# Shelving or developing?
# Optimal policy for mergers with potential competitors

**Abstract**

A start-up and an incumbent negotiate over an acquisition price. The acquisition may result in shelving the start-up's project or developing a project that would otherwise never reach the market. The optimal merger policy commits to standards of review that prohibit high-price takeovers, even if they may be welfare-beneficial ex-post. Ex ante this pushes the incumbent to acquire start-ups that cannot develop independently, increasing expected welfare. We also propose empirical tests to identify high-price takeovers that are more likely to exert anti-competitive effects.

**Keywords:** High-price acquisitions, selection effect, nascent competitors.
**JEL Classification:** L41, L13, K21

# 1 Introduction

Since the mid-90s, there has been a dramatic shift in the exit strategy of start-ups backed by venture capital, from IPOs to acquisitions (Pellegrino, 2021). In the digital economy alone, hundreds of start-ups have been bought in the last few years by incumbents such as Alphabet (Google), Amazon, Apple, Meta (Facebook) and Microsoft (The Economist, 2018; The Wall Street Journal, 2019; The New York Times, 2020). Some of these acquisitions target potential competitors, i.e. firms that currently do not exert competitive pressure but might do so in the future.

In the vast majority of cases, such acquisitions do not trigger mandatory pre-merger notification because the latter is typically based on the turnover of the merging parties. This leads to stealth consolidation (Wollmann, 2019; see also Eliason et al., 2020): acquisitions whose individual size enables them to escape regulatory scrutiny. In the few cases where Antitrust Agencies (AAs) did open an investigation, they authorised them (the recent Facebook/Giphy prohibition by the UK's CMA is the only exception we are aware of). 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; Lemley and McCreary 2020; Motta and Peitz 2021).

The traditional approach to the analysis of horizontal mergers trades off the costs of market power and the benefits of cost efficiencies (see, e.g., 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 shelve the start-up's project. This would be a "killer acquisition" as documented by Cunningham et al. (2021) 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 the availability of resources – managerial skills such as implementation skills, market opportunities, and capital – that the target firm lacks. Given this trade-off, we ask: what merger policy should an antitrust authority follow? To answer this question, we propose a model that embeds the trade-off above. Our novel insight is that the price of the deal conveys key information regarding the anti-competitive impact of acquisitions involving potential competitors.

In our model, a start-up owns a project with a positive net present value that, if developed, will allow it to compete with an incumbent firm. The start-up may be *viable* – that is, it has the necessary (managerial, financial, etc.) resources to develop the project independently – or *unviable* – that is, it cannot develop the project on its own. In the latter case, the only chance for society that the (beneficial) project sees the light is that the incumbent takes over the start-up and develops the project itself. The incumbent is assumed to have the resources to develop the project. However, cannibalisation of existing profits may weaken its investment incentives and the incumbent may shelve a project that a viable target firm would carry out.

In our baseline setting, the incumbent can acquire the start-up before project development. If the acquisition proposal is made, the AA will decide whether to approve or block it, consistently with the standards of review to which it commits at the beginning of the game. For simplicity, the AA can either approve or prohibit the merger. In a richer model, as in actual competition cases, the *prohibition* would be replaced by a *presumption* that the merger is anticompetitive. The merged entity could rebut this presumption by showing that the merger produces other efficiencies on top of allowing the development of the project of an unviable start-up. The consideration of such efficiency gains is however standard in merger control and is not modeled here. In what follows, therefore, the wording "prohibition" should be interpreted as "prohibition in the absence of other merger-specific efficiencies".

We assume that the firms and the AA are not equally informed about the start-up's ability to succeed in the absence of the acquisition. In the baseline, the start-up knows its type, whereas the incumbent and the AA only know the probability that the start-up is viable.[1] (We obtain similar results when we assume it is the incumbent that has superior information – see below.)

First, we show that the AA can make inferences on the type of start-up involved in the acquisition based on the value of the takeover price. Throughout the analysis, a price is high if it is higher than the outside option of the viable start-up. It is low otherwise. If the AA observes a low price, it learns that the start-up is unviable and knows that the takeover is (weakly) welfare-beneficial. If the incumbent develops, a new product will reach the market; if it shelves, the takeover has no impact on competition because the start-up would have not developed the product anyway. If it is high, the price does not reveal the start-up's type to the AA. If the target is an unviable start-up, the acquisition is again welfare beneficial. If it is a viable start-up,

[1] This approach is consistent with the empirical literature documenting the presence of informational frictions between acquirers and targets, especially when the latter is a knowledge-based R&D intensive firm, and thus difficult to value (Officer et al., 2009). An anecdote suggesting that incumbents may have difficulties in assessing the start-ups' ability to succeed is the negotiation between Excite and Google regarding a possible takeover in 1999 (CNBC, 2015). It was Google to approach Excite, which at the time was a big player in the search engine market, while Google was a new, small, player. After factoring in the uncertainty surrounding Google's ability to grow on its own, Excite decided to pass on the offer. In the words of George Bell, Excite's CEO (emphasis added): "I think the decision we made at the time, *with what we knew*, was a good decision. It's laughable to say that now."

the acquisition should be prohibited (recall we use this term as a shortcut for "prohibited unless the merging parties prove sufficiently high efficiency gains"): it suppresses competition when the incumbent develops; it also suppresses innovation if the incumbent shelves.

Second, the optimal merger policy commits to standards of review that will have the effect of preventing high-price takeovers. These standards should also permit low-price acquisitions. High-price acquisitions pose a trade-off because they are welfare-beneficial if the probability that the start-up is unviable is sufficiently large. We prove, however, that the merger policy should be designed in a way that such acquisitions are prohibited. The reason is that, if this is the case, the incumbent has no other option than offering a low price (when it develops) or making no takeover offer (when it shelves). In either case, expected welfare is larger than in the case in which a high-price takeover occurs.

Therefore, the merger policy exerts a "selection effect" on the takeovers offered in equilibrium. It pushes towards acquisitions that target only unviable start-ups and are thus preferable in terms of welfare. For this reason, despite the possible welfare-enhancing effect of high-price takeovers when the incumbent develops the project of an unviable start-up, the optimal merger policy commits to standards of review that prohibit high-price takeovers that may be welfare-beneficial.

When we focus on the pure-strategy equilibria of the bargaining game, there cannot exist an equilibrium in which the two possible start-ups (viable and unviable) are acquired at different positive prices. The reason is that the unviable start-up would always have the incentive to mimic the viable one. This may lead to inefficiency, since there may not be a takeover of the viable start-up even when such a takeover would increase industry profits. In the first generalisation of the baseline model, where we assume that the start-up has full bargaining power, we show that mixed-strategy equilibria alleviate this inefficiency. We prove that the optimal merger policy obtained relying on the pure-strategy equilibria of the bargaining game is still optimal when one allows for mixed strategies.

In the second generalisation of the baseline setting, we allow the incumbent to have a second chance to acquire the start-up, *after* development, and accordingly for the AA to have two different standards of review: not only one for *early* takeovers – that is, acquisitions of potential competitors – as in the baseline model, but also a possibly different one for *late* takeovers – that is, acquisitions of committed entrants.[2] Allowing for acquisitions of committed entrants does not

[2]The US Horizontal Merger Guidelines distinguish between potential entrants and committed entrants. Potential entrants are those that are "likely [to] provide [...] supply response" in the event the conditions allow them to compete on the market. Committed entrants are firms that are "not currently earning revenues in the relevant market, but that have committed to entering the market in the near future."

change the optimal policy regarding early takeovers: the standards of review should prevent high-price takeovers regardless of whether late takeovers are permitted. We also show that under specific cumulative conditions, which must all hold, the optimal policy establishes a possibly more lenient treatment toward late takeovers. A key condition is that the anticipation of a late takeover must increase the viability of the start-up (e.g., by relaxing the start-up's financial constraints).[3]

Our results question the current laissez-faire approach toward acquisitions of potential competitors. We show that the decisions that the AA optimally makes based on its standards of review are equivalent to those that it would reach using the information contained in the price of the acquisition. This provides theoretical support for the introduction of transaction value thresholds as additional notification criteria for horizontal mergers.[4] They also support the use of transaction value, on top of market shares, as a screening tool to identify transactions that are likely to be anti-competitive and thus deserve a closer look. In the conclusions, we further discuss the policy implications of our theoretical analysis.

To test the robustness of our conclusions, we reverse the information asymmetry and assume that the incumbent knows whether the start-up can develop the project, whereas the start-up and the AA do not. The optimal standards of review (based on the pure-strategy equilibria of the bargaining game) also in this case will have the effect of preventing high-price takeovers. In this setting, with pure strategies, a high takeover price signals that the start-up is viable and the takeover detrimental. When deriving the mixed-strategy equilibria, there might exist specific circumstances in which the optimal policy is such that high price takeover may take place at the equilibrium. One of the necessary conditions for this to occur is that a hybrid equilibrium is selected in which unviable start-ups may also be acquired and for this reason, generate a welfare gain.

We then discuss how our results change in alternative specifications of the model. First, we consider the case where several incumbents compete to acquire the start-up. When an acquirer shelves, there is no bidding competition (the acquisition is a public good since it eliminates a viable competitor). When an acquirer develops, the existence of several bidders may push up the price of (welfare-beneficial) acquisitions of unviable start-ups, and hence a high price might

[3]The other two necessary conditions are (i) that the incumbent shelves the project after an early takeover, and (ii) that the sacrifice of allocative efficiency caused by the takeover must be dominated by the welfare gain due to the higher probability of development.

[4]Austrian and German laws have been modified to include a transaction-value threshold for notification. Such a threshold already exists in the US, and the UK is also considering introducing it to screen acquisitions by firms in the digital sector to capture "competitively significant mergers (as signalled by having a high transaction value)" (CMA, 2021:51). Consistent with the results of our empirical tests (see below), the Italian AA has introduced the possibility of using the ratio between the price of the acquisition and the firm revenue as a way to identify acquisitions worth investigating.

not signal an anti-competitive merger any longer. In this case, the optimal policy explicitly prohibits takeovers in which the transaction price is high because it prevents viable start-ups from being acquired while allowing the acquisition of unviable start-ups (which are willing to sell out at low prices).

Second, we consider the impact of a policy that prohibits high-price takeovers on innovation incentives. If the incumbent shelves the project after acquiring the start-up, then any boost on innovation efforts given by higher takeover prices is not valuable for society. If the incumbent develops, a trade-off arises. On the one hand, prohibiting high-price takeovers limits the welfare losses from reduced competition. On the other hand, it reduces the probability of having an extra product in the incumbent's portfolio.

Finally, informed by our theoretical analysis, we propose empirical tests to screen those high-price takeovers that are more likely to be anti-competitive based on the analysis of the value of the ratio between the price of the acquisition and proxies of target firms' size. These tests hinge on the method of comparables (Berk and DeMarzo, 2014:288ff), whose key presumption is that to identify the acquisitions that carry a high price or a large market power effect, one can use the information on a set of takeovers that are comparable to the takeover under consideration. We apply these tests to the sample of acquisitions made by Google, Apple, Facebook, Amazon, and Microsoft (GAFAM) during the last decades. We find that the majority of GAFAM acquisitions for which we have information to perform the test are flagged as high-price acquisitions that are likely to be anti-competitive.[5]

**Literature review** An important contribution of our paper is to formally show that the takeover price conveys important information and should inform merger policy. We are not aware of other papers that make a similar point.

Our paper contributes to the literature which analyses theoretically the acquisition of start-ups and how this affects project development and innovation.[6] In particular, Cunningham et al. (2021) determine the conditions under which, after acquiring the potential entrant, the incumbent has incentives to shelve its project. Differently from them, our model features asymmetric information regarding the start-up's type. Moreover, we model the AA as a strategic player and

[5]See also Kühn (2021) for a similar analysis.

[6]See, among others: Rasmussen (1988); Norbäck and Persson (2009) and (2012); Bryan and Hovenkamp (2020); Letina et al. (2020); Katz (2021); Arora et al. (2021); Cabral (2021); Bisceglia et al. (2021); Denicolò and Polo (2021); Gilbert and Katz (2022); Kamepalli et al. (2020); Motta and Shelegia (2021); Callander and Matouschek (2022).

look for the optimal merger policy.

We also contribute to the vast industrial organization literature on horizontal mergers,[7] by determining the optimal merger policy in the presence of potential competition and asymmetric information. We show that even in a relatively rich setting as ours, the AA can formulate a simple "information-free" policy that does not require the knowledge of whether the start-up is viable or not, of the bargaining power allocation, or of whether the incumbent has the incentive to shelve the project.

In equilibrium, a selection effect shapes the AA's optimal policy, which flags high-price takeovers as (presumably) anticompetitive to induce parties towards acquisitions that target unviable start-ups and are thus preferable in terms of welfare. To obtain this outcome, the AA may need to block some welfare-increasing mergers. A similar selection effect arises in Nocke and Whinston (2013), where the AA optimally commits to blocking welfare-increasing mergers in equilibrium. However, the information problems in the two papers are different. They consider mergers involving actual competitors and assume that the AA knows the impact of proposed mergers on welfare, but has limited information on the alternatives that can be proposed in case the merger is turned down. We consider takeovers targeting potential competitors, for which the information problem concerns the welfare effects of the merger under investigation.

The paper proceeds as follows. Section 2 studies the baseline model. Section 3 analyses the case where it is the incumbent that has superior information. Section 4 discusses the cases where several incumbents bid for the start-up, and where the policy may affect the incentives to innovate. Section 5 proposes a test to screen anti-competitive takeovers. Section 6 concludes the paper.

## 2 The baseline model with asymmetric information

There are three players in our game: an Antitrust Authority (AA), which commits to a merger policy and later enforces it; a monopolist ($I$)ncumbent; and a ($S$)tart-up.[8] The start-up owns a project that, if developed, leads to a substitute for the incumbent's good (or to a more efficient process to produce that good).

The start-up may be 'viable' ($S = S_v$) or 'unviable' ($S = S_u$). A viable start-up will develop and market successfully the project even if independent. An unviable one, instead, lacks criti-

[7] See, e.g., Farrell and Shapiro (1990); Besanko and Spulber (1993); Armstrong and Vickers (2010); Nocke and Whinston (2010; 2013).

[8] In Section 4.1 we study the case of several incumbents bidding for the start-up.

cal resources – managerial, market opportunities, capital – that are necessary for success. The incumbent owns such resources, and it can develop the start-up's project (but might not have the incentive to do so).

The incumbent may acquire the start-up, conditional on the AA's approval. We assume that the takeover involves a negligible but positive transaction cost. This assumption serves as a tie-breaking rule when the profits are the same with and without the takeover. If the takeover takes place, the incumbent will decide whether to develop the project or shelve it.

We consider a merger policy consistent with the approach currently adopted in most jurisdictions: the AA commits to a standard of review,[9] denoted as $\bar{H}$, which indicates the maximum level of "harm" that the AA is ready to tolerate. If $\bar{H} > 0$, the AA commits to approving even mergers that reduce expected welfare, to the extent that the expected harm is lower than the tolerated one $\bar{H}$.[10] If $\bar{H} = 0$, the AA commits to approving only mergers that are expected to be welfare-beneficial. If $\bar{H} < 0$, even a welfare-beneficial merger can be blocked. The expected welfare impact of a proposed merger consists of the difference between the expected welfare in case the merger goes ahead, and in the counterfactual where it does not take place (derived by correctly anticipating the continuation equilibrium of the game).

**Payoffs** If the project has not been developed, the incumbent remains a monopolist with its existing product/technology and earns profits $\pi_I^m$. Welfare is $W^m$. If the viable start-up develops the project, then it will sell a substitute good for the incumbent's product. $S$ and $I$ will make duopoly profits, $\pi_S^d$ and $\pi_I^d$, respectively, with $\pi_I^d < \pi_I^m$. Associated (gross) welfare is $W^d$. If $I$ develops the project, it will obtain higher monopoly profits $\pi_I^M > \pi_I^m$, due to the additional product (or the use of a more efficient technology).[11] Gross welfare is $W^M$.

The ranking of (gross) welfare is $W^m < W^M < W^d$. This assumption reflects the role of market competition: $W^M < W^d$. Moreover, $W^m < W^M$, due to consumers' love for variety (or to the more efficient production process). For the same reasons, it also holds that $CS^m < CS^M < CS^d$. Hence, our analysis is qualitatively the same independent of whether the

[9] Assuming commitment of the merger policy is standard in the literature on mergers (see, e.g., Sørgard, 2009; Nocke and Whinston, 2010, 2013). Since AAs make hundreds of merger decisions a year, and precedents matter in competition law, the credibility of the commitment in this context is not an issue.

[10] In practice, $\bar{H}$ is usually strictly positive for several reasons: the law prescribes that only mergers that significantly affect competition can be prohibited; many mergers are not reviewed because they do not meet notification criteria (e.g., their combined turnover is below certain thresholds); 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.

[11] Since the investment is costly, this assumption represents a necessary (but not sufficient) condition for the incumbent to invest.

AA's objective is consumer or total surplus.

This ranking of gross welfare implies that only takeovers with an unviable start-up can be welfare-improving. If the takeover of a viable start-up could also generate synergies, it might be that $W^M > W^d$ (or $CS^M > CS^d$). For this reason, the violation of the standards of review optimally set by the AA in our model gives rise to an anticompetitive presumption for the merger. That is, the merger should be prohibited in the absence of other efficiencies. In what follows when we write that the AA decides to prohibit the merger, we mean that it establishes the presumption that the merger is anticompetitive (such a presumption can be rebutted by showing efficiencies that are not modeled here).

Development has a positive net present value (NPV) for the viable start-up:

$$\pi_S^d > K, \tag{A1}$$

where $K$ is the investment cost. Industry profits are assumed to be higher under monopoly (when the incumbent $I$ develops the project) than under duopoly:

$$\pi_I^M > \pi_I^d + \pi_S^d. \tag{A2}$$

This is the "efficiency effect" (Gilbert and Newbery, 1982), which ensures that there is always room for an acquisition. We also assume that

$$\pi_S^d > \pi_I^M - \pi_I^m, \tag{A3}$$

which corresponds to Arrow's "replacement effect" (Arrow, 1962): an incumbent has less incentive to innovate than a potential entrant because the innovation cannibalises its current profits.

While absent the acquisition, the viable start-up always develops (Assumption A1), the incumbent does not always have the incentive to do so because the increase in its profits may be insufficient to cover the investment cost (Assumption A3). Specifically, the incumbent invests in development if (and only if):

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

If this condition is not satisfied, the incumbent will shelve a project that an independent start-up would develop. If Assumption A3 did not hold, the incumbent might even develop projects that a viable entrant would find unprofitable.

Finally, the development of the project is assumed to be beneficial for society whether undertaken by the incumbent,

$$W^M - W^m > K, \tag{A4}$$

or by the start-up, $W^d - W^m > K$ (which follows from Assumption A4).

Therefore, the *first-best* is achieved when a viable start-up remains independent and when an unviable start-up is acquired and its project developed.

**Information** In the baseline model, we assume that the start-up knows its own type, but the incumbent and the AA only know the probability $p > 0$ that the start-up is viable, so that $\Pr(S = S_v) = p$ and $\Pr(S = S_u) = 1 - p$. (In Section 2.3, we discuss possible micro-foundations for the sources of asymmetric information on the start-up's type. In Section 3, we solve an alternative model in which the incumbent has superior information on the start-up's type.)

All the rest is common knowledge, so when the AA decides on a takeover proposal, it knows the identity of the firm that makes the offer, the takeover price, the investment cost $K$ and whether the incumbent develops or shelves; thus, it anticipates the payoffs in the different continuation games conditional on this information.

Finally, all agents are risk neutral.

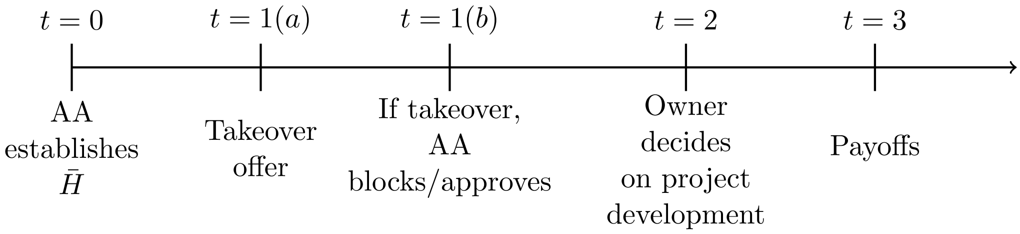
**Takeover game** We model the bargaining over the takeover price as a non-cooperative game with asymmetric information, where the incumbent has all the bargaining power and makes a take-it-or-leave-it offer. Results are qualitatively the same in a setting in which with probability $\alpha$ it is $I$ that makes the offer and with probability $1 - \alpha$ it is the start-up. (See the discussion in Section 2.4.1 and Online Appendix C for the analysis of this variant of the model.)

**Timing** The timing of the game (see also Figure 1) is the following:

- At $t = 0$, the AA commits to the standards for merger approval, $\bar{H}$.
- At $t = 1(a)$, there is the 'takeover game': $I$ makes a takeover offer, which can be accepted or rejected by $S$.
- At $t = 1(b)$, if a takeover is agreed upon, the AA approves or blocks it on the basis of the policy previously decided.
- At $t = 2$, the firm that owns the project decides whether to develop or shelve it.

- At $t = 3$, active firms sell in the product market, payoffs are realised and contracts are honoured.

Figure 1: Timeline




In what follows, we assume without loss of generality that:

$$\bar{H} \geq -(W^M - K - W^m). \tag{A5}$$

In our setting a takeover cannot produce a welfare gain higher than $W^M - K - W^m$; therefore if $\bar{H} < -(W^M - K - W^m)$ not even the most beneficial takeover would be approved.

We will say that a takeover price is "high", if the price $P$ of the transaction is larger than the outside payoff of the viable start-up.

**DEFINITION 1** (High- and low-price takeovers)**.**
*A high-price takeover features a transaction price* $P \geq \pi_S^{\emptyset}(S_v) \equiv \pi_S^d - K$. *A low-price takeover features* $P < \pi_S^{\emptyset}(S_v)$.

Before solving the game by backward induction, we consider a version of the model in which only the AA cannot observe the start-up's type. Within such a simplified environment some of the main forces at work already emerge; in particular, the key insight that the bargaining outcome between the incumbent and the start-up reveals key information for the AA.

## 2.1 Benchmark: symmetric information between firms

Suppose that the incumbent has the same information as the start-up, whereas the AA only knows the prior probability $p$ that a start-up is viable; and that the incumbent develops the project upon acquiring the start-up (condition (1) is satisfied). (One would reach the same results if the incumbent shelved the project, or the start-up would make the offers.)

First, the minimum price that a viable start-up is willing to accept, which amounts to its outside option $\pi_S^d - K > 0$, is higher than the one of an unviable start-up, equal to zero. Second, the maximum price that the incumbent is willing to pay for a viable start-up ($\pi_I^M - K - \pi_I^d$) is higher than the one for an unviable target ($\pi_I^M - K - \pi_I^m$), because in the former case product market competition takes place in the absence of the takeover. Moreover, Assumptions A2 and A3 imply that $I$'s willingness to pay for the viable start-up is higher than the outside option of $S_v$, $\pi_S^d - K$, while $I$'s willingness to pay for the unviable start-up is not. The AA, therefore, infers that the target is viable, when it observes that the price at which the deal is closed is high (i.e. $P \geq \pi_S^d - K$); it also infers that the takeover entails a welfare *loss* equal to $W^d - K - (W^M - K) < 0$ because of the suppression of competition. Instead, the AA infers that the target is unviable, when it observes a low price (i.e. $P < \pi_S^d - K$); it also infers that the takeover results in a welfare *gain* equal to $(W^M - K) - W^m > 0$ (from Assumption A4), because the incumbent develops a project that would never reach the market otherwise.

Therefore, if the merger policy commits to a high level of tolerated harm, namely $\bar{H} \geq W^d - W^M$, the merger policy commits to approve any acquisition, irrespective of the type of the target. Anticipating this, the incumbent offers a high price, $P = \pi_S^d - K$, when it observes that the start-up is viable, and a low price, $P = 0$, when it observes that it is unviable. The start-up accepts, whatever its type. Welfare, expected at $t = 0$, is $W^M - K$.

When instead the merger policy commits to $\bar{H} < W^d - W^M$, there exists no equilibrium where the incumbent offers a high price to a viable start-up and a low price to an unviable one: the AA would correctly infer that the high-price takeover involves a viable start-up and would block it. Therefore, at the perfect Bayesian equilibrium the incumbent makes no offer when it faces the viable start-up, and it offers $P = 0$ to the unviable one, which accepts it; the AA then infers that the low-price takeover involves an unviable start-up and approves it.

Welfare expected at $t = 0$ by committing to this latter policy is $p(W^d - K) + (1-p)(W^M - K)$, which is higher than under the more lenient policy $\bar{H} \geq W^d - W^M$. Hence, the optimal policy is to set $\bar{H} < W^d - W^M$, and it achieves the first best.

This analysis shows that the AA can make inferences on the type of start-up acquired by observing the transaction price and can therefore better assess the welfare consequences of the proposed transaction. A high transaction price signals that the takeover is not indispensable for the success of the start-up and is, therefore, welfare detrimental. A low price signals that the takeover promotes development and is welfare beneficial. Hence, through the choice of the standards of review, the AA determines the type of takeovers that will be approved and will occur at the equilibrium. By setting standards that are strict enough, only takeovers that involve an unviable start-up will be approved and the first-best will be achieved. In the next sections, we shall show that this insight extends to a richer setting with asymmetric information between the incumbent and the start-up, but the AA may need to set a stricter standard ($\bar{H} < 0$) in order to achieve the same first-best outcome.

### 2.2 Solution of the model

Let us solve our main model in which $I$ and the AA take their decisions facing imperfect information about whether, absent the takeover, the start-up can develop the project. They have the same prior belief $p$ that $S = S_v$ and will update their belief based on the information that is public at the time they take a decision: the price agreed for the acquisition and the incumbent's incentive to develop or shelve after the takeover takes place. Section 2.2.1 describes the AA's decision at $t = 1(b)$, for given beliefs about the start-up. Section 2.2.2 illustrates the equilibrium takeover offer and acceptance decision, together with $I$'s and AA's belief update processes. It also shows how the AA's conditions for approval affect the outcome of the bargaining game. Section 2.2.3 identifies the optimal merger policy.

**DEFINITION 2** (Perfect Bayesian equilibrium in pure strategies)**.**
*Let $s_I \in \{\emptyset, P_I\}$ be the pure-strategy profile of agent $I$ that formulates the takeover offer, where $\emptyset$ denotes that no takeover offer is made and $P_I \in \mathbb{R}$ is the offered price. Let $r_{S_j} \in \{Accept\ P_I,\ Reject\ P_I\}$ be the pure-strategy profile of agent $S_j$ that receives the price offer, with $j = u, v$. Finally, let $\phi_I(\Omega) = \phi_{AA}(\Omega) = \phi(\Omega) = \Pr(S = S_v|\Omega) \in [0, 1]$ be the incumbent and the AA's beliefs that $S = S_v$ given their information set $\Omega = \{s_I, r_{S_v}\}$ or $\Omega = \{s_I, r_{S_u}\}$. The beliefs are computed using Bayes' rule whenever possible, and each player's strategy is the optimal response to the opponents' strategies in terms of the specified beliefs. A perfect Bayesian equilibrium (PBE) in pure strategies is denoted by $\{s_I, r_{S_v}, r_{S_u}; \phi(\{s_I, r_{S_v}\}), \phi(\{s_I, r_{S_u}\})\}$.*

We characterize the PBE by specifying the (posterior) beliefs $\phi(\Omega)$ at each information set on the equilibrium path. We assume that, off equilibrium, the posterior beliefs of $I$ and AA coincide with their priors, $\phi(\Omega) = p$, if the offer or acceptance decisions do not disclose additional information on the type of the target.

If the acquisition goes through, we denote by $\pi_I^A = \max(\pi_I^M - K, \pi_I^m)$ the incumbent's profits, gross of the takeover price, where $\pi_I^A = \pi_I^M - K$ if $I$ develops and $\pi_I^A = \pi_I^m$ if it shelves.

### 2.2.1 Decision on merger approval ($t = 1(b)$)

**LEMMA 1** (Decision on merger approval)**.**

*In any PBE in pure strategies, there exists a threshold* $F_W(\pi_I^A, \bar{H}) \geq 0$ *such that the AA authorises the takeover if and only if:*

$$\phi(\Omega) \leq F_W(\pi_I^A, \bar{H}). \tag{2}$$

*The threshold* $F_W(\pi_I^A, \bar{H})$ *is: (i) strictly increasing in* $\bar{H}$*; (ii) higher if* $\pi_I^A = \pi_I^M - K$ *than if* $\pi_I^A = \pi_I^m$*.*

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

The AA authorises a takeover if, based on what it observes, it assigns a sufficiently low probability that the start-up is viable. If the start-up is unviable, the takeover is either welfare neutral (when $I$ shelves), because the project would die anyway, or welfare beneficial (when $I$ develops), because it allows the project to reach the market. Instead, if the start-up is viable, the takeover is more likely to be welfare detrimental: it suppresses product market competition and, when $I$ shelves, it suppresses project development too. For a given tolerated harm $\bar{H}$, the AA approves the takeover if the scenario in which the takeover is welfare detrimental is sufficiently unlikely, that is when the probability that the start-up is viable is low enough. Lemma 1 also shows that the AA is the more likely to approve a takeover: (i) the more lenient the standard for approval $\bar{H}$ (i.e. the higher the tolerated harm); (ii) when the incumbent develops than when it shelves. Corollary 1 describes the AA's decision in some specific cases:

**COROLLARY 1.**

1. *When the incumbent develops, the AA* always *approves a takeover if it assigns probability one to the start-up being unviable (i.e.* $\phi(\Omega) = 0$*).*
2. *When the incumbent shelves, no takeover is approved if the merger policy commits to blocking any welfare strictly detrimental takeover (i.e.* $\bar{H} < 0$*).*

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

### 2.2.2 Equilibrium offers of the takeover game

Having established when the acquisition will be approved or prohibited, we move backward to study the price offers. We find the following:

**LEMMA 2** (PBE of the bargaining game when $I$ makes the offer)**.**

*Let:*

$$F_I(\pi_I^A) \equiv \frac{\pi_S^d - K}{\pi_I^A - \pi_I^d} \in (0,1). \quad (3)$$

*For any $\bar{H}$,*

1. *If $\pi_I^A = \pi_I^m$ and either $p \leq F_I$ or $p > \max(F_W, F_I)$, no takeover occurs at the equilibrium.*

2. *For any $\pi_I^A$, if $p \in (F_I, \max(F_W, F_I)]$, the PBE is: $\{s_I^* = \pi_S^{\emptyset}(S_v) = \pi_S^d - K, r_{S_v}^* = r_{S_u}^* = r_S^* =$ Accept $\pi_S^{\emptyset}(S_v)$; $\phi(\{s_I^*, r_S^*\}) = p\}$.*

3. *If $\pi_I^A = \pi_I^M - K$ and either $p \leq F_I$ or $p > \max(F_W, F_I)$, the PBE is: $\{s_I^* = 0, r_{S_v}^* =$ Reject $0, r_{S_u}^* =$ Accept $0; \phi(\{s_I^*, r_{S_v}^*\}) = 1, \phi(\{s_I^*, r_{S_u}^*\}) = 0\}$.*

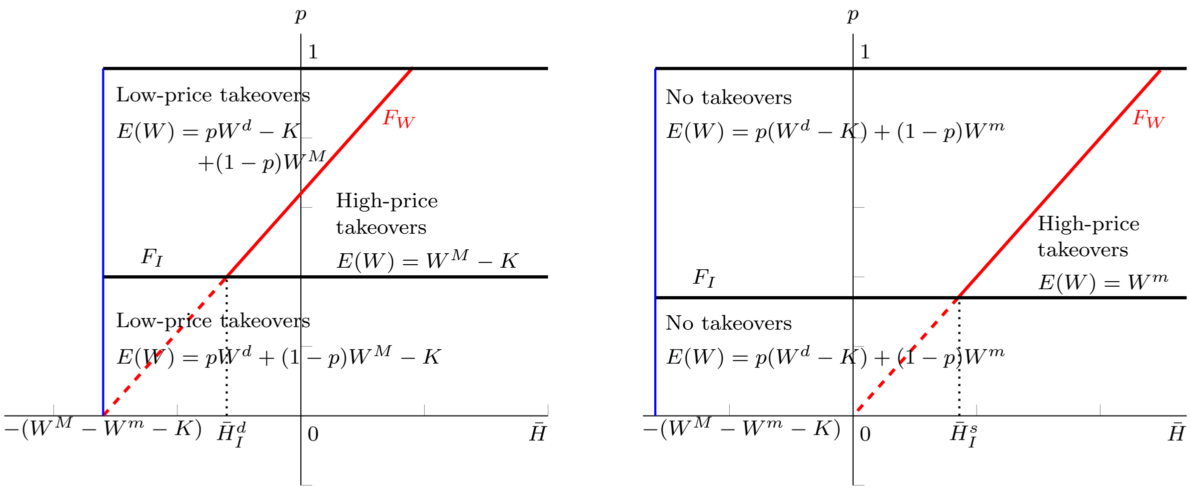
*Proof.* See Appendix A.3. Q.E.D.

Also in this setting in which both $I$ and the AA do not observe $S$'s type, the takeover price conveys key information. A low price still allows the AA (and $I$) to infer that a start-up that accepts the offer is unviable ($\phi(\Omega) = 0$). However, differently from the benchmark case with symmetric information between the firms, when the takeover price is high, no additional information is disclosed and the posterior beliefs coincide with the priors: $\phi(\Omega) = p$.

Let us consider first the case in which $I$ plans to develop the project. The incumbent can offer a *low price*, $P = 0$. A start-up that accepts the offer cannot but be unviable. Therefore, the incumbent anticipates that the AA will approve the deal (from Corollary 1). If the start-up is viable, the offer is rejected and the incumbent will face competition in the product market. Alternatively, the incumbent can offer a *high price*, equal to $\pi_S^d - K$, that any $S$ is willing to accept. Hence, the incumbent and the AA do not update their beliefs. Ignoring which $S$ it faces, the incumbent might overpay for an unviable start-up but it is certain to appropriate the project and to avoid market competition. The former is a risk worth taking when the prior probability that the start-up is viable is sufficiently high (i.e. for all $\phi(\Omega) = p > F_I$). However, the incumbent anticipates that the AA will approve the high-price takeover if the prior probability is sufficiently low (i.e. for all $\phi(\Omega) = p \leq F_W$ as defined by Lemma 1). It is only when both conditions are satisfied simultaneously that the incumbent's preferred choice is also approved by the AA, so that a high-price takeover occurs at the equilibrium (Claim 2 of Lemma 2). A low-price takeover occurs otherwise, either because it is the incumbent's preferred option (when

$p \le F_I$), or because the incumbent anticipates that a high-price takeover would be blocked and it has to settle for a low-price offer (when $p > \max(F_W, F_I)$), as in Claim 3 of the lemma.

Figure 2: Equilibrium takeovers when $S$ holds superior information.




(a) The incumbent develops

(b) The incumbent shelves

*Notes:* On the axes, $\bar{H}$ is the merger standard of review (level of tolerated harm); $p$ is the prior probability that the start-up is viable. Below $F_I$ the incumbent is unwilling to pay a high price since the probability of acquiring a viable firm is too low. Above $F_W$ the AA would not approve a high-price transaction because the probability of the acquired firm being viable is too high. $\bar{H}_I^d$ and $\bar{H}_I^s$, the values of $\bar{H}$ such that $F_W$ and $F_I$ cross when $I$ develops, and respectively when $I$ shelves, will be central to the determination of the optimal merger policy studied in Section 2.2.3. When the incumbent develops, $\bar{H}_I^d$ may be negative, a case displayed in this figure. With shelving, $\bar{H}_I^s$ is necessarily positive.

Figure 2 (left panel) displays the equilibrium takeovers and the expected welfare at $t = 0$, as a function of the standard of review, $\bar{H}$, and the prior probability that the start-up is viable, $p$. Let us focus on the region in which $p > F_I$, so that the incumbent would want to make a high-price offer, and $p > F_W$, so that the AA would block such a takeover. Anticipating the AA's prohibition decision, the incumbent will make a low-price offer. This illustrates the "selection effect" of the merger policy, which pushes the incumbent towards acquisitions targeting only unviable start-ups, which are better for welfare. Since $F_W$ increases in $\bar{H}$, as established by Lemma 1, the figure also shows that the stricter the merger policy (that is, the lower $\bar{H}$), the stronger the selection effect and the more likely that a low-price takeover occurs at the equilibrium. When the merger policy is strict enough, that is when $\bar{H} < \bar{H}_I^d$ in the figure, a high-price takeover would be blocked whenever it is the incumbent's preferred option, and only low-price takeovers occur at equilibrium. The cut-off level $\bar{H}_I^d$ is the value of $\bar{H}$ such that $F_W = F_I$, as shown in the figure.

The underlying mechanisms are similar when the incumbent plans to shelve (i.e. $\pi_I^A = \pi_I^m$). However, in this case offering a low price and acquiring an unviable start-up is equivalent to not engaging in a takeover: the project would be suppressed anyway, either by the incumbent or because of $S$'s inability to develop. Since the takeover involves a positive transaction cost, when a high-price takeover is not the incumbent's best option (i.e. when $p \leq F_I$) or it is prohibited by the AA (i.e. when $p > F_W$), no takeover occurs at equilibrium (Claim 1 of the lemma).

Equilibrium takeovers with shelving are displayed in Figure 2 (right panel), with the associated welfare expected at $t = 0$. In this case too, a sufficiently strict policy, $\bar{H} < \bar{H}_I^s$, implies that a high-price takeover will be blocked whenever it is the incumbent's preferred option and it will never occur at the equilibrium. The cut-off level $\bar{H}_I^s$ is the value of $\bar{H}$ such that $F_W = F_I$. When the incumbent shelves, a high-price takeover cannot be welfare beneficial in expected terms. Hence, differently from the case of development, the cut-off level $\bar{H}_I^s$ is necessarily positive.

#### 2.2.3 Optimal merger policy ($t = 0$)

In this section, we study the optimal merger policy at $t = 0$, when the AA commits to the threshold of tolerated harm, $\bar{H}$. Section 2.4.1 shows that results are qualitatively similar if we allow the start-up to have bargaining power.

**PROPOSITION 1** (Optimal merger policy when the incumbent makes the offer).
*The optimal merger policy commits to a standard of review that prevents high-price takeovers at the equilibrium:*

1. *If $\pi_I^A = \pi_I^M - K$, there exists a unique threshold level of $\bar{H}$, $\bar{H}_I^d > -(W^M - W^m - K)$, such that all $\bar{H} \leq \bar{H}_I^d$ are optimal.*

2. *If $\pi_I^A = \pi_I^m$, there exists a unique threshold level of $\bar{H}$, $\bar{H}_I^s > 0$ such that all $\bar{H} \leq \bar{H}_I^s$ are optimal.*

3. *All $\bar{H} \leq \min(\bar{H}_I^d, \bar{H}_I^s)$ are optimal for any value of $\pi_I^A$.*

*Proof.* See Appendix A.4. Q.E.D.

Figure 2 shows that high-price takeovers are the least desirable outcome for welfare. Hence, the merger policy that maximises expected welfare at $t = 0$ commits to standards of review that prevent high-price takeovers from occurring at the equilibrium.

Consider first the case of shelving. A high-price takeover is a killer acquisition that deprives society of the project and (strictly) decreases welfare. A policy that commits to prohibiting all takeovers that, at the moment they are reviewed, are welfare detrimental screens such takeovers out. As the right panel of Figure 2 shows, it suffices to commit to a *sufficiently low tolerated level of harm*, such that a high-price takeover is prohibited whenever it is the preferred choice of the incumbent. There is a continuum of optimal policies, all equivalent in terms of expected welfare: any $\bar{H} \leq \bar{H}_I^s$, with $\bar{H}_I^s > 0$ is optimal.

Consider next the case in which the incumbent develops. Lemma 1 shows that, for a given standard of review, the AA is more likely to approve a high-price takeover when $I$ develops than when it shelves: the takeover remedies to the start-up's inability to develop when it is not viable; and it does not kill the innovation when the start-up is viable. Therefore, in order to prevent high-price takeovers from arising, the optimal merger policy might need to commit to a more stringent standard of review than in the case of shelving. The cut-off $\bar{H}_I^d$ (such that $F_W = F_I$) below which high-price takeovers will not occur at the continuation equilibrium might be negative, as depicted in the left panels of Figures 2. When this is the case the optimal merger policy commits to prohibiting takeovers that raise welfare, if their expected welfare gain is low enough.

Why is it optimal to commit to prohibiting a takeover that is expected to increase welfare? The reason is that, under the optimal policy, the incumbent will anticipate that high-price takeovers will not be authorised. Hence, it will have no other option than to offer a low price. $S$ will accept the offer, and will be acquired, only when unviable. For this reason, the AA approves the deal. If viable, the offer is rejected, $S$ society will benefit from the intensified competition.

Since we assume that it can compute the relevant cut-offs in the various cases, at $t = 0$ the AA can also commit to an "information-free" merger policy, that is not contingent on the incumbent's decision to shelve or develop, as indicated in Proposition 1, Claim 3.

Finally, comparing the values of expected welfare in Figure 2, it turns out that the optimal policy generates the first-best.

### 2.3 Sources of asymmetric information on the start-up's type

In the baseline model, we assume that the incumbent and the AA do not observe the start-up's type. Here, we discuss possible sources of asymmetric information that are relevant in the context of potential competition.

The first depends on the possibility that the investment cost depends on non-financial resources, for instance, managerial skills, that, differently from the incumbent, the start-up may lack. Suppose that the cost of project development for the start-up is $\tilde{c}K$, with $\tilde{c} \in \{1, \bar{c}\}$. If $S$ has access to enough managerial skills then its project development cost is $K$, with $\tilde{c} = 1$.

If it lacks such resources, $S$'s development cost is $\bar{c}K$, with $\bar{c}K > \pi_S^d$. That is, the low-cost start-up would be able to profitably bring the project to the market absent the takeover, while the high-cost start-up would not. Project development costs $K$ to the incumbent.

To recast this setting within our model, we can assume that, differently from $S$ (which knows its type $\tilde{c}$), $I$ and the AA can only observe $p = \Pr(\tilde{c} = 1)$. This is in line with what is commonly assumed in the literature on innovation economics, in which the innovator is more informed than the acquirer about the value of the innovation. This is because the innovating firm is privately informed about the value of its invention (Anton and Yao, 1994), or about the existence of relevant patents or patent applications (Ganglmair and Tarantino, 2014) that may lower the cost of development, or about the skills of its managers.

The second relies on the presence of financial constraints for the start-up. There is ample evidence that financial constraints impede start-ups' growth.[12] Then assume that the start-up and the incumbent differ in their ability to fund the investment. Whereas $I$ is endowed with sufficient own assets to pay $K$, $S$ holds cash $A < K$, and needs to search for funds $K - A > 0$ in competitive capital markets. Following Holmström and Tirole (1997), the project is developed with certainty if and only if the start-up exerts non-contractible effort. Without effort, the project fails and yields no profit, but the start-up obtains private benefits $B > 0$. The financiers will fund the start-up's project if and only if $B \leq \bar{B} = \pi_S^d - K + A$.

This framework can be nested within our baseline model by assuming that $B$ is observed by $S$ and the financiers, not by $I$ and the AA. The latter observe $p = F(\bar{B})$, with $F(\bar{B}) = \Pr(B \leq \bar{B})$. This assumption reflects the different skills of the players in the game. While it is the core business of financiers to establish the financial merits of a company, it is not the key expertise of incumbents and regulators (Tirole, 2006). Moreover, financiers can inspect $S$'s banking records and history of debt repayment, while $I$ and the AA typically do not have access to this information (or may lack the financial skills that are necessary to interpret the relevant data).

### 2.4 Generalisation of the baseline model

Next, we consider two extensions of the baseline model with asymmetric information between $I$ and $S$.

[12] The Federal Reserve Bank of New York (2017) finds that 69% of US start-up applicants obtained less than the amount of funding they sought, compared to 54% of mature applicants. The Survey on the Access to Finance of Enterprises reaches similar conclusions in the sample of European small and medium firms (European Central Bank, 2019).

### 2.4.1 The start-up has the bargaining power

In this section, we assume it is the start-up that makes a take-it-or-leave-it offer. Intuitively, in this case, equilibrium prices are higher than when the incumbent has the bargaining power. Apart from this consideration, the qualitative nature of the results and the underlying intuitions are similar to those in Lemma 2. (The formal analysis is in Online Appendix C.)

**Equilibrium analysis with pure strategies.** The (pure-strategy) equilibrium may exhibit a *high-price* takeover, in which both types of start-up offer a price strictly higher than the outside option of the viable start-up. Observing such a price, the incumbent and the AA do not learn $S$'s type and do not update their beliefs. The high-price equilibrium exists when the prior probability $p$ is high enough to make the incumbent willing to accept the deal ($\phi(\Omega) = p > F_S$) because the risk of facing competition, absent the takeover, is sufficiently high. Further, the prior probability must be low enough for the AA to approve the deal ($\phi(\Omega) = p \leq F_W$).

When the incumbent develops, a *low-price* takeover may also arise at equilibrium. The viable start-up does not make any offer and the unviable one offers a strictly positive price, which extracts $I$'s willingness to pay for $S_u$, but is lower than the outside option of the viable start-up. Observing this price, $I$ and the AA infer that the start-up is unviable. Since it is indifferent, the incumbent accepts the offer. The AA approves the deal. If the incumbent shelves, the highest price that $I$ is willing to pay for $S_u$ is zero. Since the takeover involves a transaction cost, $S_u$ does not make any offer either and no takeover occurs at the equilibrium.

In this setting too, with development, a "selection effect" of the merger policy arises: when the incumbent accepts a high-price offer (i.e., when $p > F_S$), but the AA blocks the deal (because $p > F_W$), the viable start-up will not make any offer, while the unviable one will offer a low price. The merger policy, then, pushes towards acquisitions initiated only by unviable start-ups, that are superior in terms of welfare.

Finally, high-price takeovers are still the least desirable outcome for welfare. Hence, the merger policy that maximises expected welfare at $t = 0$ commits to standards of review that prevent high-price takeovers from occurring. We show in Online Appendix C that, under the policy described in Proposition 1, the game admits no high-price takeovers at the equilibrium also when the start-up makes the offer. Hence, the policy described in Proposition 1 is optimal also in a setting in which at $t = 0$ the AA knows that with probability $\alpha$ it is the incumbent that makes the offer and with probability $1 - \alpha$ it is the start-up.

**Equilibrium analysis with mixed strategies.** When focusing on pure strategies, there cannot exist an equilibrium in which the viable start-up formulates a higher price offer than the unviable one and the incumbent accepts both offers because $S_u$ would always have the incentive to mimic $S_v$. Hence, the low-price equilibrium is inefficient from the firms' perspective: the viable start-up is not acquired even though the takeover would increase the joint profits of the target and the acquirer.

If $S$ holds the bargaining power, such inefficiency is alleviated when one allows for equilibria in mixed strategies. We show in Online Appendix C that, if the incumbent develops and $p \leq F_S$, on top of the low-price equilibrium in pure strategies, other equilibria may exist where the viable start-up offers a high price $P_H$ (strictly higher than the outside option of the viable start-up) with certainty, while the unviable one randomises between $P_H$ and a lower price $P_L$ (lower than $S_v$'s outside option). When observing $P_H$ the incumbent cannot be sure that the offer originates from a viable start-up, and does not always accept. This reduces the unviable start-up's incentive to mimic the viable one. At the same time, when observing $P_H$, the incumbent (as well as the AA) updates the priors and assigns a posterior probability $\phi(P_H) > p$ to the start-up being viable, which makes the incumbent indifferent between accepting and rejecting $P_H$.

Mixed-strategy equilibria feature a unique low price $P_L$, whereas the high price $P_H$ belongs to an interval whose upper bound is determined by the merger policy. This is because, for the deal featuring $P_H$ to be approved, the posterior probability $\phi(P_H)$ must be lower than the threshold $F_W$. The lower $P_H$, the lower the probability $\phi(P_H)$ that makes $I$ indifferent between accepting and rejecting $P_H$. Hence, a more stringent merger policy (i.e. a lower $\bar{H}$), by decreasing $F_W$, also limits the set of prices $P_H$ that are low enough to trigger approval. These are key considerations for the analysis of the optimal merger policy.

**Optimal merger policy** We find that the low-price equilibrium in pure strategies dominates, in terms of welfare, any equilibrium in mixed strategies: first, because a viable start-up is never acquired and competition never suppressed; second, because an unviable start-up is always acquired and its project is developed by the incumbent. (Since the incumbent randomizes between accepting and rejecting $P_H$, in the mixed-strategy equilibrium the unviable start-up may fail to be acquired, when it offers the high price.) Therefore, the optimal policy must set standards of review that are strict enough to prevent mixed-strategy equilibria from arising, by making sure that no $P_H > \pi_S^{\emptyset}(S_v)$ triggers approval. In Online Appendix C we show that this is the case under the policy described in Proposition 1. This leads to the following Proposition:

**PROPOSITION 2** (Optimal merger policy with pure and mixed strategies)**.**
*The merger policy described in Proposition 1 remains optimal also when the start-up makes the offer and equilibria in mixed strategies are allowed for.*

### 2.4.2 Late takeovers

In this section, the incumbent can acquire the start-up either before *or after* product development. We denote the former, which involves *potential competitors* as "early takeover" and the latter, which involves *committed entrants* as "late takeover".

We allow the AA to commit to two different standards of review for early and late takeovers. More importantly, we allow for the possibility that the expectation of a late takeover increases the viability of a start-up. A natural way to rationalise this property comes from the imperfect financial market micro-foundation of the model (see Section 2.3): if the start-up has some bargaining power in the negotiation for the late takeover, the anticipation that it will appropriate some of the rents generated by the acquisition relaxes financial constraints and increases the probability that the start-up is viable. (The extended model with late takeovers and imperfect financial markets is solved in the Online Appendix D.)

While allowing for acquisitions of committed entrants does not change the optimal policy regarding early takeovers (which remains the same as in Proposition 1), paradoxically the optimal policy may establish a more lenient treatment towards late acquisitions than early ones, a result which holds under specific cumulative conditions which must all hold: the anticipation of a late takeover must increase the viability of the start-up, the incumbent must shelve the project after an early takeover, and the sacrifice of allocative efficiency caused by late takeovers must be dominated by the benefit due to the higher probability of development.

Consider first the case in which the incumbent develops the project in case of an acquisition. When late takeovers are authorised, only low-price takeovers occur at the early stage: given that a viable start-up can be acquired later, there is no point for the incumbent in overpaying for an unviable start-up in early acquisition. Since takeovers targeting unviable start-ups are always authorised, irrespective of the standard of review, the merger policy regarding early takeovers is immaterial. At the equilibrium, unviable start-ups are acquired early and viable start-ups are acquired later. When late takeovers are blocked, the early merger policy matters and it is optimal to prohibit high-price takeovers (see Section 2.2.3). Also in this case, therefore, only low-price takeovers occur at the early stage. A difference with the case in which late takeovers are authorised is that the probability that the start-up is *unviable*, and that is taken over early, is *higher*, because the ban on late takeovers impedes the relaxation of financial constraints. However, since the incumbent develops the project following the acquisition, there is no welfare loss in this. Therefore, when the incumbent develops, the optimal policy blocks late takeovers.

When the incumbent shelves the project in case of an acquisition, instead, it may be willing to engage in a high-price early takeover also when late takeovers are authorised: from its perspective, developing the project is an inefficient investment which cannot be avoided if the viable start-up remains independent; hence, it may decide to overpay for an unviable start-up at the early stage, to then shelve the project. The optimal policy prohibits such killer acquisitions, irrespective of whether late takeovers are blocked or authorised. Since, thanks to the prohibition of high-price early takeovers, only viable start-ups will reach the market when the incumbent shelves, a policy that blocks late takeovers, by decreasing the probability that the start-up is viable, produces a loss relative to the case in which late takeovers are authorised. When this loss is larger than the gain in allocative efficiency caused by intensified competition, authorising late takeovers is optimal.

## 3 The incumbent has an informational advantage

One may think that the incumbent, being already in the market, might have better insights as to whether a start-up is able to successfully develop its project. In this section, then, we assume that the incumbent has perfect information on whether $S = S_v$ or $S = S_u$, whereas the start-up and the AA assign prior probability $p$ to the start-up being viable. We also assume that the start-up learns its type after the takeover proposal and the AA's decision, and before investing (if it has not been acquired).

Initially, we present (perfect Bayesian) equilibria in pure strategies characterised as in Definition 2, with the difference that we denote by $s_I(S)$ the pure-strategy profile of $I$ when it formulates the offer to type $S \in \{S_v, S_u\}$. We then study the optimal merger policy. Finally, we allow for mixed strategies in the bargaining game and formulate the optimal policy accordingly. We directly analyse the takeover game of $t = 1(a)$, because the decision of the AA on the merger approval in $t = 1(b)$ is the same as in Section 2.2.1. We study here the case where the incumbent makes the offer. (See Online Appendix E for the case where the start-up makes the offer.)

### 3.1 Equilibria in pure strategies

**LEMMA 3** (PBE of the bargaining game when $I$ makes the offer)**.**

*Let*

$$F_{II}(\pi_I^A) \equiv \frac{\pi_I^A - \pi_I^m}{\pi_S^d - K} \in [0, 1) \tag{4}$$

*and* $\bar{H}_1(\pi_I^A)$ *be such that* $F_W(\pi_I^A, \bar{H}) = 1$.

1. *If* $\pi_I^A = \pi_I^M - K$ *and* $p \leq \min(F_W, F_{II})$*, the PBE is:* $\{s_I^*(S_u) = s_I^*(S_v) = s_I^* = p\pi_S^{\emptyset}(S_v), r_{S_v}^* = r_{S_u}^* = r_I^* = \text{Accept } p\pi_S^{\emptyset}(S_v)$*;* $\phi(\{s_I^*, r_S^*\}) = p\}$.
2. *For any* $\pi_I^A$*, if* $p > F_{II}$ *and* $\bar{H} \geq \bar{H}_1(\pi_I^A)$*, the PBE is:* $\{s_I^*(S_u) = \emptyset, s_I^*(S_v) = \pi_S^{\emptyset}(S_v)$*,* $r_{S_v}^* = \text{Accept } \pi_S^{\emptyset}(S_v)$*;* $\phi(\{s_I^*(S_v), r_{S_v}^*\}) = 1, \phi(\{s_I^*(S_u), r_{S_u}^*\}) = 0\}$.
3. *For any* $\pi_I^A$*, if* $p > \min(F_W, F_{II})$ *and* $\bar{H} < \bar{H}_1(\pi_I^A)$*, no takeover occurs at the equilibrium.*

*Proof.* See Appendix A.5. Q.E.D.

Claim 1 of the lemma reports the condition for the existence of an equilibrium where the incumbent offers the price $P = p\pi_S^{\emptyset}(S_v) = p(\pi_S^d - K)$, equal to the expected profits of a start-up that does not know its type, both to a viable and to an unviable start-up. This is a low price under our Definition 1. Since the offer does not reveal additional information on the type of start-up, $S$ does not update its prior probability ($\phi = p$), and accepts.

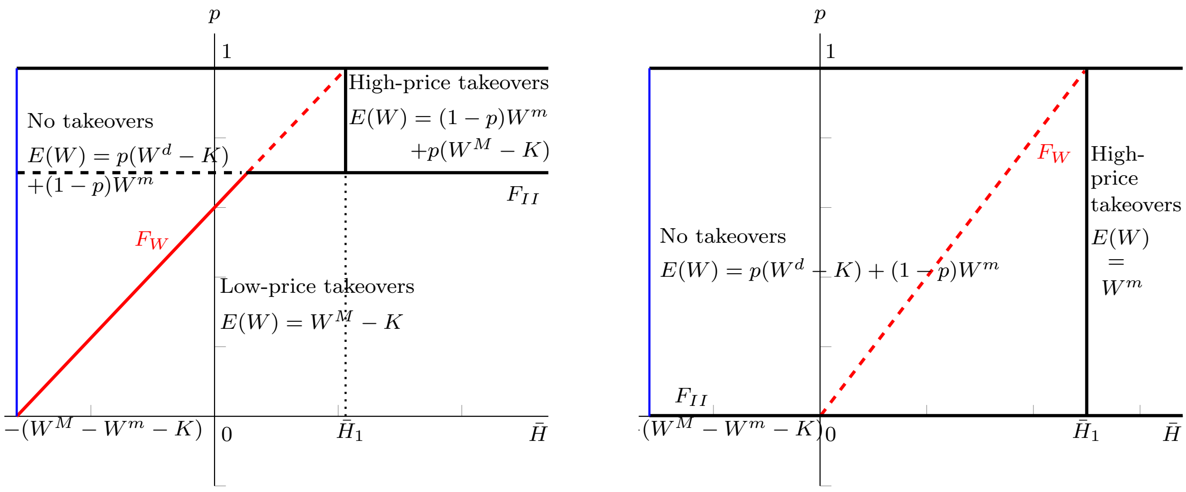
First, this equilibrium exists if offering $P = p(\pi_S^d - K)$ is profitable for the incumbent also when $S$ is unviable. This requires the prior probability, and thus the price $P$, to be sufficiently low, i.e. $p \leq F_{II}$. However, when the incumbent plans to shelve, it would never offer a positive price for an unviable start-up. Hence, in the case of shelving $F_{II} = 0$, and this cannot be an equilibrium. Second, the AA must approve the deal, which is the case if $p \leq F_W$. When $p \leq \min(F_W, F_{II})$ both conditions are satisfied and a *low-price* takeover occurs at the equilibrium.

When $p > F_{II}$, at the equilibrium the incumbent acquires only a viable start-up, by offering the *high price* $\pi_S^{\emptyset}(S_v)$ to $S = S_v$, and abstains from making an offer to $S = S_u$. For this equilibrium to exist merger control must be lenient enough to approve a takeover involving a viable start-up. This is the case if $\bar{H} \geq \bar{H}_1$.

In all the other cases no takeover occurs at the equilibrium.

Unlike the case where the start-up knows its type, now that the incumbent has superior information, both viable and unviable start-ups are acquired at the low-price $P = p\pi_S^{\emptyset}(S_v)$. This

Figure 3: Equilibrium takeovers when $I$ holds superior information.




(a) The incumbent develops

(b) The incumbent shelves

*Notes:* On the axes, $\bar{H}$ is the merger standard of review (level of tolerated harm); $p$=prior probability that the start-up is viable. Above $F_{II}$ the incumbent is unwilling to pay a low price to both a viable and an unviable start-up. Above $F_W$ the AA would not approve a low-price takeover. When $\bar{H} \leq \bar{H}_1$ the AA would not approve a high-price takeover.

is because offering a low price does not convey additional information: $I$ has the incentive to pay a low price for any $S$, and after observing a low-price offer $S$ continues ignoring its type. It is the high price $P = \pi_S^{\emptyset}(S_v) = \pi_S^d - K$ that reveals new information, namely that the start-up is viable.

Figure 3 (left panel) displays takeovers (and associated expected welfare) at equilibrium, as functions of the standard of review $\bar{H}$ and the prior probability $p$.

### 3.1.1 The optimal merger policy

**PROPOSITION 3** (The optimal merger policy when $I$ has superior information)**.** *When the incumbent has superior information it is optimal for the AA to commit to a standard of review such that only welfare-increasing takeovers are approved (i.e., $\bar{H}^* = 0$ for any $\pi_I^A$). This standard of review prevents high-price takeovers at the equilibrium.*

*Proof.* See Appendix A.6. Q.E.D.

Differently from the case where $S$ holds superior information (see Section 2) when the incumbent has superior information, the first-best outcome, i.e. the case in which only unviable start-ups are acquired, cannot be achieved by the merger policy, because it is not a feasible equilibrium (see Figure 3). However, similarly to that case, the optimal standard of review must be strict enough that high-price takeovers will be blocked. Since these takeovers target only viable start-ups, they are dominated in terms of welfare both by the no-takeover equilibrium and by low-price takeovers.

Once high-price takeovers do not occur at the equilibrium, if $I$ shelves no takeover occurs. Hence, any $\bar{H} < \bar{H}_1$ is optimal. When $I$ develops either low-price takeovers or no takeovers are possible equilibrium outcomes. In the former case, viable start-ups are acquired and competition softened, but development is promoted. It is therefore optimal to set standards of review such that only takeovers that are expected to increase welfare will be approved, i.e. $\bar{H}^* = 0$. Online Appendix E formally proves that the optimal policy does not change when $S$ makes the offer.

### 3.2 Mixed-strategy equilibria

Under the pure-strategy PBE analysed so far, unviable start-ups may not be acquired at the equilibrium, even though such acquisitions would increase joint profits and welfare. We now show that this inefficiency can be attenuated when considering mixed-strategy equilibria of the bargaining game.

**DEFINITION 3** (PBE in mixed strategies when $I$ holds superior information).
*Let $\gamma^L(S_k) = \Pr(P_I = \tilde{P}_L|S_k)$ and $1-\gamma^L(S_k) = \Pr(P_I = \tilde{P}_L|S_k)$ be the probability that $I$ assigns to offering $P_I = \tilde{P}_L$ and $P_I = \tilde{P}_H$, respectively, to start up $S_k$, with $k = v, u$, and $\tilde{P}_L, \tilde{P}_H \in \mathbb{R}$. Then, $(\gamma^L(S_v), \gamma^L(S_u))$ is the mixed-strategy profile of agent $I$. Let $\beta^L = \Pr(Accept\ \tilde{P}_L)$ and $\beta^H = \Pr(Accept\ \tilde{P}_H)$ be the probability that $S$ assigns to action* Accept $P_I$ *when $I$ plays $P_I = \tilde{P}_L$ and $P_I = \tilde{P}_H$, respectively. Then, $(\beta^H, \beta^L)$ is the mixed-strategy profile of agent $S \in \{S_v, S_u\}$. A perfect Bayesian equilibrium in mixed strategies is denoted by $\{\gamma^H(S_v), \gamma^H(S_u), \beta^H, \beta^L; \phi(\tilde{P}_L), \phi(\tilde{P}_H)\}$.*

**LEMMA 4** (Hybrid PBE of the bargaining game when $I$ has superior information).
*If $\pi_I^A = \pi_I^M - K$ and $p > F_{II}$, there exist hybrid PBE such that:*

- *$\tilde{P}_L \in (0, \pi_I^M - K - \pi_I^m]$ and $\tilde{P}_H = \pi_S^d - K$, with $\tilde{P}_H = \pi_S^{\emptyset}(S_v) > \tilde{P}_L > 0$; $\phi(\tilde{P}_L) < p$, with $\phi'(\tilde{P}_L) > 0$; $\phi(\tilde{P}_H) = 1 \leq F_W$ if and only if $\bar{H} \geq \bar{H}_1$.*

- *$I$ offers the price $\tilde{P}_L$ to $S_u$ with probability $\gamma^L(S_u) = 1$; $I$ offers $\tilde{P}_H$ with probability $1 - \gamma^L(S_v)$ to $S_v$ and $\tilde{P}_L$ with probability*

$$\gamma^L(S_v) = \frac{\tilde{P}_L(1-p)}{p(\pi_S^d - K - \tilde{P}_L)} \in (0, 1).$$

- *If the start-up receives the offer $\tilde{P}_H$, it accepts with probability $\beta^H = 1$; if the start-up receives the offer $\tilde{P}_L$, it accepts with probability*

$$\beta^L = \frac{\pi_I^M - \pi_I^d - \pi_S^d}{\pi_I^M - K - \pi_I^d - P_L} \in (0,1).$$

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

With pure-strategy equilibria, if $p > F_{II}$ the incumbent cannot acquire the unviable start-up because the price that it is willing to offer to both types is lower than $S$'s expected profits, equal to $p\pi_S^{\emptyset}(S_v)$.

If mixed strategies are allowed for, under development and $p > F_{II}$, the incumbent offers a low price $\tilde{P}_L$ with certainty when it observes an unviable start-up, while it randomises between a low price ($\tilde{P}_L$) and a high price ($\tilde{P}_H$) when it observes a viable one. Hence, a start-up receiving a low-price offer revises downwards the probability of being unviable: $\phi(\tilde{P}_L) < p$. This makes it indifferent between accepting and rejecting such an offer. In turn, the fact that $S$ randomises between accepting and rejecting a low-price offer makes the incumbent indifferent between offering a low price (accepted with some probability) and a high price (accepted with certainty) to a viable start-up. This means that, if $p > F_{II}$ and the AA authorises takeovers targeting viable start-ups (i.e. if $\bar{H} \geq \bar{H}_1 = W^d - W^M$), there also exist equilibria where both start-ups may be acquired.

In the case of shelving a hybrid PBE does not exist. This is because the highest price that the incumbent is willing to offer for an unviable start-up is zero ($\tilde{P}_L = 0$). Hence, for $S$ to be indifferent between accepting and rejecting a low-price offer, it should assign zero probability to being viable, which in turn is supported by a zero probability that the incumbent offers a low price to a viable start-up.

### 3.3 Optimal policy with pure and mixed strategies

Consider $p > F_{II}$. If $\bar{H} \geq \bar{H}_1$, two types of equilibria may arise: one in pure strategies where $I$ acquires a viable start-up at a high price equal to $\pi_S^{\emptyset}(S_v) = \pi_S^d - K$ (Lemma 3, Claim 3) and the other in mixed strategies (Lemma 4). In the former case unviable start-ups are never acquired and fail to develop. Expected welfare at $t = 0$ is:

$$E(W^{ps}) = p(W^M - K) + (1-p)W^m.$$

In the latter case, both types of start-ups may be acquired. Expected welfare is:

$$\begin{aligned} E(W^{ms}) &= p[(\gamma^L(S_v)\beta^L + 1 - \gamma^L(S_v))W^M + \gamma^L(S_v)(1-\beta^L)W^d - K] \\ &\quad +(1-p)[\beta^L(W^M - K) + (1-\beta^L)W^m]. \end{aligned}$$

If $\bar{H} < \bar{H}_1$, no takeover occurs at the equilibrium. Since viable start-ups are able to develop whereas unviable ones fail to develop, expected welfare is:

$$E(W^{no}) = p(W^d - K) + (1-p)W^m.$$

As already established in Section 3.1.1, expected welfare is higher under the no-takeover equilibrium than under the pure-strategy equilibrium in which high-price takeovers occur. Hence, if the pure-strategy equilibrium arises whenever $\bar{H} \geq \bar{H}_1$, the optimal merger policy is to establish standards of review such that high-price takeovers will be blocked, as in Proposition 3.

However, if a mixed-strategy PBE occurs whenever $\bar{H} \geq \bar{H}_1$, a trade-off arises. On the one hand, the mixed-strategy equilibrium entails two welfare losses relative to the no-takeover one: the first is when the low price $\tilde{P}_L$ is offered to a viable start-up and such an offer is accepted, which occurs with probability $p\gamma^L(S_v)\beta^L$; the second is when a high price $\tilde{P}_H$ is offered to a viable start-up, which occurs with probability $p(1-\gamma^L(S_v))$. On the other hand, the mixed-strategy equilibrium entails a welfare gain when the unviable start-up is acquired and, therefore, the takeover enables development, i.e. when the low-price $\tilde{P}_L$ offer is accepted by an unviable start-up, which occurs with probability $(1-p)\beta^L$.

Expected welfare at the mixed-strategy equilibrium is higher than in the no-takeover equilibrium when the welfare gain dominates the welfare losses, that is when the probability that the start-up is viable is small enough:

$$p \leq \frac{\beta^L(W^M - K - W^m)}{\beta^L(W^M - K - W^m) + (\gamma^L(S_v)\beta^L + 1 - \gamma^L(S_v))(W^d - W^M)} \equiv F_{WW} \in (0,1).$$

Hence, under specific cumulative conditions, listed in the proposition below, the optimal merger policy may set a tolerated level of harm that is high enough to authorise high-price takeovers:

**PROPOSITION 4** (Optimal merger policy with pure and mixed strategies)**.**
*The optimal merger policy is lenient enough to authorise high-price takeovers, i.e., any $\bar{H} \geq \bar{H}_1$ is optimal, if (and only if) the following conditions are jointly satisfied: (i) the incumbent has*

*the bargaining power; (ii) the incumbent develops; (iii)* $p \in (F_{II}, F_{WW}]$*; (iv) whenever* $\bar{H} \geq \bar{H}_1$ *the mixed-strategy equilibrium, and not the pure strategy equilibrium, arises. The merger policy* $\bar{H}^* = 0$ *is optimal if otherwise.*

The proof follows from the discussion above. The optimal policy may be such that high-price takeovers will be approved not because the acquisition of viable start-ups is beneficial per se. Rather, it is because authorising high-price takeovers sustains an equilibrium of the takeover game in which also unviable start-ups may be acquired.

# 4 Discussion

In this section, we discuss the case where more than one incumbent could acquire the start-up (Section 4.1) and the ex-ante effect of merger policy, namely the possibility that it impacts the start-ups' incentives to innovate (Section 4.2).

## 4.1 Bidding competition

The formal analysis (for simplicity, based on the model of Section 2.1 where only the AA does not know if the start-up is viable) will be developed in Online Appendix F. Here we discuss the intuitions for the results.

Let us consider first the case in which acquirers have incentive to shelve the project. If the start-up is unviable, no acquirer will make a bid and the takeover will not occur. If it is viable, the acquisition has a public good nature: each acquirer prefers the others to pay the price for the start-up and shelve the project. There is no reason to outbid each other and, at equilibrium, one firm offers the outside option of the start-up while the others make no offer. As in the base model, therefore, if the AA observes a high price, it will infer that the target is viable and that the acquisition is welfare detrimental. The optimal policy will set a standard of review such that these acquisitions will be blocked.

When acquirers have the incentive to develop, whether the start-up is viable or not, competition among bidders may push the equilibrium price above the outside option of $S_v$. In this case, the AA cannot use the information conveyed by the transaction price to make a better assessment of the welfare effects of the takeover. Hence, differently from the analysis developed so far, the outcome that maximises welfare cannot be achieved through an appropriate choice of the tolerated harm $\bar{H}$. The optimal policy, in this case, must explicitly prohibit any takeover with a transaction price (weakly) above the outside option of the viable start-up. A viable start-up will not accept any admissible price, and will not be acquired. Acquirers will outbid each other until they reach the upper bound of the admissible prices when the start-up is unviable. The latter will accept the offer and the first-best will be achieved.

### 4.2 Effects on ex-ante innovation

Throughout the paper, we have assumed that the start-up's project is exogenously given. Since the optimal policy establishes standards of review such that high-price takeovers are prohibited, it might result in a reduction of the start-up's expected profits and a decrease in its incentive to innovate.

If the incumbent shelves the project upon acquiring the start-up, the presence of ex-ante effects on innovation incentives does not change the optimal policy. Any additional innovation effort due to a higher expected price would not be valuable to society because it will be undone by the incumbent's decision to shelve the project.

If the incumbent develops, instead, a trade-off emerges. On the one hand, setting standards of review such that high-price takeovers are prohibited reduces the market inefficiency caused by the acquisition of a viable potential competitor. On the other hand, it might generate a reduction in the probability of innovating and hence in the consumer surplus created by an expansion in the range of products offered by the incumbent monopolist.

To properly assess the effects of this policy on innovation incentives, we would need a model where both the start-up and the incumbent can invest. However, we argue above that, even in a model that only considers the impact on start-up incentives, a policy that prohibits high-price takeovers may remain optimal. This is in line with recent literature studying the impact of the acquisitions of potential competitors on innovation (e.g., Letina et al., 2020; Denicolò and Polo, 2021), and showing that a policy that prohibits these acquisitions does not necessarily dampen innovation.

## 5 An empirical method to screen high-price takeovers

To assess whether a merger requires thorough examination, the current U.S. Department of Justice (DOJ) and Federal Trade Commission (FTC) Horizontal Merger Guidelines rely on the post-merger level and the change in the Herfindahl index (Nocke and Whinston, 2022). However, the Herfindahl index becomes less informative when the merger involves a potential competitor, as the target firm's market share is typically small or non-existent. An important contribution of our model is to demonstrate that a high price serves as a signal indicating a higher likelihood of the takeover raising anti-competitive concerns. If the acquisition prices are determined through negotiations, they must be higher than the target's outside option. Our model distinguishes between viable and unviable start-ups and predicts that only the outside option of viable start-ups $\pi_S^{\emptyset}(S_v)$ is relevant in identifying high-price takeovers. We propose simple empirical tests to identify which acquisitions are more likely to be priced above $\pi_S^{\emptyset}(S_v)$, thereby warranting closer scrutiny based on the deal price.

In the model, a price $P$ is high if it is larger than the outside option $\pi_S^{\emptyset}(S_v)$ of a viable target, i.e. of a target company that has the capability to succeed in the market and exert competitive pressure by remaining independent (Definition 1). To determine the value of $\pi_S^{\emptyset}(S_v)$ in the data, we will make use of the method of comparables (Berk and DeMarzo, 2014:288ff), a standard method used in finance for stock valuation. It relies on the Law of One Price, according to which investments with equivalent risk-return profiles must be traded for the same price. This method suggests that $\pi_S^{\emptyset}(S_v)$ can be computed based on information related to other comparable investments (or comparables) that are expected to generate equivalent future cash flows. In practice, we estimate $\pi_S^{\emptyset}(S_v)$ by determining the payoff that an investor expects to obtain from investing in a viable company based on the value of comparable companies. Since it is hard to find identical companies even in the same industry, the method suggests adjusting for differences in scale by computing a "multiple" $\mu$ given by the ratio of comparable companies' value to some measure of scale.

In our empirical exercise below, we first select a sample $C$ of target companies that are comparable to the target of acquisition under consideration. For each of them, to proxy firm value ($V_C$), we consider the stock market value of the target sometime before the acquisition. This gives us a proxy for the value of the target firm net of the market power effect generated by the acquisition. To adjust for differences in scale ($X_C$), we will use the value of revenue or the number of employees. The resulting market-value multiple is $\mu(V_C, X_C) = V_C/X_C$.

We approximate the outside option of a target company that has the potential to turn into a successful competitor by a (sufficiently high) percentile of the conditional distribution of comparables' market-value multiples. To estimate the distribution of comparable companies' multiples ($\mu(V_C, X_C)$), we run a quantile regression,

$$\log(\mu(V_C, X_C)) = f(\log(X_C)) + t + \varepsilon, \tag{5}$$

where $t$ is a year fixed effect that absorbs aggregate shocks. Using $\log(\mu) = m$, we assume that

$$\pi_S^{\emptyset}(S_v) = \widehat{m}(\tau|X_C), \tag{6}$$

where $\widehat{m}(\tau|X_C)$ is the estimated value of the $\tau$-th percentile of the distribution of $\log(\mu(V_C, X_C))$ conditional on $X_C$.[13]

We then say that we cannot reject the null that the acquisition of a company $G$ featuring $X = X_G$ is a low-price acquisition if the (log of the) ratio between the price $P_G$ paid by the acquirer and the size of the target company $X_G$, is lower than the lower bound of the 95% confidence interval of $\widehat{m}(\tau|X_G)$, which we denote $\underline{\widehat{m}}(\tau|X_G)$:

$$\log\left(\frac{P_G}{X_G}\right) \leq \underline{\widehat{m}}(\tau|X_G). \tag{7}$$

We reject the null if otherwise.

We next propose an additional screening to identify which high-price takeovers are likely to cause a larger welfare loss. The presumption we make is that high-price acquisitions that cause a larger increase in market power should come with a larger premium on target firms' market value. We acknowledge that such a premium could also reflect other factors. First, it could reflect bargaining power: the premium on the target firm's market value might be low, despite a strong market power effect of the acquisition, because the acquirer has significant bargaining power in the negotiation for the takeover. Our approach is, therefore, conservative. Second, a large premium on target firms' market value might reflect merger-specific efficiencies, e.g., the reduction in merging parties' marginal costs. The presence of such efficiencies could be assessed in the in-depth scrutiny that our screening triggers.

Under this caveat, analogously to what we do to identify high-price takeovers, we focus on the sample of comparable companies $C$. For each of them, we compute the price multiple $\rho(P_C, V_C) = P_C/V_C$, given by the ratio between the price paid to acquire the target and the

[13] The analysis we run to determine high-price acquisitions is similar to Kühn (2021). The main differences are two. First, Kühn (2021) uses information on the price of the acquisitions to construct the empirical thresholds, while we use the market value. Second, we propose a second test (based on the price multiple) to determine which acquisitions are more likely to exacerbate market power.

market value of the target. Then, we run the following quantile regression:

$$\log(\rho(P_C, V_C)) = g(\log(V_C)) + t + \varepsilon. \tag{8}$$

Using $\log(\rho) = \psi$, the estimation of equation (8) gives us the $\tau$-th percentile of the distribution of $\log(\rho(P_C, V_C))$ conditional on $V_C$, which we denote by $\widehat{\psi}(\tau|V_C)$. Therefore, as an additional criterion to determine whether the acquisition of a company $G$ featuring a value equal to $V_G$ is more likely to deserve closer scrutiny, we propose the following test. We cannot reject the null that the acquisition does not increase market power if its price multiple (in log) is lower than the lower bound of the 95% confidence interval of $\widehat{\psi}(\tau|V_G)$, which we denote $\underline{\widehat{\psi}}(\tau|V_G)$,

$$\log\left(\frac{P_G}{V_G}\right) \leq \underline{\widehat{\psi}}(\tau|V_G). \tag{9}$$

We fail to reject the null if otherwise.

### 5.1 Evaluation of acquisitions in the digital market

We now propose an empirical application of the tests proposed above. The goal is to illustrate how they can be used to screen high-price acquisitions that are more likely to raise anti-competitive concerns. Accordingly, we use data on acquisitions drawn from Refinitiv (Thomson Reuters) to evaluate which of the takeovers made by GAFAM (Google, Apple, Facebook, Amazon, Microsoft) during our sample period satisfies conditions (7) and (9).

We take all the acquisitions made by the companies in the high-tech category of Refinitiv.[14] The sample period goes between 1980 and 2023. The full list includes a total of 6,755 acquisitions. The descriptive statistics for the 6,025 acquisitions in the group of comparables, which excludes the acquisitions performed by GAFAM, and for the 730 acquisitions made by GAFAM are in Table B.1 (Online Appendix B).

First, we perform the test to screen high-price acquisitions. Using this dataset, we run the quantile regression in equation (5) on the set of comparables and we take the 75th percentile of the conditional distribution of market-value multiples ($\mu(V_C, X_C)$) as an approximation of the outside option of a viable target company. Table 1 reports the results for the subset of

[14]We select the takeovers made by acquirers in indexes containing stocks listed on Nasdaq (the First Trust Nasdaq 100 Technology-Sector Index and the First Trust Nasdaq Technology Dividend Index Fund.) We then further refine the selection of acquirers by excluding the companies whose primary industry is not high-tech according to Refinitiv.

GAFAM acquisitions for which our dataset contains sufficient information to perform the test in condition (7) with either revenue or employees. The null is that an acquisition carries a low price. We fail to reject (FTR) the null if condition (7) is satisfied and reject (R) the null if condition (7) is violated. The symbol "-" indicates that the test cannot be performed because of a lack of information. In column (1), the proxy for size is revenue, it is employees in column (2). In column (3), we say that we fail to reject the null (FTR) if condition (7) is satisfied either with revenue or employees. We find that the majority of acquisitions performed by GAFAM for which the test can be performed are flagged as high-price acquisitions. In particular, the method classifies as high-price acquisitions some of the acquisitions performed by GAFAM that commentators have considered controversial.

Second, we check whether any of the high-price acquisitions identified above are more likely to give rise to a large market power effect. We run the quantile regression in equation (8) on the sample of comparables to obtain the 75th percentile of the conditional distribution of price-value multiples $\rho(P_C, V_C)$. The null is that the acquisition does not increase market power. We fail to reject (FTR) the null if condition (9) is satisfied and reject (R) the null if condition (9) is violated. The symbol "-" indicates that the test cannot be performed because of a lack of information. The results are in column (4). We again find that the majority of acquisitions for which both tests can be performed are likely to increase market power.

The selection of the 75th percentile threshold for these tests was made arbitrarily. In practice, a sensitivity analysis should be conducted to explore different percentile thresholds for the conditional distribution of the multiples of interest. This analysis can help determine the most appropriate threshold that effectively screens high-price acquisitions which are more likely to raise anti-competitive concerns. Such a sensitivity analysis can enhance the validity of the results and provide a more comprehensive understanding of the implications of different percentile choices.

## 6 Policy implications and concluding remarks

The acquisition of potential competitors has been a particularly debated issue in the last few years, due to research showing that they have led to killer acquisitions (Cunningham et al., 2021) and to the vast number of unchallenged mergers with start-ups in the digital industries. Commentators and policymakers have been invoking stricter merger control, and as we write, legislative initiatives as well as changes in enforcement standards are being considered in several

Table 1: Results of the screening test for high-price acquisitions

| **Target** | **Acquirer** | (1) **75th Percentile** **Revenue** | (2) **Employees** | (3) **Screen** **High-Price** | (4) **Screen** **Market Power** |
|---|---|---|---|---|---|
| Activision Blizzard Inc | Microsoft Corp | R | R | R | R |
| Apigee Corp | Google Inc | R | - | R | FTR |
| AuthenTec Inc | Apple Inc | R | - | R | R |
| BeatThatQuote.com Ltd | Google Inc | R | - | R | - |
| C3 Technologies AB | Apple Inc | R | - | R | - |
| Danger Inc | Microsoft Corp | R | R | R | - |
| DoubleClick Inc | Google Inc | R | R | R | - |
| Fast Search & Transfer ASA | Microsoft Corp | R | R | R | R |
| Fox Software Inc | Microsoft Corp | R | - | R | - |
| Great Plains Software Inc | Microsoft Corp | R | FTR | R | FTR |
| Instagram Inc | Facebook Inc | - | R | R | - |
| Komoku Inc | Microsoft Corp | - | R | R | - |
| LinkedIn Corp | Microsoft Corp | R | R | R | R |
| Mojang AB | Microsoft Corp | R | - | R | - |
| Motorola Mobility Holdings Inc | Google Inc | FTR | - | FTR | R |
| NCompass Labs Inc | Microsoft Corp | R | - | R | - |
| Navision A/S | Microsoft Corp | R | R | R | FTR |
| NetCarta Corp(CMG Information Service Inc) | Microsoft Corp | - | R | R | - |
| Nuance Communications Inc | Microsoft Corp | R | R | R | R |
| On2 Technologies Inc | Google Inc | R | R | R | R |
| Picnik.com | Google Inc | - | FTR | FTR | - |
| PlaceWare Inc | Microsoft Corp | - | R | R | - |
| PowerSchool Inc | Apple Inc | - | FTR | FTR | - |
| Skype Global Sarl | Microsoft Corp | R | - | R | - |
| Slide Inc | Google Inc | - | R | R | - |
| Softimage Co | Microsoft Corp | R | - | R | - |
| Vicinity Corp | Microsoft Corp | R | R | R | R |
| Visio Corp | Microsoft Corp | R | - | R | FTR |
| Waze Mobile Limited | Alphabet Inc | - | R | R | - |
| WhatsApp Inc | Facebook Inc | R | - | R | - |
| Yahoo! Inc | Microsoft Corp | R | R | R | R |
| Youtube LLC | Alphabet Inc | R | R | R | - |
| Zagat Survey LLC | Google Inc | - | FTR | FTR | - |
| aQuantive Inc | Microsoft Corp | R | R | R | R |

*Notes:* In columns (1) and (2), we report the results of the test corresponding to condition (7) using revenue (column (1)) and employees (column (2)) for the 75th percentile of the distribution of the market-value multiple $V/X$ estimated using $f(\log(X_C)) = \alpha + \beta \log(X_C) + \gamma(\log(X_C))^2$ in equation (5). The null is that the acquisition carries a low-price. We fail to reject (FTR) the null if condition (7) is satisfied and reject (R) the null if condition (7) is violated. The symbol "-" indicates that the information on either revenue or employees is missing and the test cannot be performed. In column (3), we report R if condition (7) is violated either with revenue (column (1)) or with employees (column (2)). In column (4), we report the results of the test corresponding to condition (9) for the 75th percentile of the distribution of the price multiple $P/V$ estimated using $g(\log(V_C)) = \alpha + \beta \log(V_C) + \gamma(\log(V_C))^2$ in equation (8). The null is that the acquisition does not increase market power. We fail to reject (FTR) the null if condition (9) is satisfied and reject (R) the null if condition (9) is violated. The symbol "-" indicates that the information on market value is missing and the test cannot be performed.

jurisdictions.

We have investigated an environment in which such acquisitions may in principle have detrimental or beneficial effects. The former consists of the possible suppression of innovation and the elimination of competition. The latter of higher (potential) ability to develop due to the acquirer's better resources. The AA commits to the optimal standards review (ex-ante). It then decides on each specific acquisition depending on whether it violates such standards (ex-post).

We show that the optimal merger policy should commit to standards of review that are sufficiently strict to raise an anticompetitive presumption for high-price takeovers of start-ups. That is, such acquisitions should be prohibited, in the absence of other merger-specific efficiencies. This will exert a selection effect: even though ex-post certain high-price acquisitions may be welfare-beneficial, the policy pushes towards takeovers that target only unviable start-ups and that, therefore, increase welfare more. This policy does not imply blocking *all* acquisitions of potential competitors. Low-price transactions will signal the acquisition of start-ups unable to become independent competitors and should go through. Hence, the optimal standards of review will have the effect of approving low-price takeovers.

We have not modeled the possibility that the acquisition gives rise to efficiency gains other than those consisting of allowing the development of a project that an unviable firm could not pursue. If such gains were large enough, some of our assumptions could be reversed: welfare could be higher under a multi-product monopoly than under a duopoly (violating our assumption that $W^d > W^M$), and the Arrow replacement effect may not hold any longer (violating our assumption $\pi_S^d > \pi_I^M - \pi_I^m$, thus implying that an incumbent may be *more* likely to invest than a start-up) so that a high-price acquisition could be welfare beneficial. This is no novelty, however: both theory and practice have known for a long time that if the merging parties can prove that efficiency gains outweigh the competitive harm, the merger should be allowed.

The acquisitions of potential competitors pose two challenges to AA. The first is that they do not trigger mandatory pre-merger notifications. The second is that, even when these mergers are reviewed, it is difficult to determine their impact on welfare. Our results, by stressing the role of transaction price, speak to these issues in at least two ways. First, those jurisdictions where merger notification is based on turnover thresholds alone should also introduce a transaction-value criterion, as recently done by the Italian AA. This should allow AA to investigate important acquisitions of potential competitors that were so far below their radar. Second, the AA should use the information conveyed by the value of the transaction to identify those mergers that are likely to be anti-competitive.

A challenging question in terms of implementation of our policy implications concerns how to identify a high-price acquisition in real-world cases. To make progress on this front, we have suggested identifying a "high price" by using the value of comparable companies. Since finding similar enough companies is difficult, the method suggests adjusting for differences in scale by computing a "multiple" $\mu$ given by the ratio of comparable companies' value to some measure of scale. By applying this method to the digital industry we have seen that it does identify those acquisitions by the large digital platforms that commentators have considered controversial. Introducing a hard threshold may induce firms to structure their deals by manipulating equity values and gross margins to avoid Antitrust scrutiny (Kepler, Naiker, and Stewart, 2023). We leave to future research the analysis of how our proposal should be designed to avoid this form of gaming.

## References


[1] Anton, James J., and Dennis Yao (1994). "Expropriation and Inventions: Appropriable Rents in the Absence of Property Rights", American Economic Review, 84(1):190-209.

[2] Armstrong, Mark and John Vickers (2010). "A Model of Delegated Project Choice", Econometrica, 78(1):213-244.

[3] Arrow, Kenneth J. (1962). "Economic Welfare and the Allocation of Resources for Invention", in *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton University Press.

[4] Arora, Ashish, Andrea Fosfuri and Thomas Roende (2021). "Waiting for the Payday? The Market for Start-ups and the Timing of Entrepreneurial Exit", Management Science, 67(3):1329-1992.

[5] Berk, Jonathan and Peter DeMarzo (2014). *Corporate Finance*, Pearson.

[6] Besanko, David and Daniel F. Spulber (1993), "Contested Mergers and Equilibrium Antitrust Policy", Journal of Law, Economics, and Organization, 9(1):1-29.

[7] Bisceglia, Michele, Jorge Padilla, Joe Perkins and Salvatore Piccolo (2021). "Optimal Exit Policy with Uncertain Demand", University of Bergamo, Mimeo.

[8] Bryan, Kevin A. and Erik Hovenkamp (2020). "Antitrust Limits on Startup Acquisitions", Review of Industrial Organization, 56:615-636.

[9] Cabral, Luis (2021). "Merger Policy in Digital Industries", Information Economics and Policy, 54.

[10] Callander, Steven and Niko Matouschek (2022). "The Novelty of Innovation: Competition, Disruption, and Antitrust Policy", Management Science, 68(1):37-51.

[11] CMA (Competition and Markets Authority) (2021). "A new pro-competition regime for digital markets".

[12] CNBC (2015). Dotcom Bubble CEO: Why I passed on buying Google, 2 March 2015.

[13] Crémer, Jacques, Yves-Alexandre de Montjoye and Heike Schweitzer (2019). "Competition Policy for the digital era", Report for the European Commission.

[14] Cunningham Colleen, Florian Ederer and Song Ma (2021). "Killer Acquisitions", Journal of Political Economy, 129(3):649-702.

[15] Denicolò, Vincenzo and Michele Polo (2021). "Acquisitions, Innovation, and the Entrenchment of Monopoly", CEPR Discussion Paper #16826.

[16] Eliason, Paul J., Benjamin Heebsh, Ryan C. McDevitt and James W. Roberts (2020). "How Acquisitions Affect Firm Behavior and Performance: Evidence from the Dialysis Industry", Quarterly Journal of Economics, 135(1):221-267.

[17] European Central Bank (2019). "Survey on the access to finance of enterprises (SAFE)".

[18] Farrell, Joseph and Carl Shapiro (1990). "Horizontal Mergers: An Equilibrium Analysis", American Economic Review, 80(1):107-126.

[19] Federal Reserve Bank of New York (2017). "2016 Small Business Credit Survey".

[20] Furman, Jason, Diane Coyle, Amelia Fletcher, Philip Marsden and Derek McAuley (2019). "Unlocking digital competition. Report of the Digital Competition Expert Panel".

[21] Ganglmair, Bernhard and Emanuele Tarantino (2014). "Conversation with Secrets", RAND Journal of Economics, 45(2):273-302.

[22] Gilbert, Richard J. and Michael L. Katz (2022). "Dynamic Merger Policy and Pre-Merger Product Choice by an Entrant", International Journal of Industrial Organization, 81.

[23] Gilbert, Richard J. and David M. G. Newbery (1982). "Preemptive Patenting and the Persistence of Monopoly", American Economic Review, 72(3): 514-526.

[24] Holmström, Bengt and Jean Tirole (1997). "Financial Intermediation, Loanable Funds, and the Real Sector", Quarterly Journal of Economics, 112(3):663-691.

[25] Kamepalli, Sai Krishna, Raghuram G. Rajan and Luigi Zingales (2020). “Kill Zone”, NBER Working Paper #27146.

[26] Katz, Michael L. (2021). “Big-tech Mergers: Schumpeterian Competition, Innovation, and the Treatment of Emerging Competitors”, Information Economics and Policy, 54.

[27] Kepler, John D., Vic Naiker, and Christopher R. Steward (2023). “Stealth Acquisitions and Product Market Competition”, Journal of Finance, 78(5): 2837-2900.

[28] Kühn, Kai-Uwe (2021). “Screening For Potential “Killer Acquisitions” across Industries”, CCP Perspectives on Competition and Regulation Working Paper 21-03.

[29] Lemley, Mark A. and Andrew McCreary (2020). “Exit Strategy”. Stanford Law and Economics Olin Working Paper #542.

[30] Letina, Igor, Armin Schmutzler and Regina Seibel (2020). “Killer Acquisitions and Beyond: Policy Effects on Innovation Strategies”, CEPR Discussion Paper #15167.

[31] McAfee, Preston R. and Michael A. Williams (1992). “Horizontal Mergers and Antitrust policy”, Journal of Industrial Economics, 40(2): 181-87.

[32] Motta, Massimo and Martin Peitz (2021). “Big Tech Mergers”, Information Economics and Policy, 54.

[33] Motta, Massimo and Sandro Shelegia (2021). “The ”kill zone”: Copying, acquisition and start-ups’ direction of innovation.” CEPR Discussion Paper #16151.

[34] Nocke, Volker and Michael D. Whinston (2010). “Dynamic Merger Review”, Journal of Political Economy, 118(6):1200-51.

[35] Nocke, Volker and Michael D. Whinston (2013). “Merger Policy with Merger Choice”, American Economic Review, 103(2):1006-1033.

[36] Nocke, Volker and Michael D. Whinston (2022). “Concentration Thresholds for Horizontal Mergers”, American Economic Review, 112(6):1915-1948.

[37] Norbäck, Per-Johan and Lars Persson (2009). “The Organization of the Innovation Industry: Entrepreneurs, Venture Capitalists, and Oligopolists”, Journal of the European Economic Association, 7(6):1261-90.

[38] Norbäck, Per-Johan, Lars Persson and (2012). “Entrepreneurial Innovations, Competition and Competition Policy”, European Economic Review, 56(3):488-506.

[39] Officer, Micah S., Annette B. Poulsen and Mike Stegemoller (2009). “Target-firm Information Asymmetry and Acquirer Returns”, Review of Finance 13(3):467-493.

[40] Pellegrino, Bruno (2021). “Product Differentiation and Oligopoly: a Network Approach”, University of Maryland, Mimeo.

[41] Rasmussen, Eric (1988). “Entry for Buyout”, Journal of Industrial Economics, 36(3):281-299.

[42] Scott Morton, Fiona, Pascal Bouvier, Ariel Ezrachi, Bruno Jullien, Roberta Katz, Gene Kimmelman, A. Douglas Melamed and Jamie Morgenstern (2019). “Market Structure and Antitrust Subcommittee Report”, George J. Stigler Center for the Study of the Economy and the State, The University of Chicago Booth School of Business, Committee for the Study of Digital Platforms.

[43] Søgard, Lars (2009). “Optimal Merger Policy: Enforcement vs. Deterrence”, Journal of Industrial Economics, 57(3):438-456.

[44] The Economist (2018). American Tech Giants are Making Life Tough for Startups, 2 June 2018.

[45] The New York Times (2020). Big Tech’s Takeovers Finally Get Scrutiny, 14 February 2020.

[46] The Wall Street Journal (2019). How ‘Stealth’ Consolidation Is Undermining Competition, 19 June 2019.

[47] Tirole, Jean (2006). *The Theory of Corporate Finance*, Princeton University Press.

[48] Williamson, Oliver E. (1968). “Economies as an Antitrust Defense: The Welfare Tradeoffs”, American Economic Review, 58(1):18-36.

[49] Wollmann, Thomas G. (2019).“Stealth Consolidation: Evidence from an Amendment to the Hart-Scott-Rodino Act”, American Economic Review: Insights, 1(1): 77-94.

# A Appendix

To ease the exposition, whenever possible, in the proofs we suppress the functional notation.

## A.1 Proof of Lemma 1

Two cases must be considered.

*Case 1:* The incumbent plans to shelve (i.e. $\pi_I^A = \pi_I^m$). If the start-up is unviable, the takeover does not affect welfare, because the project cannot be developed by $S$. If instead, the start-up is viable, the takeover leads to the suppression of a project that the start-up would develop, and of competition. The takeover is authorised if (and only if) the expected harm, $H = \phi[W^d - K - W^m] > 0$ is lower than the tolerated harm, $\bar{H}$, i.e. if and only if:

$$\phi \leq \frac{\bar{H}}{W^d - K - W^m} = F_W(\pi_I^m, \bar{H}).$$

*Case 2:* The incumbent plans to develop (i.e. $\pi_I^A = \pi_I^M - K$). A takeover creates expected harm $H = (1-\phi)[W^m - (W^M - K)] + \phi[W^d - K - (W^M - K)]$: if the start-up is unviable, the takeover is now beneficial, because it allows the project to reach the market; if the start-up is viable, the takeover is detrimental because of the suppression of product market competition. The takeover is authorised if and only if:

$$\phi \leq \frac{\bar{H} + W^M - W^m - K}{W^d - K - W^m} = F_W(\pi_I^M - K, \bar{H}).$$

Note that (i) $F_W$ increases with $\bar{H}$ and (ii) is higher when the incumbent develops than when it shelves. This follows from $W^M - W^m - K > 0$.

Moreover, by Assumption A4, $F_W \geq 0$ when $\pi_I^A = \pi_I^M - K$.

## A.2 Proof of Corollary 1

(1) Since $F_W(\pi_I^M - K, \bar{H}) \geq 0$, condition (2) is always satisfied when $\phi(\Omega) = 0$. (2) Since $F_W(\pi_I^m, \bar{H}) < 0$ when $\bar{H} < 0$, condition (2) is never satisfied.

## A.3 Proof of Lemma 2

If $S = S_u$, the start-up's outside payoff when rejecting $I$'s offer is $\pi_S^{\emptyset}(S_u) = 0$; if $S = S_v$, it is $\pi_S^{\emptyset}(S_v) = \pi_S^d - K > 0$ from Assumption A1. The incumbent will then offer either a price $P_I = 0$

such that only the unviable start-up $S = S_u$ will accept, or a price $P_I = \pi_S^d - K > 0$ such that both types of start-up will accept. In the former case, observing that the offer is accepted allows the incumbent and the AA to update their beliefs and infer that the start-up is unviable: $\phi(\{0, \mathit{Accept}\ P_I\}) = 0$. In the latter case the acceptance decision of the start-up does not reveal its type, and the posteriors coincide with the priors: $\phi(\{\pi_S^d - K, \mathit{Accept}\ P_I\}) = p$. From Lemma 1, the deal is authorised if and only if $p \leq F_W$. Finally, there cannot exist an equilibrium in which both start-ups are acquired at a different positive price: the start-up receiving the lower price offer would pretend to be the type receiving the higher price offer, thus breaking the equilibrium.

If $I$ does not make any offer ($\emptyset$), its expected profit is:

$$p\pi_I^d + (1-p)\pi_I^m. \tag{A-1}$$

If $I$ offers $P_I = 0$ and the deal is authorised (i.e. if $\phi(\Omega) = 0 \leq F_W$, a condition that is always satisfied if the incumbent develops, from Corollary 1), $I$'s expected profit (gross of the transaction cost) is:

$$p\pi_I^d + (1-p)\pi_I^A. \tag{A-2}$$

If $I$ offers $P_I = \pi_S^d - K > 0$ and the deal is authorised (i.e. if $\phi(\Omega) = p \leq F_W$), its expected profit (gross of the transaction cost) is:

$$\pi_I^A - (\pi_S^d - K). \tag{A-3}$$

By comparing the expressions in (A-2) and (A-3) one obtains that offering $P_I = 0$ is more profitable for the incumbent than offering $P_I = \pi_S^d - K > 0$ if and only if $p \leq F_I$, where $F_I$ is defined in equation (3).

However, it must also be the case that making an offer is more profitable than not engaging in the takeover. If $\pi_I^A = \pi_I^m$ (i.e. the incumbent shelves) and $p \leq F_I$, the comparison between (A-1) and (A-2) and the existence of the positive transaction cost reveal that $I$'s equilibrium decision is not to engage in the takeover. The same equilibrium decision is taken when $\pi_I^A = \pi_I^m$ and $p > \max(F_W, F_I)$: $I$ would prefer to offer a high price, but the AA would not authorise the deal. Since offering a price $P_I = 0$ is dominated by making no offer, a takeover does not occur at the equilibrium. This concludes Claim 1 of the lemma.

If $p \in (F_I, \max(F_W, F_I)]$, the equilibrium offer involves a price $P_I = \pi_S^d - K > 0$, as the incumbent's preferred choice is authorised by the AA. The posteriors coincide with the priors as stated in Claim 2 of the lemma.

If $\pi_I^A = \pi_I^M - K$ (i.e. the incumbent develops) and either $p \leq F_I$ or $p > \max(F_W, F_I)$, $P_I = 0$ is offered at the equilibrium, and the incumbent and the AA update their beliefs based on whether the start-up accepts, as stated in Claim 3 of the lemma. When $p > \max(F_W, F_I)$ the incumbent would prefer to offer a price $P_I = \pi_S^d - K > 0$. However, anticipating that the AA would not authorise the transaction, the incumbent has to settle for a second-best offer featuring $P_I = 0$.

Finally, Assumption A1 implies that $\pi_I^A - \pi_I^d > 0$ and $\pi_S^d - K > 0$. Therefore $F_I > 0$. Moreover, $F_I < 1$ if (and only if) the joint payoff of $I$ and $S_v$ in the absence of a takeover is strictly lower than their joint payoff when the takeover occurs. Assumption A2 ensures that this is the case.

### A.4 Proof of Proposition 1

*Case 1:* The incumbent plans to develop (i.e. $\pi_I^A = \pi_I^M - K$).

Lemma 2 implies that two sub-cases must be considered:

1. If either $p \leq F_I$ or $p > \max(F_W, F_I)$, $I$ offers $P_I = 0$ in $t = 1(a)$ and only type $S = S_u$ accepts. Expected welfare is $E(W) = p(W^d - K) + (1-p)(W^M - K) > W^M - K$.

2. If $p \in (F_I, \max(F_W, F_I)]$, $I$ offers $P_I = \pi_S^d - K$ in $t = 1(a)$ and both $S = S_v$ and $S = S_u$ accept. Expected welfare is $E(W) = W^M - K$. This case arises if and only if $\bar{H}$ is sufficiently large so that $F_W > F_I$.

After comparing the two sub-cases, the optimal policy is the one that avoids high-price takeovers featuring $P_I = \pi_S^\emptyset(S_v) = \pi_S^d - K$ from arising at the equilibrium. This can be ensured by setting $\bar{H}$ such that $F_W \leq F_I$: in this way, for all the values of $p$ such that the incumbent finds it profitable to offer a high price, the takeover is blocked.

If $\pi_I^A = \pi_I^M - K$, $F_I = (\pi_S^d - K)/(\pi_I^M - K - \pi_I^d) \in (0,1)$ from Assumptions A1 and A2. Since $F_W$ is strictly increasing in $\bar{H}$ (from Lemma 1 (i)), $F_W = 0$ if $\bar{H} = -(W^M - W^m - K)$ and $F_W \geq 1$ for all $\bar{H} \geq W^d - W^M$, there exists a unique cut-off $H_I^d \in (-(W^M - W^m - K), W^d - W^M)$ such that $F_W \leq F_I$ for all $\bar{H} \leq H_I^d$. Hence, all $\bar{H} \leq \bar{H}_I^d$ in the set of admissible values of $\bar{H}$ are optimal. The set of admissible values of $\bar{H}$ is such that $\bar{H} \geq -(W^M - K - W^m)$ (Assumption

A5), and $F_W \geq 0$ for all $\bar{H} \geq -(W^M - W^m - K)$. This ensures that low-price takeovers are authorised under the optimal policy. Moreover, $H_I^d$ is not necessarily positive: $H_I^d < 0$ if $F_W > F_I$ at $\bar{H} = 0$.

*Case 2:* The incumbent plans to shelve (i.e. $\pi_I^A = \pi_I^m$).

Lemma 2 implies that two sub-cases must be considered:

1. If either $p \leq F_I$ or $p > \max(F_W, F_I)$, no early takeover occurs at the equilibrium. Expected welfare is $E(W) = p(W^d - K) + (1-p)W^m > W^m$.

2. If $p \in (F_I, \max(F_W, F_I)]$, $I$ offers $P_I = \pi_S^d - K$ in $t = 1(a)$ and both types $S = S_v$ and $S = S_u$ accept. Expected welfare is $E(W) = W^m$.

Comparing these two sub-cases, we conclude that the optimal policy avoids high-price takeovers featuring $P_I = \pi_S^\emptyset(S_v) = \pi_S^d - K$ from arising at the equilibrium. This can be ensured by setting $\bar{H}$ such that $F_W \leq F_I$. If $I$ shelves ($\pi_I^A = \pi_I^m$), $F_I = (\pi_S^d - K)/(\pi_I^m - \pi_I^d) \in (0,1)$ from Assumptions A1 and A2. Since $F_W$ is strictly increasing in $\bar{H}$, $F_W = 0$ if $\bar{H} = 0$ and $F_W \geq 1$ for all the values of $\bar{H} \geq W^d - W^m - K$, there exists a unique cut-off $H_I^s \in (0, W^d - W^m - K)$ such that $F_W \leq F_I$ for all the values of $\bar{H} \leq H_I^s$. Hence, all $\bar{H} \leq H_I^s$ in the set of admissible values of $\bar{H}$ are optimal.

*Optimal $\bar{H}$ (irrespective of shelving or developing).* All $\bar{H} \leq \min(\bar{H}_I^d, \bar{H}_I^s)$ in the set of admissible values are optimal irrespective of the value of $\pi_I^A$, as stated in Claim 3 of Proposition 1.

## A.5 Proof of Lemma 3

Given a price $P$, the start-up's acceptance decision depends on its belief on its ability to develop the project successfully. If the posterior probability coincides with the prior, the start-up will accept the offer if the takeover price $P \geq p\pi_S^\emptyset(S_v) + (1-p)0 = p\pi_S^\emptyset(S_v)$. If the incumbent's offer reveals that the start-up is of the viable type $S = S_v$, $S$ will accept if $P \geq \pi_S^\emptyset(S_v)$.

Consider an equilibrium in which the incumbent offers $p\pi_S^\emptyset(S_v) = p(\pi_S^d - K)$ to any start-up, independently of the type, $\phi = p$ and the start-up accepts the offer. This is an equilibrium if the AA approves the deal, which requires $\phi = p \leq F_W$. Moreover, it must be that the incumbent finds it profitable to offer $p\pi_S^\emptyset(S_v)$ not only to a viable start-up, so that $\pi_I^A - p\pi_S^\emptyset(S_v) \geq \pi_I^d$, but also to an unviable start-up: $\pi_I^A - p\pi_S^\emptyset(S_v) \geq \pi_I^m$. Otherwise, a start-up that is offered $p\pi_S^\emptyset(S_v)$ infers that it is of a viable type, and rejects the offer. The latter constraint (which is the more binding), is satisfied if (and only if) $p \leq (\pi_I^A - \pi_I^m)/(\pi_S^d - K) \equiv F_{II}$. If the incumbent shelves ($\pi_I^A = \pi_I^m$), $F_{II} = 0$. Therefore, in that case, an equilibrium in which $I$ offers the price $P = p\pi_S^{\emptyset}(S_v)$ to any S does not exist. When the incumbent develops ($\pi_I^A = \pi_I^M - K$), both conditions must be satisfied for a pooling equilibrium to exist, as stated in Lemma 3, Claim 1.

Are there profitable deviations for $I$ and $S$? Given $\phi = p$, any start-up $S \in \{S_v, S_u\}$ makes an expected profit equal to the takeover price. Hence, it cannot do better than accepting the offer. The incumbent has no incentive to offer a higher price. It has no incentive to decrease the price either: observing $P' < p\pi_S^{\emptyset}(S_v)$ the start-up would continue assigning the prior probability $p$ to being viable and would reject the offer.

Consider next an equilibrium in which the incumbent offers $P = \pi_S^{\emptyset}(S_v)$ to $S = S_v$ and does not make any offer to $S = S_u$.

For the equilibrium to exist, the AA must approve the deal. Since $P = \pi_S^{\emptyset}(S_v)$ reveals that the start-up is viable, the AA updates the prior beliefs to $\phi = 1$. Thus, for the deal to be approved, it must be that $F_W(\pi_I^A, \bar{H}) \geq 1$, which is satisfied if (and only if) $\bar{H} \geq \bar{H}_1(\pi_I^A)$, where $\bar{H}_1 = W^d - W^M$ when $\pi_I^A = \pi_I^M - K$, and $\bar{H}_1 = W^d - W^m - K$ when $\pi_I^A = \pi_I^m$. Note that the incumbent has no incentive to deviate and offer $P' \in (\pi_I^A - \pi_I^m, \pi_S^{\emptyset}(S_v))$ to $S_v$, where $\pi_I^A - \pi_I^m$ is the highest price that the incumbent is willing to offer to an unviable start-up. The start-up that receives the takeover offer would infer that it is viable, and would reject $P'$. Consider now a deviation to a price $P' \in [0, \pi_I^A - \pi_I^m]$. The start-up that receives the offer would not update its belief, because the incumbent has an incentive to make such an offer both to the viable and the unviable start-up. The deviation is unprofitable if the start-up rejects the offer because $P' < p\pi_S^{\emptyset}(S_v)$. This is the case if $p > F_{II}$ If the incumbent shelves ($\pi_I^A = \pi_I^m$), $F_{II} = 0$. Hence, this condition is always satisfied.

For a similar reasoning an equilibrium where the incumbent offers $P = \pi_S^{\emptyset}(S_v)$ to $S = S_v$ and offers 0 to $S = S_u$, with both $S_v$ and $S_u$ accepting the offer, cannot exist. Since the incumbent would find it profitable to offer a price equal to 0 irrespective of the type, the start-up receiving 0 should not update its prior and would reject the offer.

In all the other cases, no takeover occurs at the equilibrium, as stated in Lemma 3, Claim 3.

## A.6 Proof of Proposition 3

Expected welfare when a high-price takeover occurs at the equilibrium is $p(W^M - K) + (1-p)W^m$ if $I$ develops, and $W^m$ if $I$ shelves. If no takeover occurs, expected welfare is $p(W^d - K) + (1 -$

$p)W^m$. Finally, when a low-price takeover occurs at equilibrium (which is the case only when $I$ develops), expected welfare is $W^M - K$. Since $W^d > W^M > W^m$, expected welfare is the lowest when a high-price takeover occurs at equilibrium. Hence, a merger policy $\bar{H} \geq \bar{H}_1(\pi_I^A)$ cannot be optimal.

Let us focus on $\bar{H} \in [-(W^M - K - W^m), \bar{H}_1(\pi_I^A))$. When the incumbent shelves, any $\bar{H}$ in this set is optimal because no takeover occurs irrespective of the standard of review (recall that, in the case of shelving, $F_{II} = 0$). The conclusion is the same when the incumbent develops and $p \geq F_{II}$. Let us consider, now, the case in which $I$ develops and $p \in (0, F_{II}]$. Depending on the standard of review, either a low-price takeover occurs at the equilibrium, or no takeover. Expected welfare is higher under a low-price takeover if and only if $p \leq (W^M - K - W^m)/(W^d - K - W^m) \equiv \bar{p} = F_W(\pi_I^M - K, \bar{H} = 0)$.

To identify the optimal choice of the standard of review $\bar{H} \in [-(W^M - K - W^m), \bar{H}_1(\pi_I^A))$, two cases must be distinguished:

1. $\bar{p} \leq F_{II}$. Expected welfare is maximised if low-price takeovers are authorised whenever $p \in (0, \bar{p}]$ and blocked when $p \in (\bar{p}, F_{II}]$. $\bar{H} = 0$ ensures that this is the case. The optimal merger policy is unique.

2. $\bar{p} > F_{II}$. Expected welfare is maximised if low-price takeovers are authorised for any $p \in (0, F_{II}]$. Any $\bar{H} \geq \hat{H}$ ensures that and is optimal, where $\hat{H} < 0$ is the standard of review such that $F_W = F_{II}$. From $F_{II} \in [0, 1)$, $F_W$ strictly increasing in $\bar{H}$ (from Lemma 1, Claim (i)), $F_W = 0 \leq F_{II}$ if $\bar{H} = -(W^M - W^m - K)$ and $F_W > F_{II}$ if $\bar{H} = 0$, one can show that $\hat{H}$ exists and is unique.

Combining the optimal merger policies in all the cases considered above, one can conclude that setting $\bar{H} = 0$ is optimal for any $p$, and any $\pi_I^A$.

Note that, when $\bar{p} > F_{II}$ and $p \in [F_{II}, \bar{p}]$, no takeover occurs at the equilibrium. Expected welfare would be higher under a low-price takeover, but the parties do not have any private incentive to engage in a low-price takeover. Hence, the merger policy is powerless.

## A.7 Proof of Lemma 4

Consider first the start-up's decision. A start-up would never reject a price offer featuring $\tilde{P}_H \geq \pi_S^{\emptyset}(S_v)$. Under our mixed-strategy equilibrium, a start-up that receives an offer $\tilde{P}_L < \pi_S^{\emptyset}(S_v)$, instead, must be indifferent between accepting and rejecting it. In other words, it must hold that:

$$\tilde{P}_L = \phi(\tilde{P}_L)(\pi_S^d - k). \tag{A-4}$$

We now compute by Bayes' rule the probability that the start-up assigns to being valuable given that it receives an offer $\tilde{P}_L$:

$$\phi(\tilde{P}_L) = \frac{\gamma^L(S_v)p}{\gamma^L(S_v)p + \gamma^L(S_u)(1-p)}. \tag{A-5}$$

After plugging the last expression into equation (A-4), we obtain:

$$\gamma^L(S_v) = \frac{\gamma^L(S_u)\tilde{P}_L(1-p)}{p(\pi_S^d - K - \tilde{P}_L)}. \tag{A-6}$$

Let us now turn to the incumbent. It will (weakly) prefer to offer $\tilde{P}_L$ to an unviable start-up rather than not making it an offer if the following holds:

$$\beta^L(\pi_I^A - \tilde{P}_L) + (1-\beta^L)\pi_I^m \geq \pi_I^m. \tag{A-7}$$

This inequality can be simplified to get:

$$\beta^L(\pi_I^A - \tilde{P}_L - \pi_I^m) \geq 0. \tag{A-8}$$

If $\pi_I^A = \pi_I^m$, the above condition can be satisfied only if either $\beta_L = 0$ or $\tilde{P}_L = 0$ (which, implies $\gamma^L(S_v) = 0$). Hence, when the incumbent shelves, a mixed strategy equilibrium does not exist.

Let us focus on the case in which the incumbent develops. The above conditions is satisfied for any $\beta^L > 0$ and $\tilde{P}_L \leq \pi_I^M - K - \pi_I^m$.

In the candidate equilibrium we consider, $I$ offers $\tilde{P}_H \equiv \pi_S^{\emptyset}(S_v) = \pi_S^d - K$. For the incumbent to be indifferent between offering $\tilde{P}_L$ and $\tilde{P}_H$ to $S_v$, it must hold that:

$$\beta^L(\pi_I^M - K - \tilde{P}_L) + (1-\beta^L)\pi_I^d = \pi_I^M - \pi_S^d, \tag{A-9}$$

from which we obtain

$$\beta^L = \frac{\pi_I^M - \pi_S^d - \pi_I^d}{\pi_I^M - K - \pi_I^d - \tilde{P}_L}. \tag{A-10}$$

That $\beta^L \in (0,1)$ follows from $\pi_I^M > \pi_S^d + \pi_I^d$ (Assumption A2) and $\tilde{P}_L < \pi_S^d - K$.

We now determine the equilibrium values of $\tilde{P}_L$ and $\tilde{P}_H$. Recall that we assume that $S$, when receiving an out-of-equilibrium offer, updates the probability assigned to being viable by using Bayes' rule (whenever possible). If the offer does not convey information on the type, the start-up maintains the prior belief.

Clearly, the incumbent has no incentive to increase $\tilde{P}_H$ above $\pi_S^{\emptyset}(S_v)$. Assume instead that it offers $P' < \tilde{P}_H = \pi_S^{\emptyset}(S_v)$. If $P' > \pi_I^M - K - \pi_I^m$, the start-up infers that it is viable, because $I$ has no incentive to offer that price to an unviable start-up. However, since $P' < \pi_S^d - K$, the viable type rejects the offer and the deviation is not profitable. If $P' \leq \pi_I^M - K - \pi_I^m$, no additional information is conveyed by the price offer and the start-up assigns probability $p$ to being viable. Hence, if it also holds that $P' \geq p(\pi_S^d - K)$, the start-up accepts the offer and the deviation is profitable. It follows that offering $\tilde{P}_H = \pi_S^d - K$ is an equilibrium if (and only if) $\pi_I^M - K - \pi_I^m < p(\pi_S^d - K)$, i.e. $p > F_{II}$. There cannot exist an equilibrium in mixed strategies if $p \leq F_{II}$.

Consider now the case in which the incumbent deviates from $\tilde{P}_L$ to offer some $P' \in (\tilde{P}_L, \tilde{P}_H)$. Upon receiving a price offer featuring $P' \in (\pi_I^M - K - \pi_I^m, \tilde{P}_H)$, the start-up infers to be viable and rejects the offer. The deviation is not profitable. If $P' \in (\tilde{P}_L, \pi_I^M - K - \pi_I^m]$, the start-up assigns probability $p$ to being viable. Since $P' \leq \pi_I^M - K - \pi_I^m < p(\pi_S^d - K)$ for all $p > F_{II}$, the start-up rejects the offer and the deviation is not profitable. The reasoning is similar if $P' < \tilde{P}_L$. Hence, there is a continuum of values of $\tilde{P}_L$ that can be sustained at equilibrium: $\tilde{P}_L \in (0, \pi_I^M - K - \pi_I^m]$.

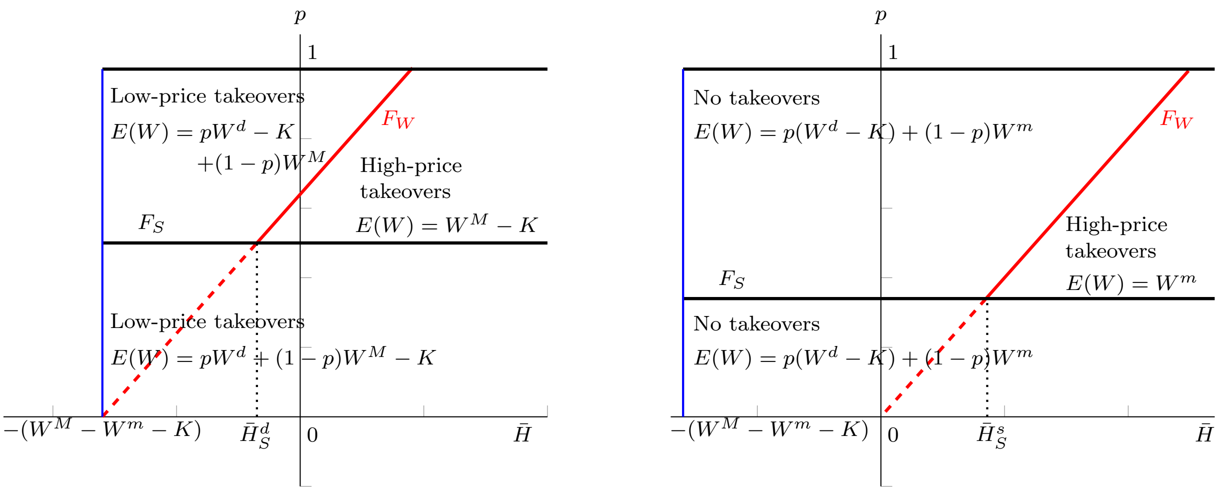
We now conclude the proof by noting that, since $\tilde{P}_L \in (0, \pi_I^M - K - \pi_I^m]$, with $\pi_I^M - K - \pi_I^m < p(\pi_S^d - K)$ for all $p > F_{II}$, the following holds: $\gamma^L(S_v) \in (0,1)$, $\gamma^L(S_u) = 1$ (condition (A-8) is always satisfied) and $\phi(\tilde{P}_H) = 1$ (only a viable start-up can receive an offer featuring $\tilde{P}_H$). Moreover, $\gamma^L(S_v) < 1$ implies that $\phi(\tilde{P}_L) < p$: when the start-up observes that it is offered a price $\tilde{P}_L$, it assigns a probability lower than the prior to being viable. Finally, the lower $\tilde{P}_L$, the lower $\gamma^L(S_v)$, the lower $\phi(\tilde{P}_L)$ and the lower $\beta^L$. Finally, $\phi(\tilde{P}_H) = 1$ implies that a hybrid PBE exists if and only if $\phi(\tilde{P}_H) = 1 \leq F_W$, or $\bar{H} \geq W^d - W^M = \bar{H}_1(\pi_I^M - K)$.

# Appendix:

# Figures and Tables

## B Additional Figures and Tables

Figure B.1: Equilibrium takeovers when $S$ makes take-it-or-leave-it offers, and associated welfare expected at $t = 0$.




(a) The incumbent develops

(b) The incumbent shelves

*Notes:* On the axes, $\bar{H}$ is the merger standard of review (level of tolerated harm); $p$ is the a priori probability that the start-up is viable. $F_S$ and $F_W$ represent the cut-off values of the prior probability that govern the decision regarding the takeover price and, respectively, the approval decision of the AA. The left panel refers to the case in which the incumbent develops: $\bar{H}_S^d$ is the value of $\bar{H}$ such that $F_W$ and $F_S$ cross in this case, and may be negative as displayed in this figure. The right panel refers to the case in which the incumbent shelves: $\bar{H}_S^s$ is the value of $\bar{H}$ such that $F_W$ and $F_I$ cross with shelving. The cut-off $\bar{H}_S^s$ is necessarily positive.

Table B.1: Descriptive statistics of the acquisitions in the group of comparables and GAFAM

| **Comparator (Tech)** | Count | Mean | p25 | p50 | p75 | SD |
|---|---|---|---|---|---|---|
| Log Deal Price | 2,331 | 4.59 | 3.09 | 4.57 | 5.99 | 2.15 |
| Log Target Revenue | 1,190 | 4.51 | 2.99 | 4.37 | 5.98 | 2.39 |
| Log Target Employees | 842 | 6.00 | 4.44 | 5.65 | 7.24 | 2.21 |
| Log Target Market Value | 498 | 6.27 | 4.83 | 6.27 | 7.77 | 2.20 |
| Number of Acquisitions | 6,025 | | | | | |
| **GAFAM** | Count | Mean | p25 | p50 | p75 | SD |
| Log Deal Price | 105 | 5.63 | 4.11 | 5.52 | 7.19 | 2.29 |
| Log Target Revenue | 82 | 4.68 | 2.30 | 4.94 | 6.90 | 2.96 |
| Log Target Employees | 77 | 5.51 | 3.53 | 4.95 | 7.77 | 2.59 |
| Log Target Market Value | 40 | 8.25 | 6.65 | 8.36 | 9.76 | 2.32 |
| Number of Acquisitions | 730 | | | | | |

*Notes:* Target Deal Price (million USD) is the total value of the acquisition paid by the acquirer. Target Revenue (million USD) reports the sales of the acquirer over the past 12 months before the acquisition. Target Employees is the count of the employees of the target company at the time of the acquisition. Target Market Value (million USD) is calculated by multiplying the total number of target outstanding shares by the closing stock price 4 weeks before the announcement of the acquisition.

# Online Appendix:

# Additional Proofs

## C The start-up has superior information and bargaining power

In this appendix, we solve the case in which the start-up holds superior information, and makes the offer. We will first show that, in this case, the bargaining game admits pure- and mixed-strategy equilibria. As stated in Proposition 2, we will also prove that, regardless of which equilibrium is selected, the optimal policy is the same as in Proposition 1.

For the discussion of the results in this appendix, see Section 2.4.1.

### C.1 Pure-strategy equilibrium of the bargaining game

The pure-strategy equilibrium of the takeover game is as follows:

**LEMMA C-1** (Pure-strategy PBE of the bargaining game when $S$ makes the offer)**.**
*Let:*

$$F_S(\pi_I^A) \equiv \frac{\pi_S^d - K + \pi_I^m - \pi_I^A}{\pi_I^m - \pi_I^d} \in (0,1). \tag{C-1}$$

*When $S \in \{S_v, S_u\}$ makes a take-it-or-leave-it offer:*

1. *If $\pi_I^A = \pi_I^m$ and either $p \leq F_S$ or $p > \max(F_W, F_S)$, no takeover occurs at the equilibrium.*
2. *For any $\pi_I^A$, if $p \in (F_S, \max(F_S, F_W)]$, the PBE is: $\{s^*_{S_u} = s^*_{S_v} = \bar{P}, r^*_I = \text{Accept } \bar{P}; \phi(\{\bar{P}, \text{Accept } \bar{P}\}) = p\}$, with $\bar{P} = \pi_I^A - \pi_I^m + p(\pi_I^m - \pi_I^d)$.*
3. *If $\pi_I^A = \pi_I^M - K$ and either $p \leq F_S$ or $p > \max(F_W, F_S)$ the PBE is: $\{s^*_{S_v} = \emptyset, s^*_{S_u} = P_L, r^*_I = \text{Accept } P_L; \phi(\{P_L, \text{Accept } P_L\}) = 0\}$, with $P_L = \pi_I^M - K - \pi_I^m > 0$.*

*Proof.* Consider a candidate equilibrium in which the start-up, irrespective of whether it is viable or not, offers price $P_{S_u} = P_{S_v} = P$. For this to be an equilibrium, price $P$ must satisfy the start-ups' participation constraints:

$$P > \pi_S^{\emptyset}(S_u) = 0 \tag{C-2}$$
$$P > \pi_S^{\emptyset}(S_v) = \pi_S^d - K, \tag{C-3}$$

where the strict inequality is used because of the small but positive transaction cost.

The price $P$ must also satisfy the incumbent's participation constraint:

$$\pi_I^A - P \geq p\pi_I^d + (1-p)\pi_I^m, \tag{C-4}$$

where the incumbent's posterior beliefs on the viability of the start-up coincide with the priors. Since the constraint (C-3) is more binding than the constraint (C-2), $P$ must satisfy:

$$\pi_S^{\emptyset}(S_v) < P \leq \pi_I^A - \pi_I^m + p(\pi_I^m - \pi_I^d) \equiv \bar{P}.$$

Since $\pi_I^m - \pi_I^d > 0$, a necessary condition for the existence of an equilibrium featuring $P = \bar{P}$ is:

$$p > F_S, \tag{C-5}$$

where $F_S$ is defined in equation (C-1).

Finally, if the offer $P = \bar{P}$ is accepted the AA does not revise its priors and it authorises the deal if (and only if) $p \leq F_W$. Combining the above conditions one obtains Claim 2 of the lemma. An equilibrium with $\tilde{P} \in (\pi_S^{\emptyset}(S_v), \bar{P})$ does not exist because $S \in \{S_u, S_v\}$ would have an incentive to deviate and increase the price: following an out-of-equilibrium offer $P' \in (\tilde{P}, \bar{P}]$, $I$ and AA would attach the prior probability to the start-up being viable. Since $p \leq F_W$ the AA would authorise the deal; since $P' \leq \bar{P}$, $I$ would accept. The deviation would be profitable. Hence, $P = \bar{P}$ is the unique equilibrium price such that $P_{S_u} = P_{S_v}$.

Consider now a candidate equilibrium in which $S = S_u$ offers $P_{S_u} = \pi_I^A - \pi_I^m$, $S = S_v$ does not make any offer ($\emptyset$), and the incumbent accepts $P_{S_u}$. From Assumptions A1 and A3, $\pi_I^A - \pi_I^m < \pi_S^d - K = \pi_S^{\emptyset}(S_v)$. Therefore, observing such an offer both $I$ and the AA infer that the start-up is unviable (i.e. $\phi(\Omega) = 0$). Then, $I$ is indifferent between accepting and rejecting $P_{S_u}$. For this to be an equilibrium, $S$ must have no incentive to deviate. To start with, $S = S_u$ must find it unprofitable not to make an offer, which, because of the transaction cost, requires that

$$P_{S_u} > \pi_S^{\emptyset}(S_u) = 0. \tag{C-6}$$

Let us focus on the case in which $I$ develops and $P_{S_u} = P_L \equiv \pi_I^M - K - \pi_I^m > 0$. Since $\pi_S^{\emptyset}(S_v) > P_L$, then $S = S_v$ has no incentive to deviate and offer $P_L$. Clearly, $S = S_u$ has no incentive to decrease its offer. Has it an incentive to offer $P' > P_L$? As long as $P' \leq \pi_S^{\emptyset}(S_v)$, the incumbent infers that the start-up is unviable and rejects the deviation offer. The deviation is unprofitable. If, instead, $P' > \pi_S^{\emptyset}(S_v)$, the incumbent attributes the offer to a viable start-up with probability $p$. The deviation is unprofitable either if $I$ would reject the offer, i.e. if $\pi_S^{\emptyset}(S_v) \geq \bar{P}$ which is satisfied if $p \leq F_S$; or if $I$ would accept the deviation offer but the AA would not authorise the deal, i.e. if $p > \max(F_S, F_W)$. For the same reason, it is not profitable for $S = S_v$ to offer $P' \geq \pi_S^{\emptyset}(S_v)$. In sum, when $I$ develops and either $p \leq F_S$ or $p > \max(F_S, F_W)$ the proposed one is an equilibrium, as stated in Claim 3 of the lemma. Note that there cannot exist an equilibrium in which $S = S_u$ offers $P_L < \pi_I^M - K - \pi_I^m$: $S = S_u$ would have an incentive to deviate and offer $P' = \pi_I^M - K - \pi_I^m$, since $I$ would accept the offer and the AA would authorise the deal.

Finally, there cannot exist an equilibrium in which $S = S_v$ offers $P_{S_v} = \tilde{P} > \pi_S^{\emptyset}(S_v)$, $S = S_u$ offers $P \neq \tilde{P}$, the incumbent accepts the former and rejects the latter. If the AA authorises the deal, $S = S_u$ would always have an incentive to mimic $S_v$ and offer $\tilde{P}$ instead. For a similar reason, there cannot exist an equilibrium in which $S = S_u$ offers $P_{S_u} = P_L$, $S = S_v$ offers $P_{S_v} \in (\pi_S^{\emptyset}(S_v), \pi_I^M - K - \pi_I^d]$ and $I$ accepts both offers.

Let us consider now the case in which $I$ shelves. Since $\pi_I^A = \pi_I^m$, then $P_{S_u} = 0$. Hence, condition (C-6) cannot be satisfied and the proposed one is not an equilibrium. Other equilibria in which each start-up is traded at a different price do not exist, for the same reasoning developed above. Therefore, if $\pi_I^A = \pi_I^m$ and either $p \leq F_S$ or $p > \max(F_W, F_S)$, there is no early takeover in equilibrium, as stated in Claim 1 of the lemma.

To conclude, $\pi_I^m > \pi_I^d$, $\pi_S^{\emptyset}(S_v) = \pi_S^d - K > 0$ and Assumption A3 imply $F_S > 0$. Moreover, $F_S < 1$ if (and only if) the joint payoff of $I$ and $S_v$ in the absence of a takeover is strictly lower than their joint payoff when a takeover occurs, which holds true by Assumption A2. Q.E.D.

## C.2 Mixed-strategy equilibria of the bargaining game

We now solve the mixed-strategy equilibria of the bargaining game. First, we introduce notation that will be useful to describe the equilibria.

**DEFINITION C-1** (Perfect Bayesian equilibrium in mixed strategies).
*Let $\gamma_k^H = \Pr(P_{S_k} = P_H|S_k)$ and $1-\gamma_k^H = \Pr(P_{S_k} = P_L|S_k)$ be the probability that $S_k$ assigns to actions $P_S = P_H$ and $P_S = P_L$, respectively, with $k \in \{v, u\}$ and $P_H, P_L \in \mathbb{R}$. Then, $(\gamma_v^H, \gamma_u^H)$ is the mixed-strategy profile of agent $S$. Let $\beta^H = \Pr(Accept\ P_H)$ and $\beta^L = \Pr(Accept\ P_L)$ be the probability that $I$ assigns to action* Accept $P_S$ *when $S$ plays $P_S = P_H$ and $P_S = P_L$, respectively. Then, $(\beta^H, \beta^L)$ is the mixed-strategy profile of agent $I$. A perfect Bayesian equilibrium in mixed strategies is denoted by $\{\gamma_u^H, \gamma_v^H, \beta^H, \beta^L; \phi(P_H), \phi(P_L)\}$.*

Lemma C-2 describes the equilibria in mixed strategies and specifies the conditions for their existence.

**LEMMA C-2** (Hybrid PBE of the bargaining game when $S$ makes the offer).
*If $\pi_I^A = \pi_I^M - K$ and $p \le F_S$, there exist hybrid PBE featuring:*

- *$P_L = \pi_I^M - K - \pi_I^m$ and $P_H \in (\pi_S^d - K, \hat{P}_H(\bar{H})]$, with $P_H > \pi_S^{\emptyset}(S_v) > P_L > 0$, and $\hat{P}_H(\bar{H}) < \pi_I^M - K - \pi_I^d$ increasing in $\bar{H}$;*
- *$\phi(P_H) \le F_W$ for all $P_H \in (\pi_S^d - K, \hat{P}_H(\bar{H})]$;*
- *$S_u$ offering $P_H$ with probability:*

$$\gamma_u^H = \frac{p}{(1-p)} \frac{(\pi_I^M - K - \pi_I^d - P_H)}{(P_H - \pi_I^M + K + \pi_I^m)} \in (0,1)$$

  *(strictly) decreasing in $P_H$;*
- *$S_v$ offering $P_H$ with probability $\gamma_v^H = 1$;*
- *$I$ accepting $P_H$ with probability $\beta^H = P_L/P_H \in (0, \beta^L)$, (strictly) decreasing in $P_H$, and accepting $P_L$ with probability $\beta^L = 1$;*
- *posterior beliefs:*

$$\phi(P_H) = \frac{p}{\gamma_u^H(1-p)+p} = \frac{P_H - \pi_I^M + K + \pi_I^m}{\pi_I^m - \pi_I^d} \in (0,1) \text{ and } \phi(P_L) = 0,$$

  *with $\phi(P_H) > p$, and $\phi(P_H)$ (strictly) increasing in $P_H$.*

*Proof.* We construct the equilibrium through a sequence of intermediate results.

**Lemma C-2.1.**
*In any mixed-strategy PBE, the probability $\gamma_u^H$ is given by:*

$$\gamma_u^H = \frac{\gamma_v^H p}{(1-p)} \frac{(\pi_I^A - \pi_I^d - P_H)}{(P_H - \pi_I^A + \pi_I^m)}. \tag{C-7}$$

*Proof.* First, we compute $\phi(P_H)$ by Bayes' rule:

$$\phi(P_H) = \frac{\gamma_v^H p}{\gamma_u^H(1-p) + \gamma_v^H p}.$$

$I$ is indifferent between accepting and rejecting a price offer featuring $P_H$ if and only if:

$$\pi_I^A - P_H = \phi(P_H)\pi_I^d + (1 - \phi(P_H))\pi_I^m.$$

Plugging the formula for $\phi(P_H)$, and simplifying, we obtain the expression for $\gamma_u^H$ in equation (C-7). Since $\pi_I^m > \pi_I^d$, $\gamma_u^H > 0$ if (and only if) $\pi_I^A - \pi_I^m < P_H < \pi_I^A - \pi_I^d$. Q.E.D.

We next define $\beta^H$.

**Lemma C-2.2.**
*In any mixed-strategy PBE, the probability $\beta^H$ is given by $\beta^H = \frac{P_L \beta^L}{P_H}$.*

*Proof.* $S_u$'s indifference between a price offer featuring $P_{S_u} = P_H$ and one featuring $P_{S_u} = P_L$ requires that:

$$\beta^H P_H = P_L \beta^L \iff \beta^H = \frac{P_L \beta^L}{P_H}.$$

with $\beta^H > 0$ if (and only if) $P_L > 0$ and $\beta_L > 0$. Q.E.D.

In the next lemma, we prove several results. First, that a necessary condition for the existence of a mixed-strategy equilibrium is that $I$ does not shelve the project of the start-up; second, that such mixed-strategy equilibrium is a hybrid equilibrium featuring $S_v$ offering $P_H$ with certainty and $I$ accepting $P_L$ with probability $\beta^L > \beta^H$. Finally, when $P_H$ is observed, the posterior probability assigned to the start-up being viable must be (weakly) higher than the a priori probability. Moreover the posterior probability is strictly increasing in $P_H$.

**Lemma C-2.3.**
*In any mixed-strategy PBE:*

1. *$S_v$ offers $P_H$ with certainty (i.e., $\gamma_v^H = 1$) for all $P_H > P_L > 0$ and $P_H > \pi_S^d - K$.*
2. *If $\pi_I^A = \pi_I^m$, there does not exist a mixed-strategy PBE in which $I$ acquires $S$. Moreover, $\phi(P_L) = 0$*
3. *If $\pi_I^A = \pi_I^M - K$, $I$ accepts any offer featuring a price $P_L \leq \pi_I^A - \pi_I^m$ with probability $\beta^L > \beta^H$.*
4. *When $P_H$ is observed, it cannot be that $\phi(P_H) < p$.*
5. *$\phi(P_H)$ is strictly increasing in $P_H$ and $\phi(P_H) < 1$ for any $\pi_S^d - K < P_H < \pi_I^A - \pi_I^d$.*

*Proof.* We start from Claim 1 $S_v$ prefers offering $P_{S_v} = P_H$ to offering a price at which there is no acquisition if (and only if):

$$P_H \beta^H + (1-\beta^H)(\pi_S^d - K) > \pi_S^d - K \iff P_H > \pi_S^d - K.$$

Moreover, $S_v$ prefers offering $P_H$ to $P_L$ if (and only if):

$$\begin{aligned} P_H \beta^H + (1-\beta^H)(\pi_S^d - K) &> P_L \beta^L + (1-\beta^L)(\pi_S^d - K) \\ \iff \beta^H &> \frac{\beta^L(P_L - \pi_S^d + K)}{P_H - \pi_S^d + K}, \end{aligned}$$

which is always satisfied if $P_H > P_L$ and $P_H > \pi_S^d - K$. Hence, $\gamma_v^H = 1$ for all $P_H > P_L > 0$ and $P_H > \pi_S^d - K$.

Let us turn to Claim 2. From $\gamma_v^H = 1$ it follows that $\phi(P_L) = 0$. Then, for $I$ not to reject $P_L$ with certainty it must be:

$$\pi_I^A - P_L \geq \pi_I^m \iff P_L \leq \pi_I^A - \pi_I^m. \tag{C-8}$$

If $\pi_I^A = \pi_I^m$, $\pi_I^A - \pi_I^m = 0$. Since it must be that $P_L > 0$, a mixed-strategy equilibrium in which a takeover takes place does not exist when $I$ shelves (Claim 2). If $\pi_I^A = \pi_I^M - K$, instead, $\pi_I^A - \pi_I^m > 0$ is the upper bound of $P_L$ such that $I$ will be willing to accept, with $\pi_I^A - \pi_I^m < \pi_S^d - K$. From this it follows that $P_H > P_L$ and $\beta^H < \beta^L$ (Claim 3).

From Claim 1 (i.e. $\gamma_v^H = 1$), it follows that:

$$\phi(P_H) = \frac{p}{\gamma_u^H(1-p) + p}. \tag{C-9}$$

Since $\gamma_u^H(1-p) + p \leq 1$, then $\phi(P_H) \geq p$ (claim 4).

From Claim 1, it also follows that:

$$\gamma_u^H = \frac{p}{(1-p)} \frac{(\pi_I^A - \pi_I^d - P_H)}{(P_H - \pi_I^A + \pi_I^m)}, \tag{C-10}$$

which is strictly decreasing in $P_H$ when $\pi_S^d - K < P_H < \pi_I^A - \pi_I^d$, where $\pi_S^d - K > \pi_I^A - \pi_I^m$. Hence, $\phi(P_H)$ is strictly increasing in $P_H$ (Claim 5).

Since $\gamma_u^H > 0$ for any $\pi_S^d - K < P_H < \pi_I^A - \pi_I^d$, $\phi(P_H) < 1$ for any $\pi_S^d - K < P_H < \pi_I^A - \pi_I^d$. This concludes claim 5. Q.E.D.

Finally, we determine the values of $P_H$ and $P_L$ that can be sustained as part of the hybrid PBE.

**Lemma C-2.4.**
*Let $\pi_I^A = \pi_I^M - K$:*

1. *If $p \leq F_S$, there exists a continuum of hybrid PBE featuring: $P_L = \pi_I^M - K - \pi_I^m$ and $P_H \in (\pi_S^d - K, \hat{P}_H(\bar{H})]$, with $P_H > \pi_S^{\emptyset}(S_v) > P_L > 0$, $\phi(P_H) \leq F_W$ and $\hat{P}_H(\bar{H}) < \pi_I^M - K - \pi_I^d$ increasing in $\bar{H}$;*

2. $\gamma_u^H \in (0,1)$, $\beta^L \in (0,1]$ *and* $\beta^H \in (0, \beta^L)$.

*Proof.* Throughout the proof, we set $\pi_I^A = \pi_I^M - K$ (the incumbent develops).

We start with Claim 1. A mixed-strategy PBE exists if the high-price offer is approved by the AA, which occurs if and only if $\phi(P_H) \leq F_W$.

Consider an offer $P_L \in (0, \pi_I^M - K - \pi_I^m)$. Such an offer cannot be sustained in equilibrium because $S_u$ would have an incentive to deviate and offer $P' \in (P_L, \pi_I^M - K - \pi_I^m)$. Since $P' < \pi_I^M - K - \pi_I^m < \pi_S^d - K$, $I$ would attribute the deviation offer to $S_u$ with certainty and would accept. The AA would authorise the deal (see Corollary 1, Claim 1). The deviation would be profitable.

Consider now $P_L = \pi_I^M - K - \pi_I^m$. $S_u$ has no incentive to deviate and offer $P' \in (P_L, \pi_S^d - K]$: $I$ would attribute the deviation offer to $S_u$ with certainty and would reject. $S_u$ has no incentive to deviate and offer $P' > \max(\bar{P}, \pi_S^d - K)$ (with $P' \neq P_H$ and $\bar{P}$ defined in Lemma C-1): $I$ would attribute the deviation offer to $S_v$ with probability $p$ and would reject. Consider now $P' \in (\pi_S^d - K, \bar{P}]$, a possibility that arises if (and only if) $p > F_S$. $I$ would attribute the deviation offer to $S_v$ with probability $p$ and would accept. From Lemma C-2.3 (part 4), $p \leq \phi(P_H)$. Hence, from $\phi(P_H) \leq F_W$ it follows that $p \leq F_W$: the deal would be authorised by the AA and the deviation would be profitable. Thus, offering $P_L = \pi_I^M - K - \pi_I^m$ is part of the equilibrium if and only if $p \leq F_S$.

Consider then an offer $P_H \in (\pi_S^d - K, \pi_I^M - K - \pi_I^d)$. For it to be sustained at the equilibrium $S$ must not have an incentive to deviate and offer $P' > P_H$. Since $P' > \pi_S^d - K$, $I$ attributes the deviation offer to $S_v$ with probability $p$. Moreover, from $p \leq F_S$ it follows that $\pi_S^d - K \geq \bar{P}$. Therefore $P' > \bar{P}$ and $I$ would reject the deviation offer. We then determine which prices $P_H$, within the interval $(\pi_S^d - K, \pi_I^M - K - \pi_I^d)$, are such that the AA approves the deal because $\phi(P_H) \leq F_W$.

From Lemma 1, when $\pi_I^A = \pi_I^M - K$, $F_W = (\bar{H} + W^M - W^m - K)/(W^d - K - W^m)$. Moreover, substituting the expression for $\gamma_u^H$ (equation (C-10)) into the expression for $\phi(P_H)$ (equation (C-9)), one obtains:

$$\phi(P_H) = \frac{P_H - \pi_I^M + K + \pi_I^m}{\pi_I^m - \pi_I^d}, \tag{C-11}$$

with $\phi(P_H) < 1$ for any $P_H < \pi_I^M - K - \pi_I^d$.

Therefore, we can distinguish the following cases:

1. $\bar{H} \geq W^d - W^M$. In this case $F_W \geq 1$. Therefore, $\phi(P_H) < 1 \leq F_W$ for any $P_H < \pi_I^M - K - \pi_I^d$. This means that, when the standard of review regarding early takeovers is sufficiently lenient, any $P_H \in (\pi_S^d - K, \pi_I^M - K - \pi_I^d)$ can be supported at the PBE in mixed strategies.

2. $\bar{H} < W^d - W^M$. In this case $F_W < 1$. Moreover, $F_W \geq 0$ for any feasible value of $\bar{H}$, i.e. for any $\bar{H} \geq -(W^M - K - W^m)$. Since $\phi(P_H) = 1$ if $P_H = \pi_I^M - K - \pi_I^d$, $\phi(P_H) = 0$ if $P_H = \pi_I^M - K - \pi_I^m$, and $\phi(P_H)$ is strictly increasing in $P_H$, for any $\bar{H} \in [-(W^M - K - W^m), W^d - W^M)$ there exists a $\hat{P}_H(\bar{H}) \in [\pi_I^M - K - \pi_I^m, \pi_I^M - K - \pi_I^d)$ such that $\phi(P_H) \leq F_W$ for any $P_H \leq \hat{P}_H(\bar{H})$. Moreover, since $F_W$ is strictly increasing

in $\bar{H}$, also $\hat{P}_H(\bar{H})$ is strictly increasing in $\bar{H}$. If $\bar{H} = -(W^M - K - W^m)$, $F_W = 0$ and $\hat{P}_H(\bar{H}) = \pi_I^M - K - \pi_I^m < \pi_S^d - K$ (from Assumption A3). Since $\pi_S^d - K < \pi_I^M - K - \pi_I^d$ and $\hat{P}_H(\bar{H})$ is strictly increasing in $\bar{H}$, there exists a cut-off level of $\bar{H}$, $\bar{H}^m \in (-(W^M - K - W^m), W^d - W^M)$ such that $\hat{P}_H(\bar{H}) \leq \pi_S^d - K$ for any $\bar{H} \leq \bar{H}^m$. Therefore:

(a) No $P_H \in (\pi_S^d - K, \pi_I^M - K - \pi_I^d)$ can be supported at the PBE in mixed strategies when $\bar{H} \leq \bar{H}^m$, i.e. when the standard of review regarding early takeovers is sufficiently strict.

(b) Any $P_H \in (\pi_S^d - K, \hat{P}_H(\bar{H})]$ can be supported at the PBE in mixed strategies when $\bar{H} \in (\bar{H}^m, W^d - W^M)$.

We conclude with Claim 2. Given $\gamma_v^H = 1$ and $P_H > \pi_S^d - K > \bar{P}$, $\gamma_u^H < 1$. Therefore $\phi(P_H) > p$. Moreover, $0 < P_L < P_H$ and $\beta^L \in (0, 1]$ implies $\beta^H \in (0, \beta^L)$. Q.E.D.

This concludes the proof of the lemma. Q.E.D.

## C.3 Optimal merger policy

### C.3.1 Optimal merger policy with pure strategies

We first extend the analysis in Section 2.4.1 to show that, when considering pure-strategy equilibria, the optimal merger policy is the same as in Proposition 1 independently of whether $I$ or $S$ holds the bargaining power (the former occurs with probability $\alpha$).

**PROPOSITION C-1** (Optimal merger policy with pure strategies).
*The optimal merger policy when focusing on the pure-strategy equilibria of the bargaining game is the same as in Proposition 1, irrespective of the value of $\alpha$.*

*Proof.* We build on the proof of Proposition 1 (Appendix A.4).
*Case 1:* The incumbent plans to develop (i.e. $\pi_I^A = \pi_I^M - K$).

If $S$ makes a take-it-or-leave-it offer at $t = 1(a)$, the optimal policy avoids high-price takeovers from arising at the equilibrium. Hence, all $\bar{H} \leq \bar{H}_S^d$ in the set of admissible values are optimal, where $\bar{H}_S^d \in (-(W^M - W^m - K), W^d - W^M)$ is the unique cut-off such that, when $\pi_I^A = \pi_I^M - K$, $F_W(\pi_I^M - K, \bar{H}_S^d) = F_S = (\pi_S^d - \pi_I^M + \pi_I^m)/(\pi_I^m - \pi_I^d)$, with $F_S \in (0, 1)$ from Assumptions A2 and A3.

*Optimal $\bar{H}$ when $I$ develops.* Since $\pi_I^M - K > \pi_I^m$, $F_S > F_I$ and $H_I^d < H_S^d$. Hence, a policy $\bar{H} \leq H_I^d$ in the set of admissible values ensures that high-price takeovers are blocked for any value of $\alpha$, and is optimal irrespective of $\alpha$.

*Case 2:* The incumbent plans to shelve (i.e. $\pi_I^A = \pi_I^m$).

If $S$ makes a take-it-or-leave-it offer at $t = 1(a)$ (so that the bargaining outcomes in Lemma C-1 apply), the optimal policy avoids high-price takeovers featuring a price $\bar{P}$ from arising at the equilibrium. This can be ensured by setting $\bar{H}$ such that $F_W \leq F_S$. When $\pi_I^A = \pi_I^m$, $F_S = F_I = (\pi_S^d - K)/(\pi_I^m - \pi_I^d) \in (0, 1)$ from Assumptions A1 and A2. As shown in the proof of Proposition 1 (Appendix A.4), setting any value of $\bar{H}$ such that $\bar{H} \leq \bar{H}_I^s$ is optimal.

*Optimal $\bar{H}$ when $I$ shelves.* The cut-off level $\bar{H}_I^s$ is positive. Hence the policy $\bar{H} \leq \bar{H}_I^s > 0$ ensures that high-price early takeovers are blocked and is, therefore, optimal, irrespective of the value of $\alpha$.

*Optimal $\bar{H}$ (irrespective of shelving or developing).* All $\bar{H} \leq \min(\bar{H}_I^d, \bar{H}_I^s)$ in the set of admissible values are optimal irrespective of the value of $\pi_I^A$ and $\alpha$.

Q.E.D.

### C.3.2 Optimal merger policy with pure and mixed strategies

To conclude, we prove that the optimal merger policy in Proposition 1 is optimal when allowing for both, the pure- and the mixed-strategy equilibria of the bargaining game.

The analysis above has shown that multiple equilibria may arise when $S$ makes the offer, $I$ plans to develop and $p \leq F_S$. Namely, the pure-strategy equilibrium in Lemma C-1 (Claim 3) and mixed-strategy equilibria in Lemma C-2.

The equilibrium in pure strategies in which a low-price takeover occurs exists for any feasible $\bar{H}$. Since a start-up is acquired only if it is unviable, expected welfare at $t = 0$ is given by:

$$E(W^{ps}) = p(W^d - K) + (1-p)(W^M - K).$$

Expected welfare at $t = 0$ with the equilibria in mixed strategies is:

$$\begin{aligned} E(W^{ms}) &= p[W^d - K - \beta^H(W^d - W^M)] \\ &+ (1-p)[W^M - K - \gamma_u^H(1-\beta^H)(W^M - K - W^m)]. \end{aligned}$$

The first term in the expression of $E(W^{ms})$ refers to the case in which the start-up is viable, which occurs with probability $p$: in that case expected welfare is given by $W^d - K$ – i.e. the welfare when the start-up remains independent and reaches the final market giving rise to a duopoly – minus the loss $W^d - W^M$ caused to welfare when the high-price offer is accepted (which occurs with probability $\beta^H$), the start-up is acquired and product market competition is suppressed. The second term refers to the case in which the start-up is unviable, which occurs with probability $1-p$: expected welfare is given by $W^M - K$ – i.e. the welfare when the start-up is acquired and the incumbent develops the project – minus the loss caused to welfare when the unviable start-up offers a high price and that offer is rejected (which occurs with probability $\gamma_u^H \times (1-\beta^H)$) and the project cannot be developed.

The comparison between $E(W^{ps})$ and $E(W^{ms})$ shows that the equilibrium in pure strategies dominates, in terms of welfare, any equilibrium in mixed strategies: first, because a viable start-up is never acquired and competition never suppressed; second, because an unviable start-up is always acquired and it is never the case that the project fails to reach the final market. These considerations are summarised in the following lemma (the proof follows from the discussion above):

**LEMMA C-3.**
*The expected welfare in the equilibrium in pure strategies featuring low-price takeovers (such that $P < \pi_S^{\emptyset}(S_v)$) is higher than in any mixed-strategy equilibrium.*

The optimal merger policy must prevent mixed-strategy equilibria from arising. This goal can be achieved by setting a sufficiently strict standard of review so that the posterior probability $\phi(P_H)$ is (strictly) higher than the threshold that governs the decision of the AA, $F_W$, for all feasible $P_H > \pi_S^d - K$. This ensures that the AA blocks the takeover whenever it observes a transaction price $P_H > \pi_S^d - K$.

We now provide the intuition for the reason why the standards of review that are optimal when one focuses on equilibria in pure strategies are optimal also when one allows for mixed strategies, as stated by Proposition 2.

For the case in which the incumbent develops and the start-up makes the offer, the optimal standards of review $\bar{H}$ characterised in Proposition 1 are such that $F_W \leq F_S$: they make sure that, whenever the incumbent is willing to accept a high price $\bar{P}$ – i.e. whenever the posterior probability $\phi(\bar{P}) = p > F_S$ – the AA blocks the transaction because $\phi(\bar{P}) = p > F_W$. $F_S$ is the cut-off value of the posterior that makes the incumbent indifferent between accepting and rejecting the offer $\bar{P} = \pi_S^d - K$ (see the proof of Lemma C-1).

In the mixed strategy equilibria, the posterior probability makes the incumbent indifferent between accepting and rejecting an offer involving the price $P_H$. Therefore, as $P_H \to \pi_S^d - K$, the posterior $\phi(P_H)$ approaches $F_S$ (from above), and $\phi(P_H) > F_S$ for all the prices $P_H > \pi_S^d - K$ that are feasible at the mixed strategy equilibria. As a consequence, the standards of review that ensure $F_W \leq F_S$ also ensure that $\phi(P_H) > F_W$: the AA blocks any transaction involving a high-price offer $P_H > \pi_S^d - K$ and mixed-strategies equilibria cannot exist.

**PROPOSITION C-2** (Optimal merger policy with pure and mixed strategies).
*Under the merger policy described in Proposition 1 the game admits no mixed strategy equilibria, hence the policy remains optimal also when equilibria in mixed strategies are allowed for.*

*Proof.* From the proof of Lemma C-2.4, it follows that when $S$ makes the offer, $\pi_I^A = \pi_I^M - K$ and $p \leq F_S$, setting $\bar{H} \leq \bar{H}^m$, with $\bar{H}^m \in (-(W^M - K - W^m), W^d - W^M)$, ensures that no hybrid PBE exists. Therefore only an equilibrium featuring a low-price exists, which is superior in terms of welfare:

$$\begin{aligned} EW^{ps} &= p(W^d - K) + (1-p)(W^M - K) > \\ EW^{ms} &= p[W^d - K - \beta^H(P_H)(W^d - W^M)] \\ &+ (1-p)[W^M - K - \gamma_u^H(P_H)(1 - \beta^H(P_H))(W^M - K - W^m)]. \end{aligned}$$

From the proof of Lemma C-2.4, $\bar{H}^m$ is such that $\hat{P}_H = \pi_S^d - K$ and, therefore, $F_W = \phi(P_H = \pi_S^d - K)$. From equation (C-11), $\phi(P_H = \pi_S^d - K) = (\pi_S^d - \pi_I^M - \pi_I^m)/(\pi_I^m - \pi_I^d) = F_S$. From the proof of Proposition C-1, $\bar{H}_S^d$ is such that $F_W = F_S$. Hence, $\bar{H}_S^d = \bar{H}^m$.

It follows that when $S$ makes the offer and the incumbent develops, setting $\bar{H} \leq H_S^d$ prevents high-price takeovers from arising not only at the equilibrium in pure strategies, but also at any hybrid PBE. Hence, when $S$ makes the offer and the incumbent develops all $\bar{H} \leq H_S^d$ are optimal, also when one allows for equilibria in mixed strategies.

The proof of Proposition C-1 shows that $\bar{H}^d = \bar{H}_I^d < \bar{H}_S^d$. Hence, when the incumbent develops, setting $\bar{H} \leq H^d$ prevents high-price takeovers from arising not only at the pure-strategy equilibrium, but also at the hybrid PBE, irrespective of who makes the offer. Therefore, all $\bar{H} \leq H^d$ are optimal for any value of $\alpha$, also when one allows for equilibria in mixed strategies at $t = 1(a)$. It also follows that $\bar{H} \leq \min(\bar{H}^d, \bar{H}^s)$ is optimal for any value of $\pi_I^A$ and $\alpha$. Q.E.D.

To sum up, the analysis in this appendix confirms the claim in Proposition 2.

# D Late takeovers

We extend the baseline model by allowing the incumbent to acquire the start-up either before or after product development. Consistently, we allow the AA to commit to two different standards of intervention, denoted as $\bar{H}_1$ (which corresponds to $\bar{H}$ in the baseline model), and $\bar{H}_2$, respectively for mergers involving a potential competitor (that is, early takeovers occurring before development), and for mergers involving a committed entrant (that is, late takeovers, occurring after development).

More importantly, we also allow the expectation of a late takeover to increase the viability of the start-up. We solve the extended model *under the imperfect financial market micro-foundation*, in which this property arises naturally when the start-up has some bargaining power in the negotiation for the takeover: as we will show in Section D.2.1, the start-up anticipates that it will appropriate some of the rents created by the late acquisition; this makes it easier to obtain funding for its project. Therefore, the probability that the start-up is viable is higher when late takeovers are authorised than in the case in which they are not.

**Funding of the project and information** 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, $S$ holds insufficient assets $A \geq 0$ to cover this initial outlay: $A < K$. Thus, $S$ will search for funding in perfectly competitive capital markets.

Following Holmström and Tirole (1997), we assume that the probability that the prototype is developed successfully depends on the non-contractible effort exerted by the start-up. In case of effort the project succeeds with probability one, whereas in case of no effort it fails with probability one and yields no profit, but the start-up obtains private benefits $B > 0$. $B$ proxies the start-up's agency costs. There are various ways in which management may not act in the firm's best interest. For example, it could take actions that are suboptimal, like relying on inefficient suppliers, or have diverging interests vis-à-vis lenders, for example preferring projects with less commercial value but stronger academic impact (as documented in biotech by Lerner and Malmendier, 2010).[15] As in Holmström-Tirole, the financial contract signed by the start-up and lenders takes the form of a sharing rule that specifies the income transferred to the start-up

[15] This framework with moral hazard is a natural choice to study a situation in which a project with positive net present value might fail to materialise because the start-up lacks resources that, instead, are available to the acquirer, thereby creating the scope for early acquisitions to be welfare beneficial. Alternatively one may assume adverse selection on the project type. This alternative setting is typically used by the literature in finance to determine optimal capital structure (Tirole, 2006). It would give rise to partitions of start-up types depending on their ability to secure funding. To the extent that inefficient credit rationing emerges also in this alternative model, and that the incumbent and the AA lack precise information on start-ups' access to finance, we would expect that such an alternative setting would give rise to qualitatively similar results to ours.

in the case of success ($R_S^s$) and failure ($R_S^f$). The investors' claim can be thought of as being either debt or equity. In other words, as shown in Tirole (2006), there is no difference between risky debt and equity in this model.

The assumption that the incumbent has enough internal resources to pay the investment cost implies that, in case of an acquisition, the management always exerts effort. An alternative but equivalent formulation would assume that also the incumbent needs to raise external funds, but it has active monitoring skills that remove the moral hazard problem when the acquisition takes place. Therefore, the incumbent is never financially constrained.

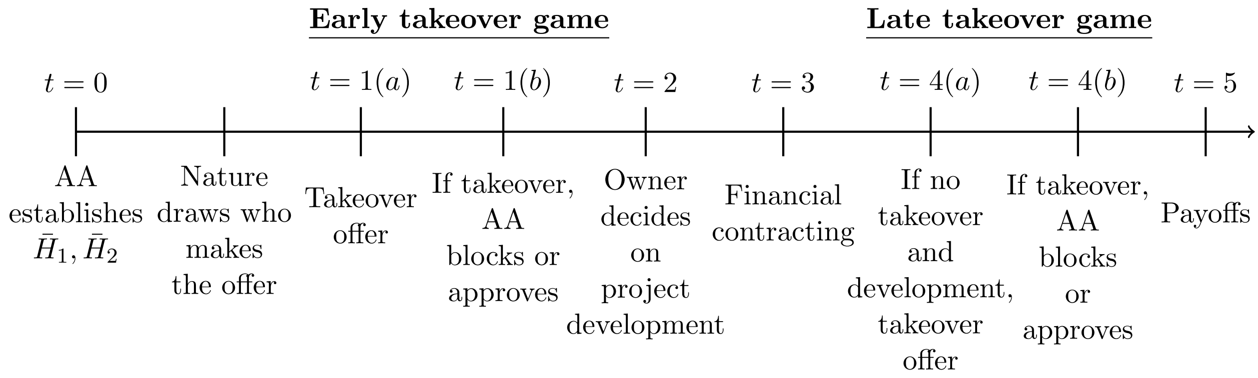
Before the game starts, $B$, the private benefit, is drawn from a continuous CDF $F(B)$, with $B \in [0, \pi_S^d]$. $S$ and external financiers observe the value of $B$, while $I$ and the AA do not. Our assumptions on the observability of $B$ reflect the different skills of the various players in the game (Tirole, 2006). While it is the core business of financiers to establish the financial merits of a company, it is not the key expertise of incumbents and regulators. Moreover financiers can inspect $S$'s banking records and history of debt repayment, while incumbents and AA typically do not have access to this information. Moreover, AAs generally lack the sophisticated financial ability necessary to interpret the relevant data, should they be able to access them. Hence, the lenders can conduct "backward looking" speculative monitoring that allows them to measure the value of $B$ with certainty. Instead, the incumbent $I$, as well as the AA, cannot engage in such a speculative monitoring and only know the distribution $F(B)$ when they take their decisions.

**Timing** Next, we describe the timing of the game.

- At $t = 0$, the AA commits to the standards for merger approval, $\bar{H}_1, \bar{H}_2$. Subsequently, nature draws who makes the take-it-or-leave-it offer both at $t = 1(a)$ and $t = 4(a)$.
- At $t = 1(a)$, there is the 'early takeover game': either $I$ or $S$ makes a takeover offer, which can be accepted or rejected by the recipient.
- At $t = 1(b)$, the AA approves or blocks the takeover proposal.
- At $t = 2$, the firm that owns the prototype decides whether to develop or shelve it.
- At $t = 3$, the owner of the prototype engages in financial contracting (if needed).
- At $t = 4(a)$, there is the 'late takeover game': either $I$ or $S$ make a takeover offer (if the takeover did not already occur at $t = 1$, and if the project was developed).
- At $t = 4(b)$, the AA approves or blocks the takeover proposal.
- At $t = 5$, active firms sell in the product market, payoffs are realised and contracts are honoured.

We solve the game by backward induction.

Figure D-1: Timeline




## D.1 Late takeover game ($t = 4$)

Note that the late takeover game is – unlike the early takeover – one with perfect information, because all the relevant information has been revealed by the time it takes place. At $t = 4$ there exists scope for a late takeover if the start-up, that has not been acquired at $t = 1$, managed to develop the project. If so, absent the takeover, there would be a duopoly, with welfare $W^d - K$. Instead, a late takeover would lead to welfare $W^M - K$.[16] Since $W^d > W^M$, the AA will block the late takeover unless $\bar{H}_2 \geq W^d - W^M$.

If $\bar{H}_2 < W^d - W^M$, no late takeover occurs. Firms' profits at $t = 4$ are:

$$\pi_S^{\emptyset}(S_v, \bar{H}_2 < W^d - W^M) = \pi_S^d - A - R_l; \quad \pi_I^{\emptyset}(S_f, \bar{H}_2 < W^d - W^M) = \pi_I^d, \tag{D-1}$$

where $S$'s profits are net of the internal resources invested in the project ($A$) and of the financial obligations to external investors $R_l$ (where $l$ stands for "lenders"). In these expressions, $\emptyset$ indicates that no takeover occured at $t = 1$ and $S = S_v$ that the start-up managed to obtain funding and is, therefore, viable.

If $\bar{H}_2 \geq W^d - W^M$, the AA authorises the late takeover. From Assumption $A2$, the takeover increases industry profits, implying that $I$ and $S$ are always willing to merge. When $I$ makes the take-it-or-leave-it offer, it pays the price that leaves $S$ with its threat point payoff. When the acquisition occurs, the incumbent also takes over the financial obligations of the start-up. Hence, $I$ offers a price equal to $\pi_S^d - R_l$ appropriating the entire increase in joint profits produced by the takeover. Conversely, when $S$ makes the offer, it requires to be paid a price equal to $\pi_I^M - \pi_I^d - R_l$ and leaves $I$ with its threat-point payoff. Net profits are given by:

$$\pi_S^{\emptyset}(S_v, \bar{H}_2 \geq W^d - W^M) = \mathbb{1}\pi_S^d + (1 - \mathbb{1})(\pi_I^M - \pi_I^d) - A - R_l; \tag{D-2}$$
$$\pi_I^{\emptyset}(S_v, \bar{H}_2 \geq W^d - W^M) = (1 - \mathbb{1})\pi_I^d + \mathbb{1}(\pi_I^M - \pi_S^d). \tag{D-3}$$

where $\mathbb{1}$ is an indicator function equal to 1 when $I$ makes the offer, and 0 otherwise. Finally, a late takeover cannot take place if the start-up did not manage to obtain external funding and

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

is unviable ($S = S_u$). In this case, the project would not be developed and firms' profits are:

$$\pi_S^\emptyset(S_u) = 0; \quad \pi_I^\emptyset(S_u) = \pi_I^m.$$

Table D-1 summarises the profits of the incumbent and the start-up, when no early takeover occurs, depending on whether late takeovers are authorised and whether the start-up was viable or not. The profits of the latter are gross of the investment cost and are denoted with a capital letter.

Table D-1: Firms' profit when no early takeover occurs

| | Profit if $S = S_v$ | Profit if $S = S_u$ |
|---|---|---|
| Late takeover prohibited: $\bar{H}_2 < W^d - W^M$ | $\Pi_S^\emptyset = \pi_S^d$ <br> $\pi_I^\emptyset = \pi_I^d$ | $\pi_S^\emptyset = 0$ <br> $\pi_I^\emptyset = \pi_I^m$ |
| Late takeover authorised: $\bar{H}_2 \geq W^d - W^M$ | $\Pi_S^\emptyset = \mathbb{1}\pi_S^d + (1-\mathbb{1})(\pi_I^M - \pi_I^d)$ <br> $\pi_I^\emptyset = (1-\mathbb{1})\pi_I^d + \mathbb{1}(\pi_I^M - \pi_S^d)$ | $\pi_S^\emptyset = 0$ <br> $\pi_I^\emptyset = \pi_I^m$ |

Table D-1 shows that, when late takeovers are authorised, either the incumbent or the start-up that receives funding ($S_v$), depending on the one who makes the offer, seizes the the increase in industry profits due to the takeover. Hence, the one who makes the offer is better off than in the scenario in which late takeovers are blocked. The anticipation of this will affect financial contracting, as shown in the next section.

## D.2 Investment decision and financial contracting

### D.2.1 Financial contracting

If no takeover took place at $t = 1(b)$, a start-up that wants to develop the project looks for funding. Lemma D-1 illustrates the outcome of the contracting game. Because of moral hazard, the start-up may be unable to obtain external funding even though the NPV of the project is positive. This is the case when the agency cost $B$ is sufficiently high because the rent that is left to the borrower, once external financiers are repaid, is insufficient to induce the borrower to exert effort. Therefore, the parties cannot find an agreement that *both* induces effort and allows the lenders to break even. More importantly, the lemma shows that the merger policy targeting late takeovers affects the severity of financial constraints. This is because the start-up expects to obtain higher profits from the development of the project when late takeovers are authorised than when they are blocked (as shown in Section D.1). This makes it easier to incentivise effort and, therefore, to raise external funds.

**LEMMA D-1** (Financial contracting).
*There exists a threshold* $\bar{B}(\bar{H}_2) = \Pi_S^\emptyset(S_v, \bar{H}_2) - K + A > 0$ *of the start-up's private benefit such*

*that:*

1. *If $B > \bar{B}(\bar{H}_2)$, the start-up does not obtain funding ($S = S_u$).*
2. *If $B \leq \bar{B}(\bar{H}_2)$, the start-up is funded ($S = S_v$). Its expected profit net of development costs is $\pi_S^{\emptyset}(S_v, \bar{H}_2) = \Pi_S^{\emptyset}(S_v, \bar{H}_2) - K$.*
3. *If the start-up holds the bargaining power, authorising late takeovers relaxes financial constraints: $\bar{B}(\bar{H}_2 \geq W^d - W^M) > \bar{B}(\bar{H}_2 < W^d - W^M)$.*

*Proof.* The financial contract stipulates the way gross profits from the development of the project are shared between $S$ and the lenders. Both the start-up and the lenders correctly anticipate that, if funded and if effort is made, the project will be successful. If no effort is exerted, the project will fail and will produce 0 profits. Hence, the borrower's limited liability implies that both sides receive 0 in case of failure. In case of success, denote by $R_l$ how much goes to external financiers. The financial contract must induce $S$ to exert effort, because otherwise the lenders cannot break even:

$$\Pi_S^{\emptyset}(S_v, \bar{H}_2) - R_l \geq B. \tag{ICC}$$

Since the lenders are assumed to behave competitively, the zero-profit condition requires that:

$$R_l = K - A. \tag{PC}$$

Substituting the investor's participation constraint (PC) in the start-up's incentive compatibility constraint, one obtains that (ICC) holds if (and only if):

$$B \leq \bar{B}(\bar{H}_2) \equiv \Pi_S^{\emptyset}(S_v, \bar{H}_2) - (K - A),$$

with $\bar{B}(\bar{H}_2 < W^d - W^M) > 0$ by Assumption A1 and $A \geq 0$. If $B < \bar{B}(\bar{H}_2)$, the start-up is not funded ($S_u$) and cannot develop the project even though the NPV of the project is positive (Claim (i) of the lemma). We will say that it is credit constrained. If, instead, $B \geq \bar{B}(\bar{H}_2)$, the start-up obtains funding ($S_v$) – we will say that it is unconstrained. Substituting $R_l = K - A$ in equations (D-1) and (D-2), one obtains the net payoff indicated in Claim 2.

In Section D.1, we showed that, if $\bar{H}_2 \geq W^d - W^M$, $\Pi_S^{\emptyset}(S_v, \bar{H}_2) = \mathbb{1}\pi_S^d + (1 - \mathbb{1})(\pi_I^M - \pi_I^d)$, where $\mathbb{1}$ is an indicator function equal to 1 when the incumbent makes the offer in the takeover game; if $\bar{H}_2 < W^d - W^M$, $\Pi_S^{\emptyset}(S_v, \bar{H}_2) = \pi_S^d \leq \mathbb{1}\pi_S^d + (1 - \mathbb{1})(\pi_I^M - \pi_I^d)$. Then, if $\bar{H}_2 \geq W^d - W^M$ and the start-up makes the offer in the takeover game, $\bar{B}(\bar{H}_2)$ is strictly larger than if $\bar{H}_2 < W^d - W^M$. Instead, if the incumbent makes the offer, $\bar{B}(\bar{H}_2)$ does not vary with $\bar{H}_2$. Q.E.D.

Finally, if the start-up was acquired by $I$ at $t = 1$, no financial contracting takes place because $I$ has enough resources to invest.

### D.2.2 The investment decision

The investment decision is the same as in the baseline model.

## D.3 Early takeover game ($t = 1$)

At $t = 1$ the parties decide whether to engage in an early takeover. The results of the baseline model hold through in the extended setting. We will state them and we will provide the formal proof. We will discuss only the new insights due to the fact that the parties anticipate that in the continuation game a late takeover may take place.

Section D.3.1 describes the AA's decision at $t = 1(b)$, for given beliefs that the start-up obtains financing. Sections D.3.2 and D.3.3 illustrate the equilibrium takeover offer and acceptance decision, together with $I$'s and AA's belief update processes.

### D.3.1 Decision on merger approval

Lemma D-2 generalises Lemma 1 of the baseline model to the case where late takeovers might be approved. Lemma D-2 also shows that the AA is the more likely to approve a takeover when late takeovers are authorised because, absent the early takeover, the viable start-up would be acquired ex-post and product market competition would be suppressed anyway.

**LEMMA D-2** (Decision on merger approval)**.**
*Let $\phi(\Omega)$ be the probability that the AA assigns to the start-up being viable, given the information set $\Omega$. There exists a threshold $F_W(\pi_I^A, \bar{H}_1, \bar{H}_2) \geq 0$ such that the AA authorises the takeover iff:*

$$\phi(\Omega) \leq F_W(\pi_I^A, \bar{H}_1, \bar{H}_2). \tag{D-4}$$

*The threshold $F_W(\pi_I^A, \bar{H}_1, \bar{H}_2)$ is: (i) strictly increasing in $\bar{H}_1$; (ii) higher when $\pi_I^A = \pi_I^M - K$ than when $\pi_I^A = \pi_I^m$; (iii) higher when $\bar{H}_2 \geq W^d - W^M$ than when $\bar{H}_2 < W^d - W^M$.*

*Proof.* Two cases must be considered. For simplicity, throughout this proof, we omit the functional notation for $\phi$.
*Case 1:* The incumbent plans to shelve (i.e. $\pi_I^A = \pi_I^m$).

- Assume late takeovers are blocked, i.e. $\bar{H}_2 < W^d - W^M$. In this case, an early takeover creates expected harm $H = \phi[W^d - K - W^m] > 0$. If the start-up cannot obtain financing in $t = 3$, the early takeover does not affect welfare, because the project would die anyway. However, if the start-up is funded, the early takeover leads to the suppression of a project that the start-up would manage to develop independently. Hence, the early takeover prevents the project from reaching the market and ex-post competition from developing. The takeover is authorised if (and only if) the expected harm is lower than the tolerated harm, i.e. iff:
$$\phi \leq \frac{\bar{H}_1}{W^d - K - W^m} = F_W(\pi_I^m, \bar{H}_1, \bar{H}_2 < W^d - W^M).$$

- Assume late takeovers are authorised, i.e. $\bar{H}_2 \geq W^d - W^M$. If the start-up cannot obtain financing in $t = 3$, the early takeover does not affect welfare. If the start-up is financed in $t = 3$, the early takeover is welfare detrimental; however, since it would be acquired anyway at $t = 4$, the harm is lower than in the case in which late takeovers are blocked because a monopoly rather than a duopoly would arise in the market absent the takeover.

The takeover is authorised iff the expected harm $H = \phi[W^M - K - W^m] > 0$ is lower than the tolerated harm, i.e. iff:.

$$\phi \leq \frac{\bar{H}_1}{W^M - K - W^m} = F_W(\pi_I^m, \bar{H}_1, \bar{H}_2 \geq W^d - W^M).$$

*Case 2:* The incumbent plans to develop (i.e. $\pi_I^A = \pi_I^M - K$).

- If $\bar{H}_2 < W^d - W^M$, an early takeover creates expected harm $H = (1-\phi)[W^m - (W^M - K)] + \phi[W^d - K - (W^M - K)]$: if the start-up is constrained, the early takeover is now beneficial, because it makes up for financial constraints and allows the project to reach the market; when the start-up is unconstrained, the early takeover is detrimental because of the suppression of product market competition. The takeover is authorised iff:

$$\phi \leq \frac{\bar{H}_1 + W^M - W^m - K}{W^d - K - W^m} = F_W(\pi_I^M - K, \bar{H}_1, \bar{H}_2 < W^d - W^M).$$

- If $\bar{H}_2 \geq W^d - W^M$, an early takeover creates expected harm $H = (1-\phi)[W^m - (W^M - K)] < 0$, i.e. an early takeover is welfare beneficial. Since late takeovers are authorised, the unconstrained start-up would be acquired anyway and so a monopoly would arise, irrespective of whether the early takeover goes through; however, when the start-up is constrained, the early takeover is beneficial. In this case early takeovers are authorised iff:

$$\phi \leq \frac{\bar{H}_1 + W^M - W^m - K}{W^M - K - W^m} = F_W(\pi_I^M - K, \bar{H}_1, \bar{H}_2 \geq W^d - W^M).$$

A comparison of $F_W$ in the different cases reveals that:

- Given $\pi_I^A$, $F_W$ is higher if later takeovers are authorised than in the case in which they are blocked (when $F_W$ is positive). This follows from $W^d > W^M$.
- Given $\bar{H}_2$, $F_W$ is higher when the incumbent develops than when the incumbent shelves. This follows from $W^M - W^m - K > 0$.

Moreover, $\bar{H}_1 \geq -(W^M - W^m - K)$ implies that $F_W \geq 0$ when $\pi_I^A = \pi_I^M - K$.

Q.E.D.

Corollary D-1 is identical to the baseline model:

**COROLLARY D-1.**

1. *When the incumbent develops, the AA* always *approves an early takeover if it assigns probability one to the start-up being constrained (i.e. $\phi(\Omega) = 0$).*
2. *When the incumbent shelves, no early takeover is approved if the merger policy commits to blocking any welfare detrimental takeover (i.e. $\bar{H}_1 < 0$).*

*Proof.* Claim 1: Since $F_W(\pi_I^M - K, \bar{H}_1, \bar{H}_2) \geq 0$, condition (D-4) is always satisfied when $\phi_{AA}(\Omega) = 0$. Claim 2: Since $F_W(\pi_I^m, \bar{H}_1, \bar{H}_2) < 0$ when $\bar{H}_1 < 0$, condition (D-4) is never satisfied.

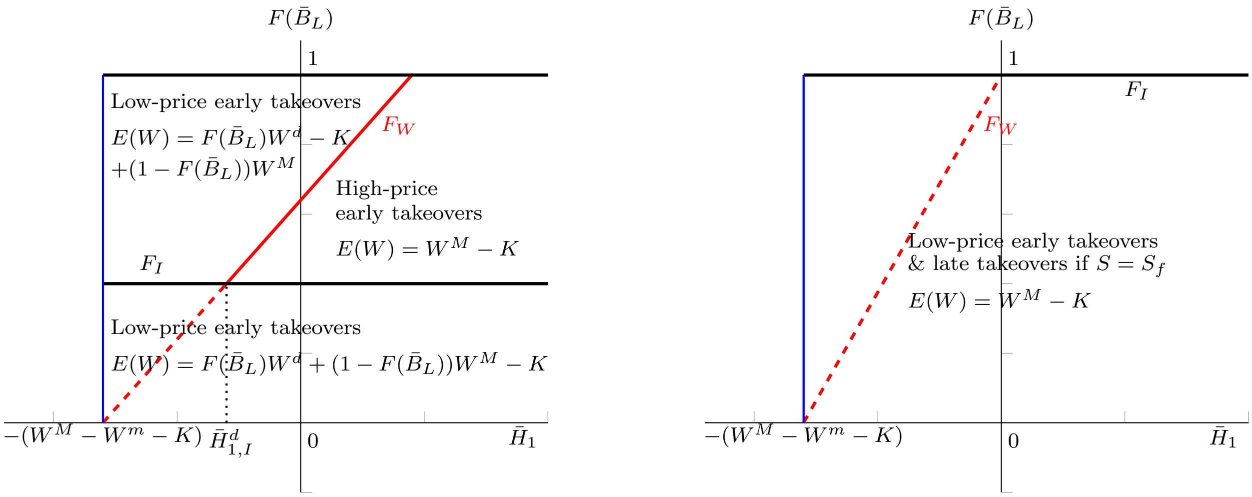
Q.E.D.

### D.3.2 Equilibrium offers at t=1(a): the incumbent holds the bargaining power

We first analyse the case in which the incumbent makes a take-it-or-leave-it offer. When this is the case, the incumbent fully appropriates the surplus produced by the late takeover and, when no early takeover occurs, the unconstrained start-up obtains the same payoff irrespective of whether the late takeover is authorised or blocked: $\pi_S^{\emptyset}(S_v, \bar{H}_2) = \pi_S^d - K$ for any $\bar{H}_2$. An implication of this is that the threshold level of $B$ that determines whether a start-up is financially constrained does not depend on the merger policy regarding late takeovers: $\bar{B}(\bar{H}_2) = \pi_S^d - K + A$ for any $\bar{H}_2$ (see Lemma D-1). We denote this threshold as $\bar{B}_L$.

The PBE of the bargaining game are described in Lemma D-3. For the case of development, Figure D-2 displays the equilibrium takeovers and the expected welfare at $t = 0$ as a function of the merger policy regarding early takeovers $\bar{H}_1$ and the prior probability that the start-up is unconstrained $F(\bar{B}_L)$. The left panel refers to the case in which late takeovers are blocked and is the same as in the baseline model. The right panel refers to the case in which late takeovers are authorised (i.e. $\bar{H}_2 \geq W^d - W^M$). In such a case only low-price early takeovers occur at the equilibrium: given that an unconstrained start-up can be acquired at $t = 2$, there is no point for the incumbent in overpaying for a constrained start-up at the early stage.[17]

Figure D-2: Equilibrium takeovers when $I$ develops (and holds the bargaining powers), and associated welfare expected at $t = 0$.




(a) Late takeovers blocked

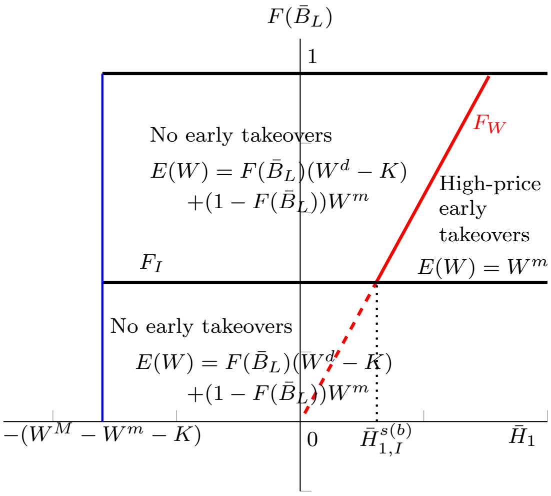
(b) Late takeovers authorised

On the axes, $\bar{H}_1$ is the standard of review (level of tolerated harm) for early takeovers; $F(\bar{B}_L)$ is the a priori probability that the start-up is unconstrained. $F_I$ and $F_W$ represent the cut-off values of the a priori probability that govern the decision of the incumbent regarding the takeover price and, respectively, the approval decision of the AA. The left panel refers to the case in which late takeovers are blocked (i.e. $\bar{H}_2 < W^d - W^M$). The right panel refers to the case in which late takeovers are authorised (i.e. $\bar{H}_2 \geq W^d - W^M$). $\bar{H}^d_{1,I}$, that is the value of $\bar{H}_1$ such that $F_W$ and $F_I$ cross, will be central to the determination of the optimal merger policy. When the incumbent develops, $\bar{H}^d_{1,I}$ may be negative, a case displayed in this figure.

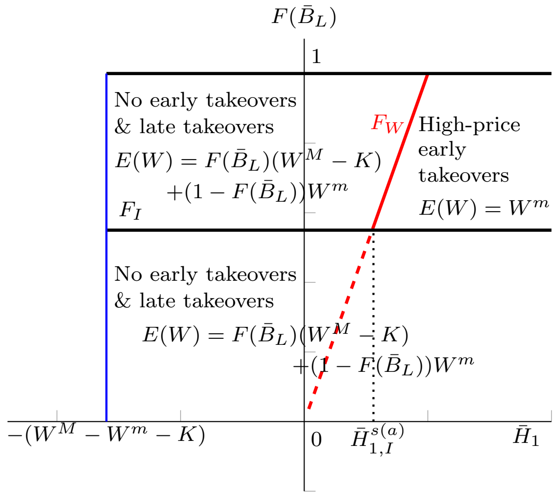
Figure D-3 refers to the case of shelving. Differently from the case of development, with shelving the incumbent may be willing to engage in a high-price takeover also when late takeovers are authorised (right panel of the figure): from the perspective of the incumbent, developing

[17] When $I$ develops and $\bar{H}_2 \geq W^d - W^M$, $F_I = 1$ so that it cannot be that $F(\bar{B}_L) > F_I$.

Figure D-3: Equilibrium takeovers when $I$ shelves (and holds the bargaining power) and associated welfare expected at $t = 0$.




(a) Late takeovers blocked




(b) Late takeovers authorised

On the axes, $\bar{H}_1$ is the standard of review (level of tolerated harm) for early takeovers; $F(\bar{B}_L)$ is the a priori probability that the start-up is unconstrained. $F_I$ and $F_W$ represent the cut-off values of the a priori probability that govern the decision of the incumbent regarding the takeover price and, respectively, the approval decision of the AA. The left panel refers to the case in which late takeovers are blocked (i.e. $\bar{H}_2 < W^d - W^M$). The right panel refers to the case in which late takeovers are authorised (i.e. $\bar{H}_2 \geq W^d - W^M$). $\bar{H}_{1,I}^{s(j)}$, with $j = b, a$ depending on whether late takeovers are blocked or authorised, is the value of $\bar{H}_1$ such that $F_W$ and $F_I$ cross, and will be central to the determination of the optimal merger policy. Differently from the case of development, with shelving $\bar{H}_{1,I}^{s(j)}$ is necessarily positive.

the project is an inefficient investment which cannot be avoided if the unconstrained start-up remains independent; hence, the incumbent may be willing to overpay for a constrained start-up at the early stage.

**LEMMA D-3** (PBE of the bargaining game when $I$ makes the offer)**.**

*Let:*

$$F_I(\pi_I^A, \bar{H}_2) \equiv \frac{\pi_S^d - K}{\pi_I^A - \pi_I^{\emptyset}(S_v, \bar{H}_2)} \in (0, 1]. \tag{D-5}$$

*When I makes a take-it-or-leave-it offer:*

1. *If* $\pi_I^A = \pi_I^m$ *and either* $F(\bar{B}_L) \leq F_I$ *or* $F(\bar{B}_L) > \max(F_W, F_I)$*, no early takeover occurs at the equilibrium.*
2. *For any* $\pi_I^A$*, if* $F(\bar{B}_L) \in (F_I, \max(F_W, F_I)]$*, the PBE is:* $\{(s_I^* = \pi_S^d - K, r_{S_v}^* = r_{S_u}^* = \textit{Accept } \pi_S^d - K); \phi(\{s_I^*, r_S^*\}) = F(\bar{B}_L)\}$.
3. *If* $\pi_I^A = \pi_I^M - K$ *and either* $F(\bar{B}_L) \leq F_I$ *or* $F(\bar{B}_L) > \max(F_W, F_I)$*, the PBE is:* $\{(s_I^* = 0, r_{S_v}^* = \textit{Reject } 0, r_{S_u}^* = \textit{Accept } 0); \phi(\{s_I^*, r_{S_v}^*\}) = 1, \phi(\{s_I^*, r_{S_u}^*\}) = 0\}$.

*Proof.* If $S = S_u$, the start-up's payoff when rejecting $I$'s offer is $\pi_S^{\emptyset}(S_u) = 0$; if $S = S_v$, it is $\pi_S^{\emptyset}(S_v, \bar{H}_2) = \pi_S^d - K > 0$ from Assumption A1.[18] The incumbent will then offer either a low price $P_I = 0$, and only the constrained start-up $S = S_u$ will accept, or a high price $P_I = \pi_S^d - K > 0$ and both types of start-up will accept. In the former case, observing that the offer is accepted allows the incumbent and the AA to update their beliefs and infer that the start-up is financially constrained: $\phi(\{0, \textit{Accept } P_I\}) = 0$. In the latter case (as well as in the case in which no offer is made) the acceptance decision of the start-up does not reveal its type. Then the posteriors coincide with the priors: $\phi(\{\pi_S^d - K, \textit{Accept } P_I\}) = F(\bar{B}_L)$. From Lemma D-2, the deal is authorised iff $F(\bar{B}_L) \leq F_W$. Finally, there cannot exist an equilibrium in which both start-ups are acquired at a different positive price: the start-up receiving the lower price offer would pretend to be the type receiving the higher price offer, thus breaking the equilibrium.

If $I$ does not make any offer, its expected profit is:

$$F(\bar{B}_L)\pi_I^{\emptyset}(S_v, \bar{H}_2) + (1 - F(\bar{B}_L))\pi_I^m. \tag{D-6}$$

If $I$ offers a low price and the deal is authorised (i.e. if $\phi(\Omega) = 0 \leq F_W$, a condition that is always satisfied if the incumbent develops, from Corollary D-1 (i)), $I$'s expected profit (gross of the transaction cost) is:

$$F(\bar{B}_L)\pi_I^{\emptyset}(S_v, \bar{H}_2) + (1 - F(\bar{B}_L))\pi_I^A. \tag{D-7}$$

If $I$ offers a high price and the deal is authorised (i.e. if $\phi(\Omega) = F(\bar{B}_L) \leq F_W$), its expected profit (gross of the transaction cost) is:

$$\pi_I^A - (\pi_S^d - K). \tag{D-8}$$

By comparing the expressions in equations (D-7) and (D-8) one obtains that offering a low price is more profitable for the incumbent than offering a high price iff $F(\bar{B}_L) \leq F_I$, where $F_I$

[18] For the sake of the exposition, throughout the proof, we drop the functional notation for $F_I$ and $F_W$.

is defined in equation (D-5). However, it must also be the case that making an offer is more profitable than not engaging in the takeover.

Therefore, when $\pi_I^A = \pi_I^m$ (i.e. the incumbent shelves) and $F(\bar{B}_L) \leq F_I$, the comparison between (D-6) and (D-7) and the existence of the positive transaction cost involved in the takeover reveal that $I$'s equilibrium decision is not to engage in the takeover. The same equilibrium decision is taken when $\pi_I^A = \pi_I^m$ and $F(\bar{B}_L) > \max(F_W, F_I)$: $I$ would prefer to offer a high price, but the AA would not authorise the deal. Since offering a low price is dominated by making no offer, an early takeover does not occur at the equilibrium. This concludes Claim 1 of the lemma.

If $F(\bar{B}_L) \in (F_I, \max(F_W, F_I)]$, the equilibrium offer involves a high price, as the incumbent's preferred choice is authorised by the AA. The posteriors coincide with the priors as stated in Claim 2 of the lemma.

Finally, if $\pi_I^A = \pi_I^M - K$ (i.e. the incumbent develops) and either $F(\bar{B}_L) \leq F_I$ or $F(\bar{B}_L) > \max(F_W, F_I)$, $P_I = 0$ is offered at the equilibrium, and the incumbent and the AA update their beliefs based on whether the start-up accepts, as stated in Claim 3 of the lemma. When $F(\bar{B}_L) > \max(F_W, F_I)$ the incumbent would prefer to offer a high price. However, anticipating that the AA would not authorise the transaction, the incumbent has to settle for a second-best low-price offer.

Assumption A1 implies that $\pi_I^A - \pi_I^{\emptyset}(S_v, \bar{H}_2) > 0$ and $\pi_S^d - K > 0$. Therefore $F_I > 0$. Moreover, $F_I < 1$ if (and only if) the joint payoff of $I$ and $S_f$ in the absence of an early takeover is strictly lower than their joint payoff when the early takeover occurs. Assumption A2 ensures that this is the case when $\bar{H}_2 < W^d - W^M$ and late takeovers are blocked. This is also the case when late takeovers are authorised and the incumbent shelves. Instead, when late takeovers are authorised and the incumbent develops the project, the joint payoff of $I$ and $S_v$ is the same irrespective of whether the takeover occurs early or at a later stage and $F_I = 1$.

Q.E.D.

### D.3.3 Equilibrium offers at $t = 1(a)$: the start-up holds the bargaining power

We now analyse the case in which the start-up makes a take-it-or-leave-it offer. Differently from the case in which the incumbent holds the bargaining power, now it is the start-up that appropriates the whole surplus produced by a late takeover. The outside option of the unconstrained start-up now *does* depend on the merger policy regarding late takeovers and is higher when late takeovers are authorised (see Table D-1). As a consequence, from Lemma D-1 (ii), authorising late takeovers alleviates financial constraints: when $\bar{H}_2 \geq W^d - W^M$, $\bar{B}(\bar{H}_2) = \pi_I^M - \pi_I^d - K + A \equiv \bar{B}_H$, which is larger than the threshold $\bar{B}(\bar{H}_2) = \pi_S^d - K + A \equiv \bar{B}_L$ associated to $\bar{H}_2 < W^d - W^M$.

Apart from this consideration, the qualitative nature of the results and the underlying intuitions are similar to the case in which the incumbent has the bargaining power. The figures displaying the equilibrium takeovers as a function of $\bar{H}_1$ and $F(\bar{B}(\bar{H}_2))$ are also similar to those presented in Section D.3.2, with $F_S$ substituting $F_I$, $F(\bar{B}_H)$ substituting $F(\bar{B}_L)$ when late takeovers are authorised, and $\bar{H}_{1,S}^i$ substituting $\bar{H}_{1,I}^i$, with $i = s, d$ depending on shelving or development (see Figure D-4). The PBE is described in Lemma D-4.

**LEMMA D-4** (Pure-strategy PBE of the bargaining game when $S$ makes the offer).

*Let:*

$$F_S(\pi_I^A, \bar{H}_2) \equiv \frac{\pi_S^{\emptyset}(S_v, \bar{H}_2) + \pi_I^m - \pi_I^A}{\pi_I^m - \pi_I^d} \in (0, 1]. \tag{D-9}$$

*When $S \in \{S_v, S_u\}$ makes a take-it-or-leave-it offer:*

1. *If $\pi_I^A = \pi_I^m$ and either $F(\bar{B}(\bar{H}_2)) \leq F_S$ or $F(\bar{B}(\bar{H}_2)) > \max(F_W, F_S)$, no early takeover occurs at the equilibrium.*

2. *For any $\pi_I^A$, if $F(\bar{B}(\bar{H}_2)) \in (F_S, \max(F_S, F_W)]$, the PBE is: $\{(s^*_{S_u} = s^*_{S_v} = \bar{P}, r^*_I = Accept\ \bar{P}); \phi(\{\bar{P}, Accept\ \bar{P}\}) = F(\bar{B}(\bar{H}_2))\}$, with $\bar{P} = \pi_I^A - \pi_I^m + F(\bar{B}(\bar{H}_2))(\pi_I^m - \pi_I^d)$.*

3. *If $\pi_I^A = \pi_I^M - K$ and either $F(\bar{B}(\bar{H}_2)) \leq F_S$ or $F(\bar{B}(\bar{H}_2)) > \max(F_W, F_S)$ the PBE is: $\{(s^*_{S_v} = \emptyset, s^*_{S_u} = P_L, r^*_I = Accept\ P_L); \phi(\{P_L, Accept\ P_L\}) = 0\}$, with $P_L = \pi_I^M - K - \pi_I^m > 0$.*

*Proof.* Consider a candidate equilibrium in which the start-up, irrespective of whether it is constrained or not, offers $P_{S_u} = P_{S_v} = P$. For this to be an equilibrium, $P$ must satisfy the start-ups' participation constraints:[19]

$$P > \pi_S^{\emptyset}(S_u) = 0 \tag{D-10}$$
$$P > \pi_S^{\emptyset}(S_v, \bar{H}_2). \tag{D-11}$$

$P$ must also satisfy the incumbent's participation constraint:

$$\pi_I^A - P \geq F(\bar{B}(\bar{H}_2))\pi_I^d + [1 - F(\bar{B}(\bar{H}_2))]\pi_I^m, \tag{D-12}$$

where the incumbent's posterior beliefs on the probability that the start-up is unconstrained coincide with the priors. Since constraint (D-11) is more binding than constraint (D-10), $P$ must satisfy:

$$\pi_S^{\emptyset}(S_v, \bar{H}_2) < P \leq \pi_I^A - \pi_I^m + F(\bar{B}(\bar{H}_2))(\pi_I^m - \pi_I^d) \equiv \bar{P}.$$

Since $\pi_I^m - \pi_I^d > 0$, a necessary condition for the existence of an equilibrium featuring $P = \bar{P}$ is:

$$F(\bar{B}(\bar{H}_2)) > F_S, \tag{D-13}$$

where $F_S$ is defined in equation (D-9).

Finally, it must be that the AA authorises the deal, if the offer $P = \bar{P}$ is accepted. This is the case if (and only if) $F(\bar{B}(\bar{H}_2)) \leq F_W$. (Given our assumptions, the AA's posterior beliefs on the probability that the start-up is unconstrained coincide with the priors.) Combining the above conditions one obtains Claim 2 of the lemma. An equilibrium with $P \in (\pi_S^{\emptyset}(S_f, \bar{H}_2), P_p)$ does not exist because $S \in \{S_v, S_u\}$ would have an incentive to deviate and increase the price: following an out-of-equilibrium offer $P' \leq \bar{P}$, $I$ and AA would attach the prior probability to the start-up being unconstrained. Since $F(\bar{B}(\bar{H}_2)) \leq F_W$ the AA would authorise the deal; since $P' \leq \bar{P}$, $I$ would accept. The deviation would be profitable. Hence, $P = \bar{P}$ is the unique equilibrium price such that $P_{S_v} = P_{S_u}$.

[19]For the sake of the exposition, throughout the proof, we drop the functional notation for $F_S$ and $F_W$.

Consider now a candidate equilibrium in which $S = S_u$ offers $P_{S_u} = P_L = \pi_I^A - \pi_I^m$, $S = S_v$ does not make any offer, and the incumbent accepts $P_L$. From Assumptions A1 and A3, $\pi_I^A - \pi_I^m < \pi_S^d - K \leq \pi_S^{\emptyset}(S_v, \bar{H}_2)$. Therefore, observing such an offer both $I$ and the AA infer that the start-up is constrained (i.e. $\phi(\Omega) = 0$). Then, $I$ is indifferent between accepting and rejecting $P_L$. For this to be an equilibrium, $S$ must have no incentive to deviate.

To start with, $S = S_u$ must find it unprofitable not to make an offer:

$$P_L > \pi_S^{\emptyset}(S_u) = 0 \tag{D-14}$$

with the inequality being strict because of the existence of a negligible but positive transaction cost associated with the takeover offer.

Let us focus on the case in which $I$ develops and $P_L = \pi_I^M - K - \pi_I^m > 0$. Since $\pi_S^{\emptyset}(S_v, \bar{H}_2) > P_L$, then $S = S_v$ has no incentive to deviate and offer $P_L$. Clearly, $S = S_u$ has no incentive to decrease its offer. Has it an incentive to offer $P' > P_L$? As long as $P' \leq \pi_S^{\emptyset}(S_v, \bar{H}_2)$, the incumbent infers that the start-up is constrained and rejects the deviation offer. The deviation is unprofitable. If, instead, $P' > \pi_S^{\emptyset}(S_v, \bar{H}_2)$, the incumbent attributes the offer to an unconstrained start-up with probability $F(\bar{B}(\bar{H}_2))$. The deviation is unprofitable either if $I$ would reject the offer, i.e. if $\pi_S^{\emptyset}(S_v, \bar{H}_2) \geq \bar{P}$ which is satisfied if $F(\bar{B}(\bar{H}_2)) \leq F_S$; or if $I$ would accept the deviation offer but the AA would not authorise the deal, i.e. if $F(\bar{B}(\bar{H}_2)) > \max(F_S, F_W)$. For the same reason, it is not profitable for $S = S_f$ to offer $P' \geq \pi_S^{\emptyset}(S_v, \bar{H}_2)$. Of course, $S_v$ has no incentive to deviate and offer $P' < \pi_S^{\emptyset}(S_v, \bar{H}_2)$. In sum, when $I$ develops and either $F(\bar{B}(\bar{H}_2)) \leq F_S$ or $F(\bar{B}(\bar{H}_2)) > \max(F_S, F_W)$ the proposed one is an equilibrium, as stated in Claim 3 of the lemma.

Note that there cannot exist an equilibrium in which $S = S_u$ offers $P_L < \pi_I^M - K - \pi_I^m$. $S = S_u$ would have an incentive to deviate and offer $P' = \pi_I^M - K - \pi_I^m$, since $I$ would accept the offer and the AA would authorise the deal.

Finally, there cannot exist an equilibrium in which $S = S_v$ offers $P_{S_f} = \tilde{P} > \pi_S^{\emptyset}(S_v, \bar{H}_2)$, $S = S_u$ offers $P \neq \tilde{P}$, the incumbent accepts the former and rejects the latter. If the AA authorises the deal, $S = S_u$ would always have an incentive to mimic $S_v$ and offer $\tilde{P}$ instead. For a similar reason, there cannot exist an equilibrium in which $S = S_u$ offers $P_{S_u} = P_L$, $S = S_v$ offers $P_{S_v} \in (\pi_S^{\emptyset}(S_v, \bar{H}_2), \pi_I^M - K - \pi_I^d]$ and $I$ accepts both offers.

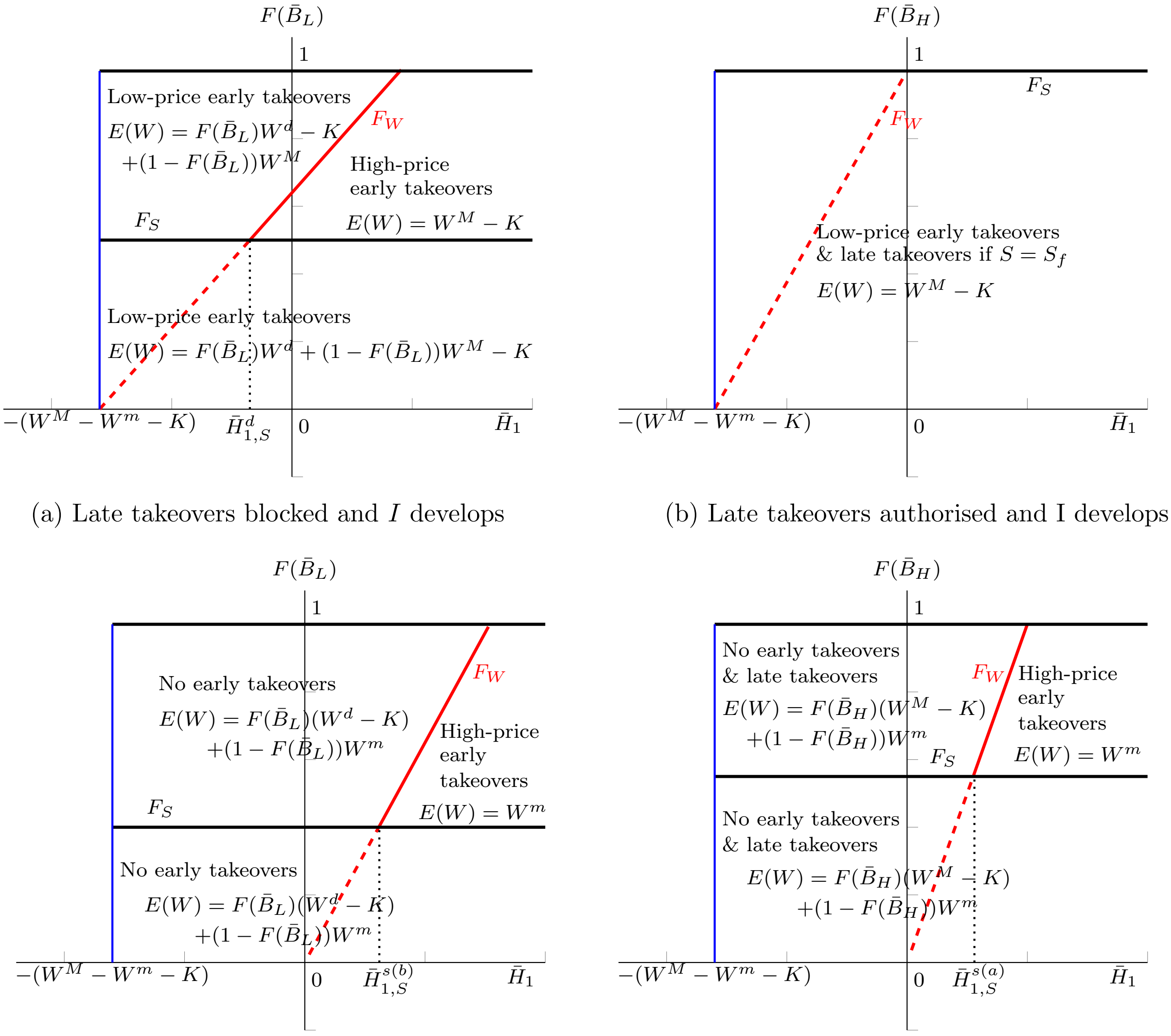
Let us consider now the case in which $I$ shelves. Since $\pi_I^A = \pi_I^m$, then $P_L = 0$. Hence, condition (D-14) cannot be satisfied and the proposed one is not an equilibrium. Other equilibria in which each start-up is traded at a different price do not exist, for the same reasoning developed above. Therefore, if $\pi_I^A = \pi_I^m$ and either $F(\bar{B}(\bar{H}_2)) \leq F_S$ or $F(\bar{B}(\bar{H}_2)) > \max(F_W, F_S)$, there is no early takeover in equilibrium, as stated in Claim 1 of the lemma.

Note that $\pi_I^m > \pi_I^d$, $\pi_S^{\emptyset}(S_v, \bar{H}_2) \geq \pi_S^d - K > 0$ (from the analysis in Section D.1 and Assumption A3) and Assumption A2 imply $F_S > 0$. Moreover, $F_S < 1$ if (and only if) the joint payoff of $I$ and $S_f$ in the absence of an early takeover is strictly lower than their joint payoff when the early takeover occurs. Assumption A1 ensures that this is the case when $\bar{H}_2 < W^d - W^M$. This is also the case when late takeovers are authorised and the incumbent shelves. Instead, when late takeovers are authorised and the incumbent develops the project, the joint payoff of $I$ and $S_f$ is the same irrespective of whether the takeover occurs early or at a later stage and

$F_S = 1$.

Q.E.D.

Figure D-4: Equilibrium takeovers when $S$ makes take-it-or-leave-it offers, and associated welfare expected at $t = 0$.




(a) Late takeovers blocked and $I$ develops



(b) Late takeovers authorised and I develops



(c) Late takeovers blocked and $I$ shelves



(d) Late takeovers authorised and $I$ shelves

On the axes, $\bar{H}_1$ is the standard of review (level of tolerated harm) for early takeovers; $F(\bar{B}_L)$ or $F(\bar{B}_H)$ is the a priori probability that the start-up is unconstrained. $F_S$ and $F_W$ represent the cut-off values of the a priori probability that govern the decision regarding the takeover price and, respectively, the approval decision of the AA. The left panels refer to the case in which late takeovers are blocked (i.e. $\bar{H}_2 < W^d - W^M$). The right panels refer to the case in which late takeovers are authorised (i.e. $\bar{H}_2 \geq W^d - W^M$).The top panels refer to the case in which the incumbent develops. $\bar{H}^d_{1,S}$ is the value of $\bar{H}_1$ such that $F_W$ and $F_S$ cross and may be negative as displayed in this Figure. The bottom panels refer to the case in which the incumbent shelves and $\bar{H}^{s(j)}_{1,S}$, with $j = b, a$ depending on whether late takeovers are blocked or authorised, is the value of $\bar{H}_1$ such that $F_W$ and $F_I$ cross. $\bar{H}^{s(j)}_{1,S}$ is necessarily positive.

### D.3.4 The optimal merger policy

In this section, we study the optimal merger policy at $t = 0$, when the AA commits to the two thresholds of tolerated harm, $\bar{H}_1$ and $\bar{H}_2$, respectively for early takeovers and late takeovers.

Allowing for late takeovers does not change the optimal policy regarding early takeovers: it is still the case that high-price takeovers are prohibited. However, under some specific cumulative conditions, specified in Proposition D-1, it is optimal to adopt a lenient approach that approves late takeover.

The optimal policy will be derived considering the pure-strategy equilibria of the bargaining game at $t = 1$. It can be shown that the mixed strategy equilibrium does not exist when late takeovers are authorised. Therefore, the result of Proposition 2 is still valid in this context.

**PROPOSITION D-1** (The optimal merger policy)**.**

1. *The optimal merger policy regarding early takeovers commits to standards of review that prevent early high-price takeovers at the equilibrium:*
   - *(a) If $\pi_I^A = \pi_I^M - K$, there exists a threshold level of $\bar{H}_1$, $\bar{H}_1^d > -(W^M - W^m - K)$, such that all $\bar{H}_1 \leq \bar{H}_1^d$ in the admissible set are optimal for any value of $\alpha$.*
   - *(b) If $\pi_I^A = \pi_I^m$, there exists a threshold level of $\bar{H}_1$, $\bar{H}_1^s > 0$ such that all $\bar{H}_1 \leq \bar{H}_1^s$ in the admissible set are optimal for any value of $\alpha$ and for any $\bar{H}_2$.*
   - *(c) All $\bar{H}_1 \leq \min(\bar{H}_1^d, \bar{H}_1^s)$ in the admissible set are optimal for any value of $\alpha$, $\pi_I^A$ and $\bar{H}_2$.*
2. *The optimal merger policy regarding late takeovers when the start-up has the bargaining power is:*
   - *(a) Lenient, i.e. all $\bar{H}_2 \geq W^d - W^M$ are optimal, if (and only if) $\pi_I^A = \pi_I^m$, $\alpha < \hat{\alpha}$ (with $\hat{\alpha} > 0$), and*
   $$\frac{F(\bar{B}_H)}{F(\bar{B}_L)} > \frac{W^d - K - W^m}{W^M - K - W^m}. \tag{D-15}$$
   - *(b) $\bar{H}_2 < W^d - W^M$ are optimal, otherwise.*

*Proof. Case 1:* The incumbent plans to develop (i.e. $\pi_I^A = \pi_I^M - K$).[20]

Let us consider the case in which the incumbent makes a take-it-or-leave-it offer at $t = 1(a)$. In this case the threshold $\bar{B}(\bar{H}_2) = \pi_S^d - K + A = \bar{B}_L$ for all $\bar{H}_2$ because $I$ has all the bargaining power (see Section D.3.2).

If $\bar{H}_2 \geq W^d - W^M$, expected welfare is the same for any feasible value of $\bar{H}_1$ (i.e. for any $\bar{H}_1 \geq -(W^M - W^m - K)$): in $t = 1(a)$, the incumbent offers a low-price, which is accepted by type $S = S_u$, and the acquisition is authorised by the AA. A start-up of the type $S = S_v$ is acquired in $t = 4(a)$. In either case, the expected welfare is $W^M - K$.

Let $\bar{H}_2 < W^d - W^M$. Lemma D-3 implies that two sub-cases must be considered:

1. If either $F(\bar{B}_L) \leq F_I$ or $F(\bar{B}_L) > \max(F_W, F_I)$, $I$ offers $P_I = 0$ in $t = 1(a)$ and only type $S = S_u$ accepts. Expected welfare is $E(W) = F(\bar{B}_L)(W^d - K) + (1 - F(\bar{B}_L))(W^M - K) > W^M - K$.

[20]For the sake of the exposition, throughout the proof, we drop the functional notation for $F_I$, $F_S$ and $F_W$.

2. If $F(\bar{B}_L) \in (F_I, \max(F_W, F_I)]$, $I$ offers $P_I = \pi_S^d - K$ in $t = 1(a)$ and both $S = S_v$ and $S = S_u$ accept. Expected welfare is $E(W) = W^M - K$. This case arises for the $\bar{H}$ such that $F_W > F_I$.

Since $E(W)$ is strictly larger when $\bar{H}_2 < W^d - W^M$ than when $\bar{H}_2 \geq W^d - W^M$ for all the values of $F(\bar{B}_L)$ such that the first sub-case arises, and it is the same for all the values of $F(\bar{B}_L)$ such that the second sub-case arises, the welfare-maximizing value of $\bar{H}_2$ is such that late takeovers are blocked, i.e. any $\bar{H}_2 < W^d - W^M$ is optimal.

Regarding early takeovers, comparing the two sub-cases, we conclude that the optimal policy is the one that avoids high-price early takeovers from arising at the equilibrium. This can be ensured by setting $\bar{H}_1$ such that $F_W \leq F_I$: in this way, for all the values of $F(\bar{B}_L)$ such that the incumbent finds it profitable to offer a high price, the takeover is blocked.

When $\pi_I^A = \pi_I^M - K$ and $\bar{H}_2 < W^d - W^M$, $F_I = (\pi_S^d - K)/(\pi_I^M - K - \pi_I^d) \in (0,1)$ from Assumptions A1 and A2. Since $F_W$ is strictly increasing in $\bar{H}_1$ (from Lemma D-2, Claim 1), $F_W = 0$ if $\bar{H}_1 = -(W^M - W^m - K)$ and $F_W \geq 1$ for all $\bar{H}_1 \geq W^d - W^M$, there exists $H_{1,I}^d \in (-(W^M - W^m - K), W^d - W^M)$ such that $F_W \leq F_I$ for all $\bar{H}_1 \leq H_{1,I}^d$. Hence, all $\bar{H}_1 \leq \bar{H}_{1,I}^d$ in the set of admissible values of $\bar{H}_1$ are optimal.

Notice that the set of admissible values of $\bar{H}_1$ is such that $\bar{H}_1 \geq -(W^M - K - W^m)$, and $F_W \geq 0$ for all $\bar{H}_1 \geq -(W^M - W^m - K)$. This ensures that low-price early takeovers are authorised under the optimal policy. Moreover, note that $H_{1,I}^d$ is not necessarily positive. Indeed, $H_{1,I}^d < 0$ if $F_W > F_I$ at $\bar{H}_1 = 0$.

We reach similar conclusions when considering the case in which $S$ makes a take-it-or-leave-it offer at $t = 1(a)$ (so that the bargaining outcomes in Lemma D-4 apply). Also in this case the optimal policy regarding late takeovers is strict (the reasoning follows the same logic as in the case in which $I$ makes the take-it-or-leave-it offers outlined above): any $\bar{H}_2 < W^d - W^M$ is optimal. Since late takeovers are blocked, the cut-off level of $B$ is $\bar{B}_L = \pi_S^d - K + A$. The cut-off level of the prior $F(\bar{B}_L)$ that characterises the cases where the start-up offers a high or a low price is now $F_S$.

As in the case in which $I$ has bargaining power, the optimal policy avoids high-price early takeovers from arising at the equilibrium. Hence, all $\bar{H}_1 \leq \bar{H}_{1,S}^d$ in the set of admissible values are optimal, where $\bar{H}_{1,S}^d \in (-(W^M - W^m - K), W^d - W^M)$ is such that, when $\pi_I^A = \pi_I^M - K$ and $\bar{H}_2 < W^d - W^M$, $F_W = F_S = (\pi_S^d - \pi_I^M + \pi_I^m)/(\pi_I^m - \pi_I^d)$, with $F_S \in (0,1)$ from Assumptions A2 and A3.

*Optimal $\bar{H}_1$ and $\bar{H}_2$:*
If $I$ develops, $\pi_I^M - K > \pi_I^m$. Hence $F_S > F_I$ and $H_{1,I}^d < H_{1,S}^d$. A policy $\bar{H}_1 \leq \bar{H}_1^d \equiv H_{1,I}^d$ in the set of admissible values ensures that high-price early takeovers are blocked for any value of $\alpha$, and is optimal irrespective for any value of $\alpha$, as stated in Proposition D-1 (Claim 1.(a)).

We have shown above that, irrespective of who makes the offer, it is optimal to block late takeovers. Hence, when $I$ develops, setting $\bar{H}_2 < W^d - W^M$ is optimal for any $\alpha$, as stated in Proposition D-1 (Claim 2.(b))

*Case 2:* The incumbent plans to shelve (i.e. $\pi_I^A = \pi_I^m$).

Let us start with the case in which $I$ makes a take-it-or-leave-it offer at $t = 1(a)$ so that $\bar{B}(\bar{H}_2) = \pi_S^d - K + A = \bar{B}_L$ for all $\bar{H}_2$ (see Section D.3.2).

Lemma D-3 implies that two sub-cases must be considered:

i.(a) If either $F(\bar{B}_L) \leq F_I$ or $F(\bar{B}_L) > \max(F_W, F_I)$, no early takeover occurs at the equilibrium. Expected welfare is $E(W) = F(\bar{B}_L)(W^d - K) + (1 - F(\bar{B}_L))W^m > W^m$ if late takeovers are blocked, and $E(W) = F(\bar{B}_L)(W^M - K) + (1 - F(\bar{B}_L))W^m > W^m$ if late takeovers are authorised.

ii.(a) If $F(\bar{B}_L) \in (F_I, \max(F_W, F_I)]$, $I$ offers $P_I = \pi_S^d - K$ in $t = 1(a)$ and both types $S = S_v$ and $S = S_u$ accept. Expected welfare is $E(W) = W^m$. This case arises if and only if $F_W > F_I$.

Comparing sub-cases i.(a) and ii.(a), we conclude that the optimal policy regarding early takeovers avoids high-price early takeovers from arising at the equilibrium, irrespective of whether late takeovers are authorised or not. This can be ensured by setting $\bar{H}_1$ such that $F_W \leq F_I$.

When $\pi_I^A = \pi_I^m$ and $\bar{H}_2 < W^d - W^M$, $F_I = (\pi_S^d - K)/(\pi_I^m - \pi_I^d) \in (0, 1)$ from Assumptions A1 and A2. Since $F_W$ is strictly increasing in $\bar{H}_1$, $F_W = 0$ if $\bar{H}_1 = 0$ and $F_W \geq 1$ for all the values of $\bar{H}_1 \geq W^d - W^m - K$, there exists a cut-off value $H_{1,I}^{s(b)} \in (0, W^d - W^m - K)$ such that $F_W \leq F_I$ for all the values of $\bar{H}_1 \leq H_{1,I}^{s(b)}$. The apex $b$ in the cut-off level of $\bar{H}_1$ indicates that late takeovers are blocked.

When $\pi_I^A = \pi_I^m$ and $\bar{H}_2 \geq W^d - W^M$, $F_I = (\pi_S^d - K)/(\pi_I^m - (\pi_I^M - \pi_S^d)) \in (0, 1)$ from Assumption A1 and $K > \pi_I^M - \pi_I^m$. Since $F_W$ is strictly increasing in $\bar{H}_1$, $F_W = 0$ if $\bar{H}_1 = 0$ and $F_W \geq 1$ for all the values of $\bar{H}_1 \geq W^M - W^m - K$, there exists a cut-off value $H_{1,I}^{s(a)} \in (0, W^M - W^m - K)$ such that $F_W \leq F_I$ for all the values of $\bar{H}_1 \leq H_{1,I}^{s(a)}$. The apex $a$ in the cut-off level of $\bar{H}_1$ indicates that late takeovers are authorised.

Let us consider now the case in which $S$ makes a take-it-or-leave-it offer at $t = 1(a)$ (so that the bargaining outcomes in Lemma D-4 apply). The threshold $F_I$ is substituted by $F_S$. More importantly, the relevant cut-off level of $B$ depends on whether late takeovers are authorised: $\bar{B}(\bar{H}_2 \geq W^d - W^M) = \pi_I^M - \pi_I^d - K + A = \bar{B}_H > \bar{B}_L = \pi_S^d - K + A = \bar{B}(\bar{H}_2 < W^d - W^M)$ as established in Lemma D-1.

Therefore,

i.(b) If either $F(\bar{B}(\bar{H}_2)) \leq F_S$ or $F(\bar{B}(\bar{H}_2)) > \max(F_W, F_S)$, no early takeover occurs at the equilibrium. Expected welfare is $E(W) = F(\bar{B}_L)(W^d - K) + (1 - F(\bar{B}_L))W^m > W^m$ if late takeovers are blocked, and $E(W) = F(\bar{B}_H)(W^M - K) + (1 - F(\bar{B}_H))W^m > W^m$ if late takeovers are authorised.

ii.(b) If $F(\bar{B}(\bar{H}_2)) \in (F_S, \max(F_W, F_S)]$, both types $S = S_v$ and $S = S_u$ offer $\bar{P}$ in $t = 1(a)$ and $I$ accepts. Expected welfare is $E(W) = W^m$. This case arises if and only if $F_W > F_S$.

Regarding early takeovers, the comparison between sub-cases i.(b) and ii.(b) allows us to conclude that, irrespective of whether late takeovers are authorised or blocked, the optimal policy is the one that avoids high-price early takeovers from arising at the equilibrium. This can be ensured by setting $\bar{H}_1$ such that $F_W \leq F_S$.

When $\pi_I^A = \pi_I^m$ and $\bar{H}_2 < W^d - W^M$, $F_S = F_I = (\pi_S^d - K)/(\pi_I^m - \pi_I^d) \in (0,1)$ from Assumptions A2 and A3. As shown above, setting any value of $\bar{H}_1$ such that $\bar{H}_1 \leq \bar{H}_{1,I}^{s(b)}$ is optimal.

When $\pi_I^A = \pi_I^m$ and $\bar{H}_2 \geq W^d - W^M$, $F_S = \frac{\pi_I^M - \pi_I^d - K}{\pi_I^m - (\pi_I^m - \pi_I^d)} \in (0,1)$ from Assumptions A2, A3 and from $K > \pi_I^M - \pi_I^m$. Since $F_W$ is strictly increasing in $\bar{H}_1$, $F_W = 0$ if $\bar{H}_1 = 0$ and $F_W \geq 1$ for all the values of $\bar{H}_1 \geq W^M - W^m - K$, there exists $H_{1,S}^{s(a)} \in (0, W^M - W^m - K)$ such that $F_W \leq F_S$ for all $\bar{H}_1 \leq H_{1,S}^{s(a)}$.

*Optimal $\bar{H}_1$ and $\bar{H}_2$:*
Note that the cut-off levels $\bar{H}_{1,I}^{s(b)}$, $\bar{H}_{1,I}^{s(a)}$ and $\bar{H}_{1,S}^{s(a)}$ are all positive. Hence the policy $\bar{H}_1 \leq \bar{H}_1^s = \min(\bar{H}_{1,I}^{s(b)}, \bar{H}_{1,I}^{s(a)}, \bar{H}_{1,S}^{s(a)}) > 0$ ensures that high-price early takeovers are blocked and is, therefore, optimal, irrespective of the value of $\alpha$ and of $\bar{H}_2$, as stated in Proposition D-1 (Claim 1.(b)).

Let us consider now the policy regarding late takeovers. Since the optimal policy prevents high-price takeovers from arising and, because the incumbent would shelve, no takeover is always more profitable than a low-price early takeover, no early takeover occurs at the equilibrium.

When the incumbent makes the offer at $t = 1(a)$, which occurs with probability $\alpha$, expected welfare is $F(\bar{B}_L)(W^d - K) + (1 - F(\bar{B}_L))W^m$ if late takeovers are blocked, and $F(\bar{B}_L)(W^M - K) + (1 - F(\bar{B}_L))W^m$ if late takeovers are authorised. Hence, authorising late takeovers causes a welfare loss equal to $F(\bar{B}_L)(W^d - W^M)$.

When the start-up makes the offer at $t = 1(a)$, which occurs with probability $1 - \alpha$, expected welfare is $F(\bar{B}_L)(W^d - K) + (1 - F(\bar{B}_L))W^m$ if late takeovers are blocked, and $F(\bar{B}_H)(W^M - K) + (1 - F(\bar{B}_H))W^m$ if late takeovers are authorised. Since $\bar{B}_H > \bar{B}_L$, authorising late takeovers is not necessarily welfare detrimental.

When condition (D-15) does not hold, authorising late takeovers causes a welfare loss also when the start-up makes the offer. Hence, it is optimal to block late takeovers for any $\alpha$, as stated in Proposition D-1 (Claim 2.(b)).

When, instead, condition (D-15) holds, authorising late takeovers causes a welfare gain when the start-up makes the offer. In $t = 0$, the AA will authorise late takeovers if and only if the gain enjoyed when $S$ makes the offer dominates the loss suffered when $I$ makes the offer:

$$\Delta(\alpha) = (1-\alpha)[F(\bar{B}_H)(W^M - K - W^m) - F(\bar{B}_L)(W^d - K - W^m)] - \alpha[F(\bar{B}_L)(W^d - W^M)] > 0.$$

Since $\Delta(0) > 0$ if condition (D-15) is satisfied, $\Delta(1) < 0$ and $\Delta(\alpha)$ is strictly decreasing in $\alpha$, there exists a threshold level of $\alpha$, $\hat{\alpha} \in (0,1)$, such that $\Delta(\alpha) > 0$ if (and only if) $\alpha < \hat{\alpha}$.

To sum up, when $\pi_I^A = \pi_I^m$, condition (D-15) holds and $\alpha < \hat{\alpha}$, the optimal policy is to authorise late takeovers, as stated in Proposition 1 (Claim 2.(a)). In all the other cases, the optimal policy is to block late takeovers, as stated in Proposition 1 (Claim 2.(b)).

Recall that $B \in [0, \pi_S^d]$. Moreover, if $A = K$, $B_L = \pi_S^d$ and $B_H = \pi_I^M - \pi_I^d > \pi_S^d$. Hence, if $A = K$, $F(\bar{B}_H) = F(\bar{B}_L) = 1$, the l.h.s. of condition (D-15) is equal to 1, and condition (D-15) is not satisfied. As $A$ decreases in $[K - (\pi_I^M - \pi_I^d - \pi_S^d), K]$, $F(\bar{B}_H) = 1$ because $B_H$ is still higher than $\pi_S^d$, whereas $F(\bar{B}_L) < 1$ and decreases as $A$ decreases. Hence, the left hand side of condition (D-15) increases as $A$ decreases $[K - (\pi_I^M - \pi_I^d - \pi_S^d), K]$ and condition (D-15) will not be satisfied for $A$ sufficiently close to $K$.

To conclude, we now derive a policy that is optimal also irrespective of whether $I$ shelves or develops the project after the early takeover.

*Optimal $\bar{H}_1$ (irrespective of shelving or developing):*

All $\bar{H}_1 \leq \min(\bar{H}_1^d, \bar{H}_1^s)$ in the set of admissible values are optimal irrespective of the value of $\pi_I^A$, $\alpha$ and $\bar{H}_2$, as stated in Proposition D-1 (Claim 1.(c)).

Q.E.D.

# E The incumbent has superior information and the start-up holds the bargaining power

We turn here to the case where the start-up makes take-it-or-leave-it offers at the takeover stage.

## E.1 Equilibrium of the bargaining game

**LEMMA E-1** (PBE of the bargaining game when $S$ makes the offer)**.**
*Let*

$$F_{SS}(\pi_I^A) \equiv \frac{\pi_I^A - \pi_I^m}{\pi_I^A - \pi_I^d} \in [0, 1), \tag{E-1}$$

*with $F_{SS} \leq F_{II}$, and $\bar{H}_1(\pi_I^A)$ be such that $F_W(\pi_I^A, \bar{H}) = 1$.*

*When $S$ makes a take-it-or-leave-it offer:*

1. *If $\pi_I^A = \pi_I^M - K$ and either $\bar{H} < \bar{H}_1$ and $p \leq \min(F_W, F_{II})$ or $\bar{H} \geq \bar{H}_1$ and $p \leq F_{SS}$, the PBE is: $\{s_S^* = P_L, r_I^*(S_v) = r_I^*(S_u) = r_I^* =$ Accept $P_L$; $\phi(\{s_S^*, r_I^*\}) = p\}$, with $P_L = \pi_I^M - K - \pi_I^m$.*
2. *For any $\pi_I^A$, if $\bar{H} \geq \bar{H}_1$ and $p > F_{SS}$, the PBE is: $\{s_S^* = \pi_I^A - \pi_I^d, r_I^*(S_v) =$ Accept $\pi_I^A - \pi_I^d$, $r_I^*(S_u) =$ Reject $\pi_I^A - \pi_I^d$; $\phi(\{s_S^*, r_I^*(S_v)\}) = 1, \phi(\{s_S^*, r_I^*(S_u)\}) = 0\}$.*
3. *For any $\pi_I^A$, if $\bar{H} < \bar{H}_1$ and $p > \min(F_W, F_{II})$, no takeover occurs at the equilibrium.*

*Proof.* One possible equilibrium entails $S$ offering the price $P_L = \pi_I^A - \pi_I^m$, knowing it will be accepted irrespective of the type of the start-up: this is the highest price that the incumbent is willing to pay when it observes that the start-up is unviable.

For this to be an equilibrium, $S$ must not have an incentive to deviate and offer the price $P' = \pi_I^A - \pi_I^d > \pi_S^{\emptyset}(S_v)$, i.e. the highest price that the incumbent is willing to pay when it observes that the start-up is viable. Such an offer will be accepted with probability $p$. Hence, for the deviation not to be profitable, it must hold that $P_L = \pi_I^A - \pi_I^m \geq p(\pi_I^A - \pi_I^d)$, which is satisfied if (and only if) $p \leq (\pi_I^A - \pi_I^m)/(\pi_I^A - \pi_I^d) \equiv F_{SS} \in [0, 1)$. When the incumbent shelves ($\pi_I^A = \pi_I^m$), the highest price that the incumbent is willing to pay for an unviable start-up is $P_L = 0$. Hence, offering $P'$ is always a profitable deviation ($F_{SS} = 0 = F_{II}$), and the equilibrium in which $S$ offers $P_L$ does not exist.

Moreover, the deal must be approved by the AA, which requires $p \leq F_W$. Hence, when the incumbent develops, both conditions must be satisfied for the offer of the price $P_L$, accepted irrespective of the type of the start-up, to be an equilibrium.

When $p > F_{SS}$, $S$ finds it more profitable to offer the high price $P = \pi_I^A - \pi_I^d > \pi_S^{\emptyset}(S_v)$ that the incumbent accepts only when it observes that the start-up is viable. However, for the high-price offer to be an equilibrium, the deal must be authorised by the AA. After observing this price the AA updates its beliefs ($\phi = 1$). Hence, the deal will be authorised only when $1 \leq F_W$, or $\bar{H} \geq \bar{H}_1(\pi_I^A)$.

When $p > F_{SS}$ and $\bar{H} < \bar{H}_1(\pi_I^A)$, the high-price offer featuring $P \geq \pi_I^A - \pi_I^d$ is blocked by the AA. $S$ might therefore make the second-best offer $P_L = \pi_I^A - \pi_I^m$. It will do so, when making such an offer is more profitable than making no offer, which requires $P_L = \pi_I^A - \pi_I^m \geq p(\pi_S^d - K)$ or, equivalently, $p \leq F_{II}$. Moreover, the AA must authorise the low-price takeover, which requires that $p \leq F_W$. When the incumbent shelves ($\pi_I^A = \pi_I^m$), $F_{II} = 0$ and the low-price offer is not an equilibrium.

Finally, no takeover occurs when $\bar{H} < \bar{H}_1(\pi_I^A)$ and $p > \min(F_W, F_{II})$: either the AA blocks also a low-price takeover featuring $P_L$, or $S$ finds it more profitable not to engage in any takeover than offering $P_L$.

Q.E.D.

### E.2 Optimal merger policy

We now prove that the same optimal merger policy as in the case featuring $I$ making the offer emerges in this context featuring $S$ making the offer.

**PROPOSITION E-1** (Optimal merger policy when $I$ has superior information).
*When the incumbent has superior information and the start-up has the bargaining power, it is optimal for the AA to commit to the same standard of review as in Proposition 3.*

*Proof.* See the proof of Proposition 3 (in Appendix A.6). Q.E.D.

## F Bidding competition

We solve a version of the model in which two incumbents (1 and 2) compete to acquire the start-up. We consider the case where there is symmetric information between the bidders and the start-up, and the potential acquirers make the offers. Moreover, we consider a merger policy explicitly based on the transaction price, not on standards of review.

As we will see, in the case of shelving, a policy that commits to the appropriate standards of review would achieve the same outcome. In the case of development, instead, a merger policy that explicitly prohibits high-price takeover may be necessary to maximise expected welfare. The reason is that bidding competition may push the price up, above the outside option of $S_v$, also when the target is unviable. In Lemma F-2 below this is the case when the willingness to pay of the losing incumbent is higher than the outside option of the viable start-up. If so, a high price fails to convey information that the AA can use to make a better assessment of the welfare effect of the takeover. Hence, the optimal outcome cannot be achieved through the appropriate choice of the standards of review.

We need to adapt the notation of our model and the assumptions to this setting with two incumbents. The condition that the NPV of the project is positive becomes:

$$\pi_S(1,2,S) > K, \tag{A1'}$$

where $(1,2,S)$ to denote the market configuration where incumbent firms 1 and 2, and start-up $S$, sell. Thus, $\pi_S(1,2,S)$ is the profit of the start-up when it competes with two incumbents (in the baseline model, it was $\pi_S^d$).

Next, for at least one incumbent firm $i$, with $i,j = 1,2$ and $i \neq j$, the following must hold:

$$\pi_i(i+S,j) > \pi_i(i,j,S) + \pi_S(i,j,S) \tag{A2'}$$

$$\pi_S(i,j,S) > \pi_i(i+S,j) - \pi_i(i,j) \tag{A3'}$$

where $(i+S,j)$ denotes the case where the acquirer $i$ develops the project (the equivalent of $\pi_I^M$ in the baseline model) and $(i,j)$ the one where it does not (the equivalent of $\pi_I^m$). Assumption A2' restates the efficiency effect: the joint profits of an incumbent $i$ and the start-up are higher when they merge ($\pi_i(i+S,j)$) than when they compete ($\pi_i(i,j,S)+\pi_S(i,j,S)$). It implies that at least an incumbent firm will be able to acquire the start-up. Assumption A3' restates the Arrow replacement effect.

We also keep the assumptions that $W(i,j,S) > W(i+S,j)$, i.e., competition improves welfare, and that project development by the incumbent $i$ is welfare beneficial:

$$W(i+S,j) - K > W(i,j). \tag{A4'}$$

Finally, the value of the outside option of a viable start-up ($S_v$) is $\pi_S^{\emptyset}(S_v) = \pi_S(i,j,S) - K$; thus, we say that an acquisition carries a high price if $P \geq \pi_S(i,j,S) - K$.

## F.1 Shelving

If no incumbent firm would develop after acquiring $S$: $\pi_i(i,j) > \pi_i(i+S,j) - K$, for $i,j = 1,2$, the following holds:

**LEMMA F-1** (Equilibrium of the bidding game when the incumbent firms shelve). *Let $\pi_i(i,j) > \pi_i(i+s,j) - K$, for $i,j = 1,2$. Then, at equilibrium:*

1. *If $S = S_v$, (i) under laissez-faire, incumbent $i$ bids $P_i = \pi_S(i,j,S) - K$, the other bids $P_j = 0$, and $S_v$ accepts $i$'s offer. (ii) If there is a policy rule which allows an acquisition provided that its price $P < \pi_S^{\emptyset}(S_v) = \pi_S(i,j,S) - K$, then no takeover takes place.*

2. *If $S = S_u$, incumbent firms make no bid and there is no takeover.*

*Proof.* Claim 1.(i): Given $P_j = 0$, firm $i$ has no incentive to deviate: if it reduced its bid the start-up would reject the offer, and $i$ would gain $\pi_i(i,j,S) < \pi_i(i,j) - \pi_S(i,j,S)$, which follows from Assumption (A2') and from the shelving hypothesis. And of course, it has no incentive to raise its bid given that $S$ already accepts the offer. Firm $j$ has no incentive to deviate either. The start-up's threat of competition is eliminated by the acquisition by $i$. Outbidding $i$ by setting $P_j' > P_i$ would reduce profit from $\pi_j(i,j)$ to $\pi_j(i,j) - P_j'$. In turn, $S$ obtains its outside option and it cannot improve it by rejecting the offer. Finally, there is no equilibrium where no incumbent buys the start-up because $i$ would deviate and purchase the start-up, obtaining $\pi_i(i,j) - \pi_S(i,j,S) > \pi_i(i,j,S)$.

Claim 1.(ii): For any price below its outside option, the start-up will reject the offer.

Claim 2: When the start-up is not viable, and a potential acquirer would shelve, no firm will make a takeover bid to avoid transaction costs. Q.E.D.

## F.2 Development

Next, consider the case where incumbent firms have the incentive to develop after acquiring $S$: $\pi_i(i+S,j)-K > \pi_i(i,j)$. Denote firm $i$'s willingness to pay as: $w_i = \pi_i(i+S,j)-K-\pi_i(i,j+S)$, with $i,j = 1,2;\ \ i \neq j$, and assume without loss of generality that $w_1 > w_2$. We also adopt a tie-break rule according to which, if the incumbent firms formulate the same offer, the one with a higher willingness to pay acquires the start-up.

**LEMMA F-2** (Equilibrium of the bidding game when incumbent firms develop). *Let $\pi_i(i+S,j) - K > \pi_i(i,j)$. Then, at equilibrium:*

1. *If $S = S_v$, (i) under laissez-faire, incumbent firm 1 bids $P_1^v = \max(\pi_2(1,2+S) - K - \pi_2(1+S,2); \pi_S(1,2,S) - K)$, incumbent firm 2 bids $\max(\pi_2(1,2+S) - K - \pi_2(1+S,2), 0)$, and the start-up accepts the offer of incumbent firm 1. (ii) If there is a policy rule which allows an acquisition provided the acquisition price $P < \pi_S(i,j,S) - K$, no bid is made and no takeover takes place.*

2. *If $S = S_u$, (i) under laissez-faire, incumbent firm 1 bids $P_1^u = \max(\pi_2(1,2+S) - K - \pi_2(1+S,2); 0\}$, incumbent firm 2 bids $\max(\pi_2(1,2+S) - K - \pi_2(1+S,2), 0)$, and the start-up accepts the offer of incumbent firm 1. (ii) If there is a policy rule which allows an acquisition provided its price $P \leq P^a$, with $P^a < \pi_S(i,j,S) - K$, firm $j$ bids $\min(P^a, \max(\pi_2(1,2+S) - K - \pi_2(1+S,2), 0))$, firm $i$ matches the offer and it takes over the start-up.*

*Proof.* Claim 1.(i): Suppose first that incumbent firm 2's valuation is not large enough to acquire the start-up: $w_2 = \pi_2(1,2+S) - K - \pi_2(1+S,2) \leq \pi_S(1,2,S) - K$. In this case, the incumbent firm 1 will acquire the start-up by offering $\pi_S(1,2,S) - K$, which follows from Assumption A2'. If instead $w_2 = \pi_2(1,2+S) - K - \pi_2(1+S,2) > \pi_S(1,2,S) - K$, then both firms are willing to make offers for the start-up, and the incumbent firm 1, which has the higher valuation, will acquire it.

Claim 1.(ii): Since the allowed price is always below the outside option of the start-up, there is no point for an incumbent to make an offer.

Claim 2.(i): If $\pi_2(1,2+S) - K - \pi_2(1+S,2) > 0$, then the two incumbent firms will bid for the start-up and at equilibrium $P_1^u = \pi_2(1,2+S) - K - \pi_2(1+S,2)$. If instead $\pi_2(1,2+S) - K - \pi_2(1+S,2) \leq 0$ then the incumbent firm 1 will acquire $S$ by paying $P_1^u = 0$.

Claim 2.(ii): If there is a binding constraint in the acquisition price, firm 2 can either bid $P^a$ or below it if its valuation is inferior to $P^a$. Either the incumbent firm 1 bids higher than the incumbent firm 2, or under our tie-break rule, the incumbent firm 1 will acquire $S$ in case of equal bids. The start-up receives an offer which is at least as high as its outside option and will sell to the incumbent firm 1. Q.E.D.

### F.3 Optimal merger policy with bidding competition

Building on the previous lemmas, we can now state the optimal policy.

**PROPOSITION F-1** (Optimal merger policy with bidding competition)**.**
*Whether potential acquirers have the incentive to shelve or to develop, a merger policy which prohibits an acquisition whose price is* $P \geq \pi_S^{\emptyset}(S_v) = \pi_S(i,j,S) - K$ *is optimal.*

*Proof.* In the case of shelving, if $S = S_v$, prohibiting high-price takeovers would strictly raise welfare: $W(i,j,S) > W(i,j)$; if $S = S_u$, it would leave welfare unaffected, because takeovers do not take place anyhow. In the case of developing, if $S = S_v$ prohibiting high-price takeovers would strictly raise welfare: $W(i,j,S) - K > W(i+S,j) - K$; if $S = S_v$ welfare is unchanged because a welfare-beneficial takeover will still take place ($W(i+S,j) - K > W(i,j)$ by Assumption A4'), just at a lower acquisition price than absent the cap. Q.E.D.