome of the takeover game at $t = 1$ under this policy and that under a strict merger policy (as described by Proposition 1), it is straightforward to see that a strict merger policy weakly dominates.

In particular, if it is expected to shelve and $F(\overline{A}) \in [0, \Phi^{'}(\cdot))$, under this more lenient policy the incumbent makes a pooling bid, whereas under the strict merger policy it would have made no offer. This policy decreases expected welfare because it authorises a killer acquisition that shelves projects that would reach the market with a positive probability if developed by the (unconstrained) start-up:

$$\Delta EW = W^m - W^m - (1 - F(\overline{A}))[p(W^d - W^m) - K] < 0.$$

If the incumbent is expected to develop and $F(\overline{A}) \in [0, \min\{\Phi(\cdot), \Gamma(0)\})$, as shown above under this policy the incumbent makes a pooling bid, whereas under a strict merger policy it would have made a separating bid. Expected welfare decreases relative to a strict merger policy:

$$\begin{aligned}\Delta EW &= (1-p)W^m + pW^M - K - [(1-p)W^m + p(F(\overline{A})W^M + (1-F(\overline{A}))W^d) - K] \\ &= p(1-F(\overline{A}))(W^M - W^d) < 0.\end{aligned}$$

A.4.2 Mergers authorised at $t = 2$ and blocked at $t = 1$ when the incumbent makes a pooling bid and plans to shelve

We now consider the policy described in Section 5.2.

As discussed in Section 5.2, this policy is associated to a level of harm $\overline{H} \in (W^d - W^M, H^2]$, i.e. when Condition 5 is not satisfied. We have already analysed in Section 4.2 financial contracting when takeovers are authorised at $t = 2$: external financiers are willing to fund the start-up when $A \geq \overline{A}^T$. Let us analyse now the decision of the AA at t=1(b).

Proof of Lemma 5

Proof. **Separating bid.** If the AA observes that the incumbent at $t = 1(a)$ made a low takeover bid, i.e. $P = P_L = 0$, and that the start-up accepted the bid, then it infers that the start-up is credit-rationed, i.e. that $A < \overline{A}^T$. Following the same reasoning as in the proof of Lemma 3, we conclude that the AA authorises the takeover both when the incumbent is expected to shelve (because total welfare remains the same) and when it is expected to invest (because the change in expected welfare is strictly positive).

Pooling bid. If the AA observes that the incumbent at $t = 1(a)$ made a high takeover bid, i.e. $P = P_H = p\pi_S^d - K$, then it cannot infer whether the start-up is constrained or not.

In this case, if the AA blocks the merger and the start-up is constrained – which occurs with probability $F(\overline{A}^T)$ – the investment will not be done and total welfare will be W^m; if it is not constrained – which occurs with probability $1 - F(\overline{A}^T)$ – the start-up will invest. If the investment is successful, which occurs with probability p, the start-up will be acquired by the incumbent at $t = 2$ (because $\overline{H} > W^d - W^M$ and the merger will be authorised), giving rise to total welfare W^M; if instead the investment fails, total welfare will be again W^m.

Therefore, total expected welfare is given by:

$$EW^{block} = F(\overline{A}^T)W^m + (1 - F(\overline{A}^T))[pW^M + (1-p)W^m - K].$$

If the AA authorises the merger and then the incumbent shelves (i.e. if Condition 1 is not satisfied), total welfare is W^m. In this case, the change in expected welfare if the merger is authorised is:

$$\Delta EW^{shelve} = -(1 - F(\overline{A}^T)[p(W^M - W^m) - K] < 0$$

by Assumption A4. Since the harm caused by the merger, $(1 - F(\overline{A}^T)[p(W^M - W^m) - K] \equiv H^2$, is larger than $\overline{H}$, the merger is blocked.

If the AA authorises the merger and the incumbent invests (i.e. if Condition 1 is satisfied), expected welfare is:

$$EW_{dev}^{auth} = pW^M + (1 - p)W^m - K.$$

Authorising the takeover, causes a change in expected welfare equal to:

$$\Delta EW_{dev}^{pooling} = F(\overline{A}^T)[p(W^M - W^m) - K] > 0$$

from Assumption A4. Q.E.D.

A.5 Cournot competition with differentiated products

A.5.1 Assumptions and production market payoffs

One can check that, under Cournot competition, the product market payoffs are:

$$\begin{aligned}
\pi_I^m &= \frac{1}{4},\ \pi_I^M = \frac{1}{2(1+\gamma)},\ \pi_S^d = \frac{1}{(2+\gamma)^2} = \pi_I^d, \\
CS^m &= \frac{1}{8},\ CS^M = \frac{1}{4(1+\gamma)},\ CS^d = \frac{1+\gamma}{(2+\gamma)^2}, \\
W^m &= \frac{3}{8},\ W^M = \frac{3}{4(1+\gamma)},\ W^d = \frac{3+\gamma}{(2+\gamma)^2}.
\end{aligned}$$

One can also check that, as assumed in the base model, $\pi_I^d < \pi_I^m < \pi_I^M$ and $W^m < W^M < W^d$ for any $\gamma \in (0, 1)$. Assumptions A1 and A2 boil down, respectively, to:

$$\begin{aligned}
A1: &\quad \frac{\gamma^2}{2(2+\gamma)^2(1+\gamma)} > 0 \\
A2: &\quad \frac{\gamma(\gamma^2+3\gamma+4)}{4(2+\gamma)^2(1+\gamma)} > 0
\end{aligned}$$

and are always satisfied for any $\gamma \in (0, 1)$.

Instead Assumptions A3 and A4 require substitutability among the products of the incumbent and the start-up not to bee too high:

$$\begin{aligned}
A3: &\quad \gamma < \sqrt{\frac{p}{K}} - 2 \equiv \gamma_{A3} \\
A4: &\quad \gamma < \frac{3p - 8K}{8K + 3p} \equiv \gamma_{A4}.
\end{aligned}$$

The former condition ensures that duopoly profits are large enough to make the NPV of the project positive; the latter that the incumbent's development of the new product is beneficial for society. A necessary condition for the above inequalities to be satisfied is that both cut-off levels of the degree of substitutability are positive, which requires:

$$K < \frac{p}{4}.$$

Assumptions A3 and A4 are simultaneously satisfied if (and only if):

$$\gamma < \min\{\gamma_{A3}, \gamma_{A4}\} \equiv \overline{\gamma}.$$

Finally, Assumption A5 translates into:

$$A5: \quad B_{A5} \equiv \frac{p}{(2+\gamma)^2} - K < B < K.$$

A.5.2 Building blocks

The investment decision The incumbent finds it profitable to invest if (and only if):

$$\gamma \leq \frac{p-4K}{p+4K} \equiv \gamma_{Inv}.$$

Substitutability needs to be low enough to ensure that the expected increase in monopoly profits caused by the new product dominates the investment cost. From Assumption A2 it follows that $\gamma_{Inv} < \gamma_{A3}$ and from $CS^M > CS^m$ it follows that $\gamma_{Inv} < \gamma_{A4}$. Hence, $\gamma_{Inv} < \overline{\gamma}$.

Financial contracting under a strict merger policy Under a strict merger policy, the start-up is credit-constrained if (and only if):

$$A \leq \overline{A} \equiv B + K - \frac{p}{(2+\gamma)^2} > 0.$$

Financial contracting under a laissez-faire policy Under a laissez-faire policy, the start-up is never credit constraint. We prove below that the cutoff level of the start-up's own resources $\overline{A}^T$ is negative. Therefore, $F(\overline{A}^T) = 0$.

Proof. $\overline{A}^T = B + K - p\pi_I^M$. Note that $\overline{A}^T < 2K - p\pi_I^M < 2p\pi_S^d - p\pi_I^M$. The first inequality follows from $B < K$ (Assumption A5), the second from $K < p\pi_S^d$ (Assumption A3). Since product market payoffs in this application are such that $2\pi_S^d < \pi_I^M$ for any $\gamma \in (0,1)$, $\overline{A}^T < 0$. Q.E.D.

A.5.3 The optimal policy

Proof of Proposition 5

Proof. First, it is necessary that the intermediate policy is feasible, i.e. that Condition 5 does not hold:

$$F(\overline{A}^T) = 0 < \frac{p(W^M - W^m) - K - (W^d - W^M)}{p(W^M - W^m) - K}.$$

Therefore, it must be that:

$$p(W^M - W^m) - K - (W^d - W^M) > 0. \tag{A-4}$$

The inequality in (A-4) is satisfied when $\gamma = 0$ (because $W^d = W^M$ when products are independent), whereas it is not satisfied when $\gamma \to \gamma_{A4}$ (because $W^M - W^m \to K$). Moreover, as substitutability increases $W^M - W^m$ (strictly) decreases and $W^d - W^M$ (strictly) increases. Hence, the LHS in (A-4) is strictly decreasing in γ and there exists a threshold level of the degree of substitutability, $\gamma_{C6} \in (0, \gamma_{A4})$, such that Condition 5 is satisfied if (and only if) $\gamma < \gamma_{C6}$. Since $\gamma_{C6} < \gamma_{A4}$ but it is not necessarily lower than γ_{A3}, $\hat{\gamma} \equiv \min\{\gamma_{C6}, \gamma_{A3}\} < \gamma_{A4}$.

Second, as discussed in section 6.2, a trade-off between a strict merger policy and the intermediate policy arises if (and only if) $\gamma > \gamma_{Inv}$, i.e. when the incumbent plans to shelve.

For the above conditions to be both satisfied it must be that $\gamma_{Inv} < \gamma_{C6}$, i.e. Condition 5 must be satisfied when $\gamma = \gamma_{Inv}$. By substituting the expressions of W^M, W^m and W^d in the LHS of (A-4), and then by evaluating the function at $\gamma = \gamma_{Inv}$, one obtains that there exists scope for satisfying both the above conditions if (and only if):

$$\frac{-5p^3 + 64K^3(3+p) + 12Kp^2(3p-1) + 16K^2p(5+6p)}{8p(4K+3p)^2} > 0. \tag{A-5}$$

The inequality in A-5 is not satisfied when $K = 0$ and it is satisfied when $K = \frac{p}{4}$. Moreover, the LHS in A-5 is strictly increasing in K. Hence, there exists a threshold level of the investment cost, $\hat{K} \in (0, \frac{p}{4})$, such that $\gamma_{Inv} < \gamma_{C6}$ if (and only if) $K > \hat{K}$.

Finally, it must be that Condition 6 is not satisfied. Since $F(\overline{A}^T) = 0$, it must be that:

$$F(\overline{A}) > 1 - \frac{p(W^M - W^m) - K}{p(W^d - W^m) - K}. \tag{A-6}$$

Note that le RHS in (A-6) is increasing in γ (as substitutability increases, $W^M - W^m$ decreases while $W^d - W^m$ increases) and tends to 1 as $\gamma \to \gamma_{A4}$. Since $\hat{\gamma} < \gamma_{A4}$, when the policy is feasible the r.h.s. in (A-6) is strictly lower than 1. Hence, one can always find a distribution function of the start-up own resources that assign sufficient probability to low values of A to satisfy Condition A-6. Q.E.D.

A.5.4 A numerical example

If we set $K = \frac{1}{9}$ and $p = \frac{3}{4}$, $\gamma_{A3} = \frac{3\sqrt{3}}{2} - 2 = 0.598$, $\gamma_{A4} = \frac{49}{113} = 0.4336 = \overline{\gamma}$. Hence the feasible values of B and γ are such that $0 \leq \gamma < \frac{49}{113}$ and $\frac{p}{(2+\gamma)^2} - K < B < K$. Moreover, $\gamma_{Inv} = \frac{11}{43} = 0.2558$ and $\hat{\gamma} = \gamma_{C6} = 0.2847$.

Finally, assuming that A is distributed uniformly over $(0, K)$, Condition 6 fails to be satisfied if (and only if):

$$B > p\pi_S^d - K\frac{p(W^M - W^m) - K}{p(W^d - W^m) - K} = \frac{p}{(2+\gamma)^2} - K\frac{p(\frac{3}{4(1+\gamma)} - \frac{3}{8}) - K}{p(\frac{3+\gamma}{(2+\gamma)^2} - \frac{3}{8}) - K}$$

$$= \frac{3}{4(2+\gamma)^2} - \frac{\frac{9}{16(1+\gamma)} - \frac{113}{288}}{\frac{27(3+\gamma)}{4(\gamma+2)^2} - \frac{113}{32}} \equiv B_{C7}.$$

Note that $\frac{p(W^M - W^m) - K}{p(W^d - W^m) - K} < 1$ implies that Assumption A5 is satisfied when $B > B_{C7}$.

A.6 Equity contract

Assume that the start-up invests and the project is successful. If the incumbent makes a takeover offer, it knows that the AA will approve the takeover. Moreover, the equity contract implies that a fraction $(1-x)$ of the product-market profits π_S^d goes to the investors and a fraction x goes to the start-up. Thus, I must formulate a takeover offer at least as large as $(1-x)\pi_S^d + x\pi_S^d = \pi_S^d$. Therefore, the crucial difference between debt and equity is that, with equity, after the start-up equity-holders accept, there is no residual financial obligation that the incumbent has to satisfy. Since outside investors obtain $(1-x)\pi_S^d$ when they sell their shares to the incumbent at $t = 2$, they do not expect the pledgeable income to increase when a takeover occurs ex-post, and financial constraints are not relaxed by policies that authorise those mergers.[27]

More formally, consider now the financial contracting game in $t = 1$. The use of equity implies that S obtains a share $x_S^s \in [0,1]$ in case of success and $x_S^f \in [0,1]$ in case of failure of the project. In case of funding, the start-up will exert effort if (and only if) the following condition is satisfied:

$$px_S^s(\pi_S^d) + (1-p)x_S^f(0) \geq B + x_S^f(0),$$

or

$$px_S^s\pi_S^d \geq B. \tag{A-7}$$

Investors are willing to lend $K - A$ if they expect to break even:

$$p\pi_S^d(1 - x_S^s) \geq K - A. \tag{A-8}$$

Substituting $x_S^s = B/p\pi_S^d$ (from a binding Condition (A-7)) in the investors' participation constraint (A-8), and rearranging, one obtains that (A-8) holds if (and only if):

$$A \geq B - (p\pi_S^d - K),$$

[27] If, however, the incumbent did not have the whole bargaining power in the negotiation for the takeover, the start-up and the investors would obtain more than π_S^d from the late takeover, and the laissez-faire policy would relax financial constraints also under equity contracts, even though to a (weakly) lower extent as compared to debt contracts.

which is the same threshold $\overline{A}$ as with the strict merger policy, with $\overline{A} > \overline{A}^T$. Moreover, conditional on getting funded ($A \geq \overline{A}$), the start-up's payoff will be given by the project's NPV (namely, $p\pi_S^d - K$). Finally, the start-up's payoff will be zero if $A < \overline{A}$.

Compared with the results of the financial contracting game with debt, the entrepreneur's payoffs are the same, but the threshold value for A is lower with debt (see Lemma 4). It follows that, under the laissez-faire or the intermediate policy, the start-up will prefer debt to equity.

A.7 Perfect Information

In this Appendix we assume that the incumbent and the AA can observe the realisation of the start-up's own resources, the former when it formulates a takeover bid at $t = 1(a)$, the latter when it reviews a merger proposal.[28] Instead, when it establishes the standard for merger policy at $t = 0$, the AA only knows the distribution of A (the merger policy is formulated for all possible acquisitions, involving start-ups which might have very different amount of own resources).

In the next Section we analyse the equilibrium of the game under a strict merger policy (i.e. $\overline{H} = 0$) and we compare it with the one arising under a laissez-faire policy (Section A.7.2). Section A.7.3 considers less extreme policies and Section A.7.4 identifies the optimal policy.

Note that the assumption on information does not affect the evolution of the game from stage $1(c)$ onwards. Instead, it affects the decision of the AA at stage $1(b)$ and that of the incumbent at $t = 1(a)$.

A.7.1 Strict merger policy

LEMMA A-2. *(The decision of the AA)*
When information is perfect, under a strict merger policy:

- *The AA authorises the takeover if (and only if) $A < \overline{A}$.*
- *The AA blocks the takeover otherwise.*

Proof. When the AA observes that $A < \overline{A}$, similarly to the case of a separating bid analysed in Appendix A.1, welfare will be W^m if the takeover is blocked, because the start-up would not develop the project. If Condition 1 is not satisfied, welfare will also be W^m when the AA authorises the takeover, because the incumbent is expected to shelve. If, instead, the incumbent is expected to develop (i.e. Condition 1 is satisfied), expected welfare when the takeover is authorised will be given by:

$$EW_{dev.}^{auth.} = pW^M + (1-p)W^m - K \tag{A-9}$$

[28] It would be difficult to assume that the AA cannot observe A while I can: the AA has certainly more power to inspect the financial position of a start-up than a rival, even if a prospective acquirer.

The change in expected welfare, if the takeover is authorised, is therefore positive because the takeover avoids the inefficiency caused by financial constraints:

$$\Delta EW_{dev} = p(W^M - W^m) - K > 0. \tag{A-10}$$

Instead, if $A \geq \overline{A}$ the start-up has enough own funds to develop the project. Hence, when the takeover is blocked, expected welfare is:

$$EW^{block} = pW^d + (1-p)W^m - K \tag{A-11}$$

When the takeover is authorised and I is expected to shelve, welfare will be W^m; the takeover is a killer acquisition and the change in expected welfare, if it is authorised, is negative :

$$\Delta EW_{shelve} = -p(W^d - W^m) - K < 0. \tag{A-12}$$

When I is expected to develop, expected welfare will be $pW^M + (1-p)W^m - K$. The change in expected welfare, if the takeover is authorised, is therefore negative because of the lessening of ex-post competition:

$$\Delta EW_{dev.} = -p(W^d - W^M) < 0. \tag{A-13}$$

Q.E.D.

At $t = 1(a)$, the incumbent anticipates that, when $A \geq \overline{A}$, takeovers will not be authorised. When $A < \overline{A}$ and I plans to shelve, the takeover will be authorised, but it is more profitable for I not to engage in it. When $A < \overline{A}$ and I plans to develop, the takeover will be authorised and it is profitable for I. The next Proposition summarises the equilibrium of the game:

PROPOSITION A-1. *(Equilibrium of the game).*
When information is perfect, under a strict merger policy:

- *A takeover takes place at* $t = 1$ *if (and only if)* $A < \overline{A}$ *and* $p(\pi_I^M - \pi_I^m) \geq K$. *In this case expected welfare is:*
$$pW^M + (1-p)W^m - K$$
- *No takeover takes place (either at* $t = 1$ *or at* $t = 2$*) otherwise. In this case, if* $A < \overline{A}$ *and* $p(\pi_I^M - \pi_I^m) < K$*, expected welfare is* W^m*; if* $A \geq \overline{A}$*, expected welfare is:*
$$pW^d + (1-p)W^m - K.$$

A.7.2 Laissez-faire merger policy

Let us consider a policy that authorises any takeover. This case corresponds to $\overline{H} > \max\{W^d - W^M, p(W^M - W^m) - K\}$.

PROPOSITION A-2. *(Equilibrium of the game).*
When information is perfect, under a laissez-faire policy:

- *No takeover takes place (either at $t = 1$ or at $t = 2$) if (and only if) $A < \overline{A}^T$ and $p(\pi_I^M - \pi_I^m) < K$. In this case expected welfare is W^m.*
- *A takeover takes place at $t = 1$ otherwise. In this case, if $p(\pi_I^M - \pi_I^m) \geq K$, expected welfare is:*

$$pW^M + (1 - p)W^m - K.$$

If $A \geq \overline{A}^T$ and $p(\pi_I^M - \pi_I^m) < K$ expected welfare is W^m.

Proof. When $A < \overline{A}^T$ and $p(\pi_I^M - \pi_I^m) < K$ the incumbent finds it more profitable to let the project die because of financial constraints. When $A < \overline{A}^T$ and $p(\pi_I^M - \pi_I^m) \geq K$, I's payoff is π_I^m if it does not engage in the takeover; it is $p\pi_I^M + (1 - p)\pi_I^m - K$ if it engages in the takeover (since the start-up is constrained, the takeover price is 0). From I finding it profitable to develop it follows that the latter is larger. When $A \geq \overline{A}^T$ and $p(\pi_I^M - \pi_I^m) < K$, I's payoff is $p(\pi_I^M - \pi_S^d) + (1 - p)\pi_I^m$ if it does not engage in the takeover (recall that, if the start-up develops successfully, then the incumbent will take it over at $t = 2$ paying a takeover price equal to π_S^d); if it engages in the takeover, I's payoff is $\pi_I^m - (p\pi_S^d - K)$ (since the start-up is unconstrained, the takeover price is $p\pi_S^d - K$). From I finding it profitable to shelve it follows that the latter is larger. When $A \geq \overline{A}^T$ and $p(\pi_I^M - \pi_I^m) \geq K$, I's payoff is $p(\pi_I^M - \pi_S^d) + (1 - p)\pi_I^m$ if it does not engage in the takeover. If it engages in the takeover, I's payoff is $p\pi_I^M + (1-p)\pi_I^m - K - (p\pi_S^d - K) = p(\pi_I^M - \pi_S^d) + (1-p)\pi_I^m$. In this case the incumbent is indifferent between making the takeover either ex-ante or ex-post. (We are assuming that when indifferent, the incumbent engages in the takeover at $t = 1(a)$.) Q.E.D.

A.7.3 Less extreme policies

As long as takeovers are blocked at $t = 2$, a policy that is less strict at $t = 1$ would only harm welfare. Hence, a policy that established $\overline{H} = 0$ dominates any policy with $\overline{H} \in (0, W^d - W^M)]$.

Let us consider now a policy that authorises ex-post mergers: $\overline{H} > W^d - W^M$. At $t = 1(b)$, when the incumbent is expected to develop, a takeover is either welfare beneficial (namely, when the start-up is constrained, i.e. $A < \overline{A}^T$), or welfare neutral (when the start-up is unconstrained and the takeover, if blocked ex-ante, would occur ex-post). Instead, when the incumbent is expected to shelve, the takeover is welfare neutral when the start-up is constrained, but it is welfare detrimental when the start-up is unconstrained, because it is a killer acquisition. In the latter case, the expected harm to welfare caused by the takeover is:

$$p(W^M - W^m) - K$$

If $p(W^M - W^m) - K < W^d - W^M$, there is no scope for a policy that authorises takeovers at

$t = 2$ and is stricter at $t = 1$. If, instead, $p(W^M - W^m) - K \geq W^d - W^M$, such a policy is feasible. The decision of the AA in such a case is described by the following Lemma:

LEMMA A-3. *(The decision of the AA under the intermediate policy)*
When information is perfect and $\overline{H} \in (W^d - W^M, p(W^M - W^m) - K]$,

- *the AA blocks the takeover if (and only if) $A \geq \overline{A}^T$ and the incumbent is expected to shelve;*
- *the AA authorises the takeover otherwise.*

Proof. It follows form the above discussion. Q.E.D.

When shelving is more profitable than developing, the incumbent prefers not to engage in the takeover when the start-up is constrained, while it anticipates that the takeover will be blocked when the start-up is unconstrained. Instead, the incumbent engages in the takeover when it plans to develop, as it anticipates that the takeover will always be authorised and that it is profitable (as shown by Proposition A-2).

PROPOSITION A-3. *(The equilibrium of the game.)*
When information is perfect, under the intermediate merger policy,

- *If $p(\pi_I^M - \pi_I^m) < K$, no takeover takes place at $t = 1$. If $A < \overline{A}^T$, no takeover takes place at $t = 2$ either. Expected welfare is W^m. If $A \geq \overline{A}^T$ a takeover takes place at $t = 2$, if the start-up develops successfully. Expected welfare is:*

$$pW^M + (1-p)W^m - K$$

- *If $p(\pi_I^M - \pi_I^m) \geq K$, the takeover takes place at $t = 1$. Expected welfare is:*

$$pW^M + (1-p)W^m - K$$

When it is feasible, an intermediate policy dominates a laissez-faire policy because it prohibits killer acquisitions.

A.7.4 Optimal policy

The comparison between Proposition A-1, Proposition A-2 and Proposition A-3 allows us to identify the optimal policy.

PROPOSITION A-4. *(The optimal policy.)*
When information is perfect,

- *An intermediate policy (that blocks takeovers at $t = 1$ when $A \geq \overline{A}^T$ and the incumbent is expected to shelve, and authorises all other takeovers) is optimal when it holds simultaneously that: (i) the incumbent is expected to shelve; (ii) $p(W^M - W^m) - K \geq W^d - W^M$; (iii) Condition 6 is not satisfied.*

- *Otherwise, a strict merger policy is optimal.*

Proof. Let us start showing that when, information is perfect, a laissez-faire policy is (weakly) dominated by a strict merger policy.

When $A < \overline{A}^T$, the two merger policies are equivalent. The start-up is constrained under either policy. Then, if the incumbent is expected to shelve, no takeover takes place in either case; if the incumbent is expected to develop, the takeover occurs in either case and is welfare beneficial by avoiding financial constraints.

When $A \in [\overline{A}^T, \overline{A})$, the two merger policies are again equivalent. The start-up is constrained under a strict policy, while it is unconstrained under a laissez-faire policy. Then, if the incumbent is expected to shelve, no takeover takes place under a strict policy, whereas under a laissez-faire policy the incumbent finds it profitable to engage in the takeover and kill the project. Welfare is the same in either case. If the incumbent is expected to develop, the takeover is authorised under a strict policy, because the start-up is constrained; the start-up is unconstrained under a laissez-faire policy, and the incumbent is indifferent between taking it over ex-ante or ex-post. Expected welfare is the same in either case.

When $A > \overline{A}$, the strict merger policy dominates the laissez-faire policy. The start-up is unconstrained in either case. Under a strict merger policy no takeover takes place either at $t = 1$ and $t = 2$, while the takeover occurs at $t = 1$ under a laissez-faire policy. The strict merger policy increases expected welfare by avoiding a killer acquisition (when the incumbent is expected to shelve) and by avoiding the lessening of product market competition (when the incumbent is expected to develop).

Therefore, a laissez-faire policy cannot be optimal and, when the intermediate policy is not feasible (i.e. when $p(W^M - W^m) - K < W^d - W^M$), a strict merger policy is optimal.

Let us compare now the strict policy and the intermediate policy, when the latter is feasible. When the incumbent is expected to develop, the intermediate policy leads to the same outcome as the laissez-faire policy. As shown above, the strict merger policy (weakly) dominates. However, a trade-off arises when the incumbent is expected to shelve because the intermediate policy at $t = 1$ blocks the killer acquisitions that would occur when $A \geq \overline{A}^T$, while authorising ex-post takeovers. The authorisation of ex-post takeovers, by relaxing financial constraints, produces a pro-competitive effect: when $A \in [\overline{A}^T, \overline{A})$, the start-up is constrained under a strict merger policy and the project is not developed, whereas the start-up is unconstrained under the intermediate policy and the project is developed (with probability p). When, instead, $A \geq \overline{A}$, the start-up is unconstrained also under a strict merger policy and, by authorising ex-post takeovers, the intermediate policy reduces total welfare by leading to an increase of ex-post market power.

Evaluated at $t = 0$, when the AA does not observe the realisation of A, the intermediate policy dominates the strict one if (and only if):

$$[F(\overline{A}) - F(\overline{A}^T)][p(W^M - W^m) - K] \geq [1 - F(\overline{A})]p(W^d - W^M)$$

By adding $[1 - F(\overline{A})][p(W^M - W^m) - K]$ on both sides, one can write he above inequality as:

$$[1 - F(\overline{A})^T][p(W^M - W^m) - K] \geq [1 - F(\overline{A})][p(W^d - W^m) - K],$$

which is satisfied if (and only if) condition 6 does not hold:

$$\frac{p(W^d - W^m) - K}{p(W^M - W^m) - K} \geq \frac{1 - F(\overline{A}^T)}{1 - F(\overline{A})}$$

Q.E.D.