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

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Abstract

A start-up and an incumbent negotiate over an acquisition price under asymmetric information about the start-up's ability to succeed in the market. The acquisition may result in the shelving of the start-up's project or the development of a project that would otherwise never reach the market because of financial constraints. Despite this possible pro-competitive effect, 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 lacking the financial resources to develop independently, and increases expected welfare.

Keywords: Optimal merger policy, selection effect, nascent competitors.

JEL Classification: L41, L13, K21

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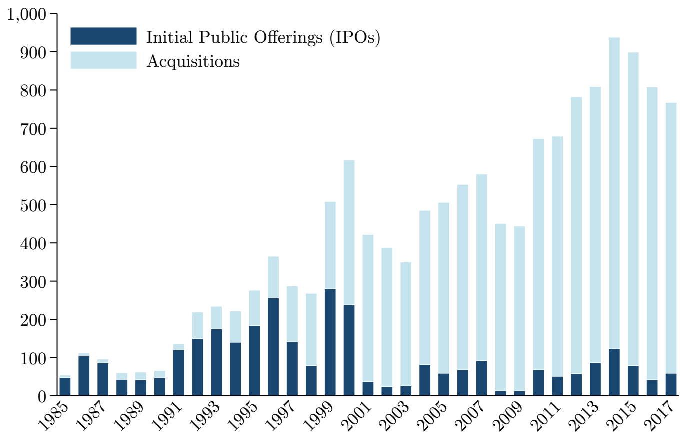
1 Introduction

Potential competitors are firms that currently do not exert competitive pressure but might do so in the future. The acquisition of these firms is a widespread phenomenon. As Figure 1 shows, since the mid-90s there has been a dramatic shift in the exit strategy of venture-capital backed start-ups, from IPOs towards acquisitions. 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), but this phenomenon extends beyond the digital industries. Similar patterns prevail in other industries such as, among the others, the healthcare and the pharmaceutical industries, as documented by Eliason et al. (2020) and Cunningham et al. (2021), respectively.

Figure 1: Venture capital start-up exit by type.



The figure is drawn from Pellegrino (2021). It plots the number of successful exits of venture-capital backed start-ups in the US by year and type (Initial Public Offering vs. Acquisition). The data is sourced from the National Venture Capital Association (NVCA).

In the vast majority of cases, such acquisitions did not trigger mandatory pre-merger notification requirements, leading to stealth consolidation (see Wollmann, 2019). When Antitrust Agencies (AAs) did open an investigation, they authorised them, with the exception of the recent Facebook/Giphy decision by the UK's CMA. 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, among many others, Williamson, 1968; Farrell and Shapiro, 1990; McAfee and Williams, 1992). The acquisition of potential competitors triggers an additional trade-off. On the one hand, the incumbent may acquire the start-up to then shelve the start-up's project. This would be a "killer acquisition" as documented by Cunningham et al. (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 availability of resources – managerial skills, market opportunities, capital – that the target firm lacks.

In this paper we focus on financial resources as the key asset start-ups may be short of and that acquirers can complement. There is ample evidence that the presence of financial constraints is an important impediment to the start-ups' growth. Based on the Small Business Credit Survey, the Federal Reserve Bank of New York (2017) concluded that, in the US, more than two-thirds of start-ups faced financial challenges.[1] Moreover, Erel et al. (2015) empirically document that acquisitions can relieve financial frictions, especially when the target is relatively small. Building on this evidence we then ask: in the presence of potential entrants facing financial constraints, what merger policy should the antitrust authority follow?

To answer this question we propose a model where a start-up owns a project with positive net present value that, if developed, will allow it to compete with an incumbent firm. The start-up has insufficient resources to invest in development, and has to raise external funds. However, depending on the severity of moral hazard, proxied in the model by the start-up's private benefits B, inefficient credit rationing may arise at the equilibrium, and the start-up may be denied external funding. In that case, the start-up will not be able to develop the project and succeed in the market as an independent company. Hence, depending on the realization of B, our model features two types of start-ups: those that are financially constrained and those that are not.

We assume that the incumbent can acquire the start-up in two moments. The first moment is prior to project development, before the start-up asks for funding. We will denote these acquisitions, which involve *potential competitors*, as *early takeovers*. If a start-up managed to secure funding, the second opportunity for an acquisition is after development, i.e. when it is *committed to entering* the market. We will denote these acquisitions as *late takeovers*.[2] We model the bargaining over the takeover price as a non-cooperative game. With some probability it is the incumbent that makes a take-it-or-leave-it offer to the start-up; with complementary probability it is the start-up. This probability captures agents' relative bargaining power. Whatever the stage at which the acquisition proposal is made, an AA will decide whether to approve or block it consistently with the standard of review to which it commits at the beginning of the game.[3]

The incumbent is assumed to own enough resources to be able to cover the cost of development.

[1]The survey finds that 69% of start-up applicants experienced a financing shortfall, meaning they obtained less than the amount they sought, compared to 54% of mature applicants. Similarly, in the Survey on the Access to Finance of Enterprises (European Central Bank, 2019) a significant share of small and medium firms report that access to funding is their most important problem. Of course, there is also wide sectoral variation in the extent to which small firms have access to funding, and in the type of funding (Berck and DeMarzo, 2020).

[2]This is a relevant distinction in practice. The US Horizontal Merger Guidelines explicitly distinguish between potential entrants and committed entrants. The potential entrants are those that are "likely [to] provide [...] supply response" in the event the conditions allow them to compete on the market. The 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."

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

Following an early takeover, it can develop the project itself, thereby introducing a new product in the market when financial constraints might prevent the target from doing so. However, cannibalisation of existing profits may weaken investment incentives and the incumbent may shelve a project that an unconstrained target would carry out.

Finally, we assume that players are not equally informed about the start-up's ability to raise external funds and, therefore, to succeed in the absence of the acquisition. Financiers (and the start-up) observe the severity of the moral hazard problem, that is, they observe the value of B, and know whether the start-up will be able to pay back the loan. Instead, when engaging in the early takeover, the incumbent and the AA only know the distribution of B. This approach reflects 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 the start-up's banking records and history of debt repayment, while incumbents and AA may not have access to the same amount of information. Further, AAs generally lack the sophisticated financial ability necessary to interpret the relevant data, should they be able to access them.[4]

All these assumptions imply that the price of early takeovers is determined in a non-cooperative bargaining game with asymmetric information, and alternative bargaining power allocation. When we restrict the analysis to equilibria in pure strategies, the early takeover bargaining game can feature two types of equilibrium offers: either a high takeover price, such that any start-up would accept (or offer) that price, irrespective of its type; or a low takeover price, targeting only the financially constrained start-ups.

If a low price is accepted, the AA infers that the start-up is financially constrained and will authorise the deal. This is the case in which the early takeover is (weakly) beneficial: if the incumbent develops, a new product will reach the market; if it shelves, nothing changes since the start-up would not have been able to develop the product anyway. A high price, instead, does not reveal additional information on the type of start-up. The AA will authorise the deal if the prior probability that the start-up is unconstrained is low enough. If so, the scenario in which the early takeover is welfare detrimental, because of the suppression of product market competition and, when the incumbent shelves, also of project development, is sufficiently unlikely. However, the incumbent needs to be willing to pay a high price for the start-up. By doing so, it is certain to appropriate the project and avoid product market competition, but it may end up overpaying for a constrained start-up. This is a risk worth taking when the prior probability that the start-up is unconstrained is high enough.

[4]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 on their own is the negotiation between Excite and Google regarding a possible takeover (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 the uncertainty surrounding Google's ability to grow on its own, Excite decided to pass on the offer. In the words of George Bell, the Excite's CEO at the time (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."

Based on these considerations, we derive the optimal merger policy. We show that the merger policy targeting early takeovers exerts a "selection effect": for configurations of the parameters for which a high-price offer is profitable for the incumbent, the anticipation that the deal will be blocked leaves no other option than offering a low price. In this case, the merger policy pushes towards early acquisitions that target only constrained start-ups and are thus preferable in terms of welfare. Moreover, the more stringent the standards of review established for early takeover, the stronger the selection effect and the more likely that a low-price takeover replaces a high-price takeover at the equilibrium. This is the main message of the paper: despite the possible pro-competitive effect when the incumbent develops, the optimal merger policy should not be lenient towards early takeovers. We show that the optimal merger might commit to standards of review that prohibit high-price takeovers that ex post are welfare-beneficial. By forcing the switch to a low-price takeover, such a merger policy makes expected welfare even higher.

As part of the characterisation of the optimal decision of the AA, we also derive an "information-free" optimal merger policy regarding early takeovers, that is, a policy that is neither contingent on the incumbent's decision to shelve or develop, nor on the allocation of bargaining power. This policy requires that the AA is able to compute the relevant payoffs in the various scenarios.

When we focus on pure strategies, there cannot exist an equilibrium in which the two start-ups (unconstrained and constrained) are acquired at different positive prices. The reason is that the constrained start-up would always have an incentive to mimic the unconstrained one. This may lead to an inefficiency from the firms' perspective, since there may not be a takeover of the unconstrained start-up even when such takeover would increase industry profits. Mixed-strategy equilibria alleviate this inefficiency. We characterise the conditions for the existence of such equilibria. Moreover, we show that the merger policy that is optimal when one considers only equilibria in pure strategies is still optimal when one allows for equilibria in mixed strategies.

Finally, we show that the optimal merger policy establishes a possibly more lenient treatment towards late acquisitions than early acquisitions. This result may seem paradoxical. However, note that the anticipation of a late takeover – which allows the start-up to share the gains from higher industry profits – relaxes financial constraints and makes it more likely that the new product reaches the final market. Nevertheless, this lenient approach is optimal when a number of cumulative conditions hold: (i) the incumbent is expected to shelve the project in case of an early takeover; (ii) the sacrifice of allocative efficiency is dominated by the gain in "dynamic efficiency"; (iii) start-ups have sufficient power in bargaining over the takeover.

From a policy perspective, our analysis questions the current laissez-faire approach towards acquisitions of potential competitors and supports the current proposals towards stricter enforcement of these mergers. Moreover, it suggests that AAs should use the information conveyed by the takeover price when reviewing acquisitions of potential competitors.

In our setting, a high takeover price signals that the takeover may not be indispensable for the success of the start-up and that, therefore, is likely to raise anti-competitive concerns. This insight can be applied more broadly: in our model one can interpret as synergies the fact that I's assets, by complementing the assets of the start-up, may enable development, but acquisitions might produce synergies of different nature. Also in those cases a high transaction price may reflect that the start-up does not need those synergies to grow and have success in the market, and that the takeover may harm competition. This insight supports the use of a transaction value threshold as an additional test to identify mergers that are potentially anti-competitive and that deserve a closer look.[5] This echoes the proposals made by various AAs to revise their approach towards mergers in digital markets (see, CMA, 2021:51). However, the validity of this approach extends beyond the digital industries and can be applied to screen any merger involving a potential competitor.

Our results also suggest that the information conveyed by a high transaction value should be used not only for the initial screening but also for the assessment of the counterfactual to the mergers that are investigated and of their effects on competition.

Literature review Our paper contributes to several literatures at the intersection between industrial organization, financial economics and innovation economics.

A recent literature has analysed theoretically how the acquisitions of potential competitors affect the target's project development.[6] Cunningham et al. (2021) determine the conditions under which, after acquiring the potential entrant, the incumbent has incentives to shelve the entrant's project. In this way, the monopoly avoids the cannibalisation of own existing products' sales. Differently from them, our model features asymmetric information regarding the start-up's type. Moreover, we model the AA as a strategic player, and derive the optimal merger policy accordingly. Wang (2021) shows that blocking a merger can exacerbate financial constraints and lead to underinvestment in project development in a model with adverse selection à la Myers and Majluf (1984). This is similar to our insight that approving late acquisitions can relax financial constraints. However, our analysis is different in two important dimensions. First, we model the link between investments and product market competition. Second, since the AA is a strategic player of the game, we show that the optimal merger policy gives rise to a selection effect in the choice of the takeovers that occur in equilibrium. Another difference with respect to both papers is that we also distinguish between the acquisitions of potential competitors and those of committed entrants.

There is a literature that studies the interaction between late and early takeovers. In particular, in Norbäck and Persson (2009), incumbents engage in a pre-emptive early acquisition to avoid

[5]The current notification thresholds mostly based on both merger parties having a sufficiently high turnover, prevent AAs from investigating the vast majority of mergers involving potential competitors.

[6]There is also a literature that emphasizes the effect of acquisitions of potential competitors on innovation and on the direction of innovation (e.g., among others, Rasmusen, 1988; Norbäck and Persson, 2012; Bryan and Hovenkamp, 2020; Letina et al., 2020; Katz, 2020; Cabral, 2021; Bisceglia et al., 2021; Denicolò and Polo, 2021; Gilbert and Katz, 2021; Kamepalli et al., 2021; Motta and Shelegia, 2021; Callander and Matouschek, 2022). Our paper is related to this literature to the extent that it shows the possible ex-ante effects of late takeovers: the expectation of higher future gains (by selling out, the start-up would appropriate some of the rents from lower competition) may increase the chances of receiving funding, which in turn may make it easier to bring the new product to the market. (This literature mostly focuses on the incentives for entrepreneurs to innovate in the first place.)

"excessive" investment in project development by the independent start-up which, in turn, is due to the prospect of a late acquisition. Arora et al. (2021) study the interaction from the perspective of the start-up. Their model analyses the trade-off faced by the start-up, between capturing more value being acquired late, when the business is more mature, and running a greater risk of failing due to lacking assets. In these papers, however, there is no AA taking decisions on the mergers, and they do not investigate merger policy.

We also contribute to the vast industrial organization literature on horizontal mergers (see, e.g., Farrell and Shapiro, 1990; Besanko and Spulber, 1993; Armstrong and Vickers, 2010; Nocke and Whinston, 2010; Nocke and Whinston, 2013), by determining the optimal merger policy regarding both committed entrants and potential competitors in the presence of 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 financially constrained, of the bargaining power allocation or of whether the incumbent has an incentive to shelve the project.

In equilibrium, a selection effect shapes the AA's optimal merger policy, which forbids high-price takeovers to induce parties towards early acquisitions that target constrained start-ups, and are thus preferable in terms of welfare. To obtain this outcome, the AA may have to block some welfare-increasing mergers. A similar selection effect arises in Nocke and Whinston (2013), where the AA also 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.

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

The paper proceeds as follows. Section 2 presents the ingredients of the model. Sections 3 to 6 solve the model by backward induction. In particular, Section 5 presents the equilibria in pure strategies and Section 6 identifies the optimal merger policy in this context. Section 7 characterises the equilibria when one allows for mixed strategies and shows that the merger policy identified in Section 6 is still optimal. Section 8 concludes the paper.

2 The model

There are three players in our game: an Antitrust Authority (AA), which at the beginning of the game decides its merger policy;[7] a monopolist (I)ncumbent; and a (S)tart-up.[8] The start-up owns a "prototype" (or project) that, if developed, can give rise to a substitute/higher quality product to the incumbent's existing product, or a more efficient production process. The start-up does not have enough own resources to develop the project. It has two options: it can either obtain additional funds from competitive capital markets, or sell out to the incumbent. The incumbent will have to decide whether and when it wants to acquire the start-up (and if it does so before product development, it has to decide whether to develop the prototype or shelve it), conditional on the AA's approval of the acquisition. We assume that the takeover involves a negligible but positive transaction cost.[9]

The AA commits at the beginning of the game to a merger policy. We shall consider a policy consistent with the approach currently adopted in most jurisdictions: initially the AA commits to a standard of review, that we will denote as $\bar{H}$; when a merger project will be proposed, the AA's decision to approve or block the merger will have to be consistent with the committed standard.

$\bar{H}$ indicates the maximum level of "harm" that the AA it is ready to tolerate. If $\bar{H} > 0$, the AA commits to approving even mergers that produce a reduction in 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 $\bar{H} < 0$, also a welfare beneficial merger can be blocked, if the expected increase in welfare is lower than the minimum level $\bar{H}$ that the AA requires. The expected impact on welfare of a proposed merger consists of the difference between the expected welfare if the merger goes ahead, and in the counterfactual where it does not take place (derived of course by correctly anticipating the continuation equilibrium of the game).

We allow the AA to commit to two different standards for mergers involving a potential competitor, that is, before project development, denoted as $\bar{H}_1$, and for mergers involving a committed entrant, that is, after project development, denoted as $\bar{H}_2$. In what follows, we call "early takeover" one which involves a potential competitor, and "late takeover" one which involves a committed entrant.

Product market payoffs We now describe the payoffs that firms and consumers obtain depending on whether the innovation is taken to the market and on which firm has developed the

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

[8]We follow Cunningham et al. (2021) and consider a model with a single acquirer I.

[9]This assumption serves as a tie-breaking rule when the profits of the agent making the offer are the same with and without the takeover (gross of the transaction costs).

[10]In the real world $\bar{H}$ is usually strictly positive for several reasons: the law prescribes that only mergers that *significantly* affect competition can be prohibited; some mergers may not even be reviewed because they do not meet notification criteria (e.g., in most jurisdictions the merger has to be notified only if the combined turnover goes beyond certain thresholds); 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.

project successfully.

If either the investment in the project has not been undertaken, or it was undertaken but it failed, the incumbent remains a monopolist with its existing product/technology. Total welfare (gross of the investment cost K, if any) is W^m.[11] If the development of the project has been successful and S markets the innovation, then the start-up offers a substitute good that competes with the incumbent's product. S and I will make duopoly profits, π_S^d and π_I^d, respectively, with $\pi_I^d < \pi_I^m$. The associated (gross) welfare level will be W^d. If I develops the project, it will obtain the higher monopoly profits $\pi_I^M > \pi_I^m$, due for instance to the commercialization of the new product or the use of the more efficient technology.[12] Gross welfare is W^M.

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

We assume throughout the paper that:

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

which amounts to saying that industry profits are higher under monopoly (when the incumbent I develops the project) than under duopoly. This is the "efficiency effect" (Gilbert and Newbery, 1982) which ensures that there is always room for a late acquisition: since the monopolist can always duplicate the situation of the competing duopolists, it can use extra profits to acquire the rival. If this assumption did not hold, the takeover would not take place. We also assume that:

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

which corresponds to the well-known Arrow's "replacement effect" (Arrow, 1962): an incumbent has less incentive to innovate (in a new/better product or a more efficient production process) than a potential entrant because the innovation would cannibalise the incumbent's current profits. If this condition did not hold, then not only shelving would not take place, but also the incumbent might develop projects that even a sufficiently endowed entrant would not consider.

Funding and development of the project The development of the prototype requires a fixed investment K, which can be undertaken either by the start-up or by the incumbent, if the latter acquires the start-up at the beginning of the game. The start-up and the incumbent differ in their ability to fund the investment. Whereas I is endowed with sufficient own assets to pay

[11] Our analysis is qualitatively the same independently of whether the AA uses consumer surplus or total welfare as a benchmark. For a discussion of the merits of consumer surplus and total surplus as standards in antitrust, see Farrell and Katz (2006).

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

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).[13]

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

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

The development of the project is not only privately beneficial for the start-up, but also for society, whether undertaken by the incumbent or the start-up:

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

Assumption A4 implies that a fortiori welfare increases when the start-up invests: $W^d - W^m > K$.

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 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.

Takeover game and information We model the bargaining over the takeover price as a non-cooperative game. With probability α it is the incumbent I that makes a take-it-or-leave-it offer to the start-up S, at the early takeover stage and at the late one; with probability $1 - \alpha$ it is S

[13]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.

that makes the take-it-or-leave-it offer. Parameter α proxies I's bargaining power relative to S.[14]

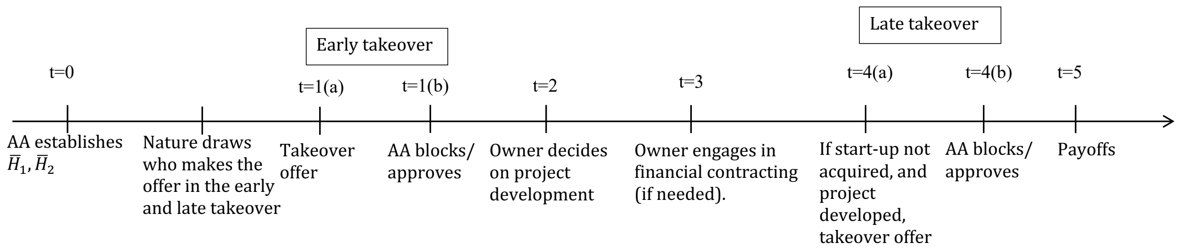
The late takeover bargaining game is one with perfect information, because all the relevant information has been revealed by the time it takes place. The early takeover game, instead, is a non-cooperative game with asymmetric information. Before the game starts, B, the private benefit, is drawn from 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.

All the rest is common knowledge, so that when the AA establishes the merger policy and when it decides on a takeover proposal, it knows the investment cost and can anticipate the product market payoffs in the different continuation games. Moreover, when it reviews a proposed takeover, the AA observes who has made the offer. Finally, all agents are risk neutral, the borrowing firm S is protected from liability and the risk-free interest rate is zero.

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 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.

Figure 2: Timeline



In what follows, we assume without loss of generality that the set of admissible values of $\bar{H}_1$ is such that $\bar{H}_1 \geq -(W^M - K - W^m)$. In our setting an early takeover cannot produce a welfare gain higher than $W^M - K - W^m$; therefore if $\bar{H}_1 < -(W^M - K - W^m)$ not even the most beneficial early takeover would be approved. Likewise, we assume that $\bar{H}_2 \geq 0$ because late takeovers cannot produce any positive welfare gain at the time they are proposed.

We solve the game by backward induction.

3 Late takeover game (t=4)

The incumbent can acquire the start-up either at $t = 1$ or at $t = 4$. Thus, only in the absence of an early takeover can the start-up be acquired at $t = 4$. In this section we focus on this case.

At $t = 4$ there is room for a late takeover if a start-up that has not been acquired at $t = 1$ managed to obtain external funds and develop the project. If so, absent the late takeover there is a duopoly, with welfare being $W^d - K$. Instead, a late takeover would lead to welfare $W^M - K$.[15] Since $W^d > W^M$, the AA will block the takeover of a committed entrant (or late takeover) unless the tolerated level of harm $\bar{H}_2$ exceeds $W^d - W^M$.

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

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

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 $S = S_f$ that the start-up managed to obtain $f$unding.

If $\bar{H}_2 \geq W^d - W^M$, the AA authorises the late takeover. From Assumption A1, 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

[14] Assuming that the bargaining power is the same both in early and late takeovers allows us to be agnostic about the determinants of bargaining power and the reasons why it may change in early vs. late takeovers.

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

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:

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

$$\pi_I^{\emptyset}(S_f, \bar{H}_2 \geq W^d - W^M) = (1-\mathbb{1})\pi_I^d + \mathbb{1}(\pi_I^M - \pi_S^d). \tag{3}$$

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 ($S = S_{nf}$). In this case, the project would not be developed and firms' profits are:

$$\pi_S^{\emptyset}(S_{nf}) = 0; \quad \pi_I^{\emptyset}(S_{nf}) = \pi_I^m.$$

Table 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 receives funding. The profits of the start-up that obtains funding are gross of the investment cost and are denoted with a capital letter.

Table 1: Firms' profit when no early takeover occurs

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

Table 1 shows that, when late takeovers are authorised, either the incumbent or the start-up that receives funding (S_f), 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.

4 Investment decision and financial contracting

4.1 Financial contracting

If no takeover took place at $t = 1(b)$, a start-up that wants to develop the project looks for funding. Lemma 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 3). This makes it easier to incentivise effort and, therefore, to raise external funds.

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

(i) *If* $B > \bar{B}(\bar{H}_2)$*, the start-up does not obtain funding (*$S = S_{nf}$*).*

(ii) *If* $B \leq \bar{B}(\bar{H}_2)$*, the start-up is funded (*$S = S_f$*). Its expected profit net of development costs is* $\pi_S^{\emptyset}(S_f, \bar{H}_2) = \Pi_S^{\emptyset}(S_f, \bar{H}_2) - K$*.*

(iii) *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. See Appendix A.1. 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.

4.2 The investment decision

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

LEMMA 2 (Investment decision)**.**

- *A start-up that obtains financing always invests in the development of the project.*
- *The incumbent invests if (and only if):*

$$\pi_I^M - \pi_I^m \geq K. \tag{4}$$

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

5 Early takeover game ($t = 1$)

At $t = 1$ the parties decide whether to engage in an early takeover, i.e. a takeover having a potential competitor as a target. The incumbent and the AA take their decisions facing imperfect information about whether, absent the takeover, the start-up can develop the project independently. They have prior beliefs on S's type, based on the distribution $F(B)$, and will update these beliefs based on the information that is public at the time the decision is taken: the offered price and the acceptance decision, who holds the bargaining power and the incumbent's decision to develop or shelve in case the takeover takes place. Throughout the analysis that follows we assume that I and the AA have the same beliefs and information. Section 5.1 describes the AA's decision at $t = 1(b)$, for given beliefs that the start-up obtains financing. Section 5.2 illustrates the equilibrium takeover offer and acceptance decision, together with I's and AA's belief update processes. We will also show how the AA's conditions for approval affect the outcome of the bargaining game. In this section we present the equilibria in pure strategies. In Section 7 we will allow for equilibria in mixed strategies.

DEFINITION 1 (Perfect Bayesian equilibrium in pure strategies).
Let $s_j \in \{\emptyset, P_j\}$ be the pure-strategy profile of agent $j \in \{I, S\}$ that formulates the takeover offer, where $\emptyset$ denotes that no takeover offer is made and $P_j \in \mathbb{R}$ is the price offered by agent j. Let $r_{\neg j} \in \{Accept\ P_j,\ Reject\ P_j\}$ be the pure-strategy profile of the agent $\neg j$ that receives the price offer, with $\neg j \neq j$. Finally, let $\phi_I(\Omega) = \phi_{AA}(\Omega) = \phi(\Omega) = \Pr(S = S_f|\Omega) \in [0, 1]$ be the incumbent and the AA's beliefs that $S = S_f$ given their information set Ω. If the incumbent makes the offer, $\Omega = \{s_I, r_S\}$. If S makes the offer, $\Omega = \{s_S, r_I\}$. The beliefs are computed using Bayes' rule whenever possible. A perfect Bayesian equilibrium (PBE) in pure strategies is denoted by $\{(s_j, r_{\neg j}); \phi(\Omega)\}$, with $j \in \{I, S\}$ and $\neg j \neq j$.

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, $\phi(\Omega) = F(\bar{B}(\bar{H}_2))$, 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.

5.1 Decision on merger approval

LEMMA 3 (Decision on merger approval).
Let $\phi(\Omega)$ be the probability that the AA assigns to the start-up being unconstrained, given the information set Ω. 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:

$$\phi(\Omega) \leq F_W(\pi_I^A, \bar{H}_1, \bar{H}_2). \tag{5}$$

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

Lemma 3 shows that the AA authorises an early takeover if it assigns a sufficiently low probability that the start-up is not financially constrained. When the start-up is constrained (and therefore unable to develop the project as a stand-alone entity), the early takeover is either welfare neutral (when I shelves), because the project would die anyway; or it is welfare beneficial (when I develops), because it makes up for financial constraints and allows the project to reach the market. Instead, when the start-up is unconstrained, the early takeover is welfare detrimental: it suppresses product market competition and, when I shelves, it also suppresses project development. For a given $\bar{H}_1$, the AA approves the early takeover if the scenario in which the takeover is welfare detrimental is sufficiently unlikely, that is when the probability that the start-up is unconstrained is low enough.

Lemma 3 also shows that the AA is the more likely to approve a takeover: (i) the more lenient the standard for approval $\bar{H}_1$ (i.e. the higher the tolerated harm); (ii) when the incumbent develops than when the incumbent shelves; (iii) when late takeovers are authorised because, absent the early takeover, the unconstrained start-up would be acquired ex-post and product market competition would be suppressed anyway.

Corollary 1 describes the AA's decision in some specific cases:

COROLLARY 1.

(*i*) *When the incumbent develops, the AA* always *approves an early takeover if it assigns probability one to the start-up being constrained (i.e.* $\phi(\Omega) = 0$*).*

(*ii*) *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. See Appendix A.4. Q.E.D.

We will use these results for the derivation of the equilibrium of the early takeover game.

5.2 Equilibrium offers at t=1(a)

Having established the circumstances under which the early acquisitions will be approved or prohibited, we move backwards to study the price offers. In Section 5.2.1, we assume that the incumbent makes a take-it-or-leave-it offer at the early takeover stage and at the late one. In Section 5.2.2 we assume that it is the start-up that makes it.

5.2.1 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: $\pi_S^{\emptyset}(S_f, \bar{H}_2) = \pi_S^d - K$ 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 1). We denote this threshold as $\bar{B}_L$.

We find the following:

LEMMA 4 (PBE of the bargaining game when I makes the offer)**.**

Let:

$$F_I(\pi_I^A, \bar{H}_2) \equiv \frac{\pi_S^d - K}{\pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2)} \in (0, 1]. \tag{6}$$

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 π_I^A, if $F(\bar{B}_L) \in (F_I, \max(F_W, F_I)]$, the PBE is: $\{(s_I^* = \pi_S^d - K, r_{S_f}^* = r_{S_{nf}}^* =$ 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: $\{(s_I^* = 0, r_{S_f}^* =$ Reject 0$, r_{S_{nf}}^* =$ Accept 0$); \phi(\{s_I^*, r_{S_f}^*\}) = 1, \phi(\{s_I^*, r_{S_{nf}}^*\}) = 0\}$.*

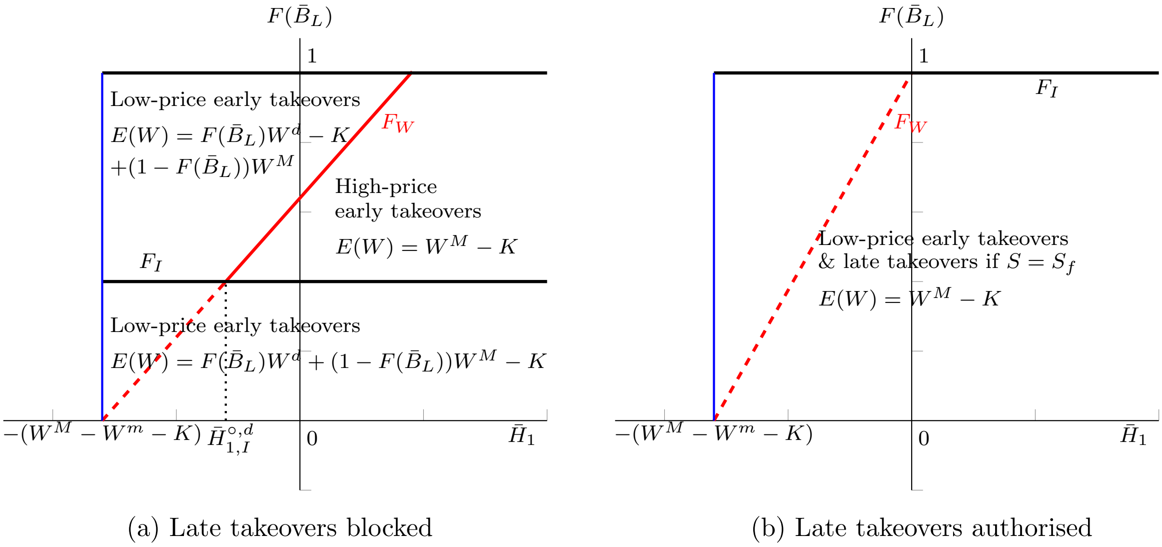
Proof. See Appendix A.5. Q.E.D.

Lemma 4 hinges on the agreed takeover price conveying key information to the AA. If the takeover price is lower than the outside option of the unconstrained start-up, $\pi_S^{\emptyset}(S_f, \bar{H}_2) = \pi_S^d - K$, the AA infers that a start-up that accepts the offer is financially constrained ($\phi(\Omega) = 0$): a firm that is able to raise external funds and to develop the project independently would never accept such a low price. Instead, if the takeover price is larger than $\pi_S^d - K$, it cannot be excluded that the start-up accepting the offer is unconstrained. In this case, the posterior beliefs coincide with the priors: $\phi(\Omega) = F(\bar{B}_L)$. The anticipation of this crucially affects the incumbent's decision on which takeover price to offer.

Let us consider first the case in which the incumbent plans to develop the project. The incumbent anticipates that, if it offers a low price, the deal will be authorised (from Corollary 1 (i)). Instead, if it offers a high price, the takeover will be blocked, unless the a priori probability that it involves an unconstrained start-up is sufficiently low (i.e. for all $\phi(\Omega) = F(\bar{B}_L) \leq F_W$ as defined by Lemma 3). Moreover, with a high-price offer, the incumbent is certain to appropriate the project and avoid product market competition, but it might overpay for a constrained start-up. The latter is a risk worth taking when the a priori probability that the start-up is unconstrained is sufficiently high (i.e. for all $\phi(\Omega) = F(\bar{B}_L) > F_I$).

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 early takeover occurs at the equilibrium (part 2. of Lemma 4). A low-price early takeover occurs otherwise, either because it is the incumbent's preferred option (when $F(\bar{B}_L) \leq F_I$), or because the incumbent anticipates that a

Figure 3: Equilibrium takeovers when I develops (and holds the bargaining powers), and associated welfare expected at $t = 0$.



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. $\bar{H}_2 \geq W^d - W^M$). $\bar{H}^{\circ,d}_{1,I}$, 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 studied in Section 6. When the incumbent develops, $\bar{H}^{\circ,d}_{1,I}$ may be negative, a case displayed in this figure.

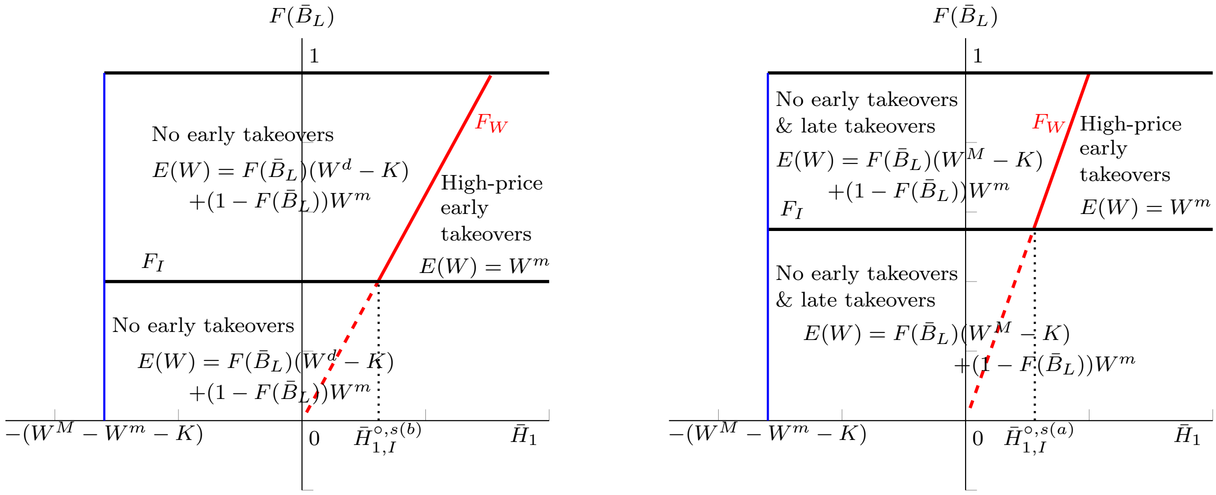
high-price takeover would not be authorised and has to settle for a second-best low-price offer (when $F(\bar{B}_L) > \max(F_W, F_I)$), as claimed in part 3. of the lemma.

Figure 3 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 a priori probability that the start-up is unconstrained $F(\bar{B}_L)$. 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.[16]

The left panel refers to the case in which late takeovers are blocked (i.e. $\bar{H}_2 < W^d - W^M$). The figure shows the regions where high- and low-price takeovers emerge at the equilibrium. Let us focus on the region in which $F(\bar{B}_L) > F_I$, so that the incumbent would want to make a high-price offer, and $F(\bar{B}_L) > F_W$, so that the AA would block such a takeover. Anticipating the AA's prohibition decision, the incumbent will then make a low-price offer. This illustrates the "selection effect" of the merger policy, that pushes the incumbent towards acquisitions that target only constrained start-ups, and are better for welfare. Since F_W increases in $\bar{H}_1$, as established by Lemma 3, the figure also shows that the stricter the merger policy, the stronger the selection effect and the more likely that a low-price takeover occurs at the equilibrium instead of a high-

[16] As shown in Appendix A.4. 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 4: 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. $\bar{H}_2 \geq W^d - W^M$). $\bar{H}_{1,I}^{\circ,s(j)}$, 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 studied in Section 6. Differently from the case of development, with shelving $\bar{H}_{1,I}^{\circ,s(j)}$ is necessarily positive.

price takeover. When the merger policy is strict enough, that is when $\bar{H}_1 < \bar{H}_{1,I}^{\circ,d}$ 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 the equilibrium. The cut-off level $\bar{H}_{1,I}^{\circ,d}$ is the value of $\bar{H}_1$ 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 a constrained start-up is equivalent to not engaging in an early takeover: the project would be suppressed anyway, either by the incumbent or because of S's inability to raise external funds. Since the takeover involves a negligible but positive transaction cost, when a high-price takeover is not the incumbent's best option (i.e. when $F(\bar{B}_L) \leq F_I$) or it is prohibited by the AA (i.e. when $F(\bar{B}_L) > F_W$), no early takeover occurs at equilibrium (part 1. of the lemma).

Equilibrium takeovers with shelving are displayed in Figure 4, with the associated welfare expected at $t = 0$. 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 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.

Also in the case of shelving, a sufficiently strict merger policy, that is $\bar{H}_1 < \bar{H}_{1,I}^{\circ,s(j)}$, implies that a high-price takeover would be blocked whenever it is the incumbent's preferred option and never occurs at the equilibrium. The cut-off level $\bar{H}_{1,I}^{\circ,s(j)}$, with $j = b, a$ depending on whether late takeovers are blocked or authorised, is the value of $\bar{H}_1$ such that $F_W = F_I$, as shown in the figure. However, 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 $\bar{H}_{1,I}^{\circ,s(j)}$ is necessarily positive.

5.2.2 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 1). As a consequence, from Lemma 1 (iii), 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 $\bar{H}_2 < W^d - W^M$.

The equilibrium of the takeover game is as follows:

LEMMA 5 (Pure-strategy PBE of the bargaining game when S makes the offer)**.**

Let:

$$F_S(\pi_I^A, \bar{H}_2) \equiv \frac{\pi_S^{\emptyset}(S_f, \bar{H}_2) + \pi_I^m - \pi_I^A}{\pi_I^m - \pi_I^d} \in (0, 1]. \tag{7}$$

When $S \in \{S_f, S_{nf}\}$ 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. Unconstrained start-ups are acquired at $t = 4$ if $\bar{H}_2 \geq W^d - W^M$.*

2. *For any π_I^A, if $F(\bar{B}(\bar{H}_2)) \in (F_S, \max(F_S, F_W)]$, the PBE is: $\{(s_{S_{nf}}^* = s_{S_f}^* = P_p, r_I^* = \text{Accept } P_p); \phi(\{P_p, \text{Accept } P_p\}) = F(\bar{B}(\bar{H}_2))\}$, with $P_p = \pi_I^A - \pi_I^m + F(\bar{B}(\bar{H}_2))(\pi_I^m - \pi_I^d)$.*

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: $\{(s_{S_f}^* = \emptyset, s_{S_{nf}}^* = \underline{P}, r_I^* = \text{Accept } \underline{P}); \phi(\{\underline{P}, \text{Accept } \underline{P}\}) = 0\}$, with $\underline{P} = \pi_I^M - K - \pi_I^m > 0$. Unconstrained start-ups are acquired at $t = 4$ if $\bar{H}_2 \geq W^d - W^M$.*

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

In an early takeover the start-up makes an offer that leaves the incumbent indifferent between accepting and rejecting the deal given its beliefs about the start-up's type. Hence, equilibrium prices are higher than in the case in which 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 4. Consider an equilibrium in which both start-ups offer the same price P, which is (strictly) larger than the outside option of the unconstrained start-up. Observing such a price, the incumbent and the AA do not learn S's type, and assign the a priori probability $F(\bar{B}(\bar{H}_2))$

to the start-up being unconstrained. The incumbent must be at least indifferent between paying that price and rejecting the offer. For this to be the case, the a priori probability must be high enough (i.e. $F(\bar{B}(\bar{H}_2)) > F_S$) because, in that case, the risk of overpaying for a constrained start-up is relatively low. However, the a priori probability must be sufficiently low for the AA to authorise the deal ($F(\bar{B}(\bar{H}_2)) \leq F_W$). It is only when both conditions are simultaneously satisfied that a high-price equilibrium exists (as claimed in part 2. of Lemma 5).

When, instead, either the incumbent is not willing to pay a price $P > \pi_S^{\emptyset}(S_f, \bar{H}_2)$ (i.e. when $F(\bar{B}(\bar{H}_2)) \leq F_S$), or the incumbent would accept that offer but it is the AA that would block the deal (i.e. when $F(\bar{B}(\bar{H}_2)) > F_W$), then the unconstrained start-up does not make any offer and the constrained one offers a low price $\underline{P} = \pi_I^A - \pi_I^{\emptyset}(S_{nf}) < \pi_S^{\emptyset}(S_f, \bar{H}_2)$. The incumbent and the AA, observing this price, infer that the start-up is constrained. Since it is indifferent, the incumbent accepts the offer. When the incumbent develops ($\pi_I^A = \pi_I^M - K$), the AA authorises the deal (from Corollary 1 (i)), as claimed in part. 3. of Lemma 5. Instead, if the incumbent shelves ($\pi_I^A = \pi_I^m$), the highest price that the incumbent is willing to pay is $\underline{P} = 0$. Since engaging in the takeover involves a positive transaction cost, the constrained start-up does not make any offer either and no early takeover occurs at the equilibrium (part 1. of Lemma 5). Finally, an equilibrium in pure strategies in which the unconstrained start-up also makes an (acceptable, but different) offer cannot exist, because the constrained start-up would have an incentive to mimic the unconstrained start-up.

With development, a "selection effect" of the merger policy arises: when a high-price offer is accepted by the incumbent (that is, when $F(\bar{B}(\bar{H}_2)) > F_S$) but the AA blocks the deal (because $F(\bar{B}(\bar{H}_2)) > F_W$)), the unconstrained start-up will refrain from making an offer, while the constrained start-up will offer a low price. The merger policy, then, pushes towards early acquisitions that target only constrained start-ups and are superior in terms of welfare. Moreover, the stricter the merger policy (that is, the lower $\bar{H}_1$), the stronger the selection effect and the more likely that a low-price takeover replaces a high-price takeover at the equilibrium.

If S holds the bargaining power, the figures displaying the equilibrium takeovers as a function of $\bar{H}_1$ and $F(\bar{B}(\bar{H}_2))$ are similar to those presented in Section 5.2.1, with F_S substituting F_I, $F(\bar{B}_H)$ substituting $F(\bar{B}_L)$ when late takeovers are authorised, and $\bar{H}_{1,S}^{\circ,i}$ substituting $\bar{H}_{1,I}^{\circ,i}$, with $i = s, d$ depending on shelving or development (see Figure B.1 in Appendix B).

6 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. The optimal policy will be derived considering the pure-strategy equilibria of the bargaining game at $t = 1$ (we shall also build on Figure 3, Figure 4 and Figure B.1 for an intuitive explanation of the optimal policy). In Section 7 we shall extend our analysis to consider mixed-strategy equilibria, and derive the optimal merger policy for all the admissible equilibria of the continuation game.

We shall show that the merger policies identified in this section are optimal also when allowing for mixed strategy equilibria. Proposition 1 describes the AA's optimal choice.

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

i. 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* $\bar{H}_1$*,* $\bar{H}_1^{\circ,d} > -(W^M - W^m - K)$*, such that all* $\bar{H}_1 \leq \bar{H}_1^{\circ,d}$ *in the admissible set are optimal for any value of* α*.*

(b) If $\pi_I^A = \pi_I^m$*, there exists a threshold level of* $\bar{H}_1$*,* $\bar{H}_1^{\circ,s} > 0$ *such that all* $\bar{H}_1 \leq \bar{H}_1^{\circ,s}$ *in the admissible set are optimal for any value of* α *and for any* $\bar{H}_2$*.*

(c) All $\bar{H}_1 \leq \min(\bar{H}_1^{\circ,d}, \bar{H}_1^{\circ,s})$ *in the admissible set are optimal for any value of* α*,* π_I^A *and* $\bar{H}_2$*.*

ii. The optimal merger policy regarding late takeovers 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*

$$\frac{F(\bar{B}_H)}{F(\bar{B}_L)} > \frac{W^d - K - W^m}{W^M - K - W^m}. \tag{8}$$

(b) Strict, i.e. all $\bar{H}_2 < W^d - W^M$ *are optimal, otherwise.*

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

Figures 3 and 4 (and Figure B.1 in Appendix B) show that high-price early takeovers are the least desirable outcome for welfare. Hence, the merger policy that maximises welfare expected at $t = 0$ is the one that commits to standards of review that remove the possibility that high-price early takeovers occur at the equilibrium.

Consider first the case of shelving. A high-price early takeover is a killer acquisition that deprives society of the project and (strictly) decreases welfare relative to the no-takeover scenario. A merger policy that commits to prohibiting all takeovers that, at the moment in which they are reviewed, are welfare-detrimental screens such takeovers out. As Figure 4 and Figure B.1 (bottom panels) show, 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 agent that makes the offer. Therefore, any $\bar{H}_1 \leq \bar{H}_{1,i}^{\circ,s(j)}$ is optimal, with $i = I, S$ and $j = a, b$.[17] By taking the minimum value of the cut-offs across the relevant cases, that is $\bar{H}_1^{\circ,s} \equiv \min(\bar{H}_{1,i}^{\circ,s(j)}) > 0$, Proposition 1, part *i.(b)*, characterises the policy that is optimal irrespective of the bargaining power allocation, and of the policy regarding late takeovers.

[17] Recall from Section 5.2 that $\bar{H}_{1,i}^{\circ,s(j)} > 0$ is the cut-off level of $\bar{H}_1$ such that $F_W = F_i$, with $i = I, S$ depending on who makes the offer, and $j = a, b$, depending on whether late takeovers are blocked (b) or authorised (a). Although there exists a continuum of optimal policies, all are equivalent in terms of expected welfare. Therefore, in this discussion and in the following ones we name optimal policy the one that commits to the less strict standard of review among the equivalent ones.

To sum up, under the optimal policy concerning early takeovers, anticipating that high-price takeovers will be blocked, the incumbent (or the start-up, if it has the bargaining power) will abstain from making any offer at the early stage, and no early takeover will occur at the equilibrium. Therefore only a start-up that is unconstrained will develop the project and reach the final market.

We now turn to the policy targeting late takeovers, in the case of shelving. Clearly, a lenient approach towards late takeovers is not optimal when I makes the offer because, by softening product market competition, it limits the welfare gains from project development. However, when the start-up makes the take-it-or-leave-it offer, and therefore appropriates the surplus generated by the late takeover, a lenient approach towards late takeovers relaxes financial constraints (see Lemma 1). A trade-off arises: authorising late takeovers sacrifices allocative efficiency but, by helping start-ups to obtain external funds and develop the project independently, it makes it more likely that the project reaches the final market. When the former effect prevails so that condition (8) in the proposition does not hold, authorising late takeovers is welfare detrimental also when the start-up makes the offer. In that case, a strict merger policy regarding late takeovers is optimal for any value of α. Instead, when the latter effect prevails and condition (8) in Proposition 1 does hold, authorising late takeovers is welfare beneficial when the start-up makes the offers. Therefore, at $t = 0$, it is optimal to commit to authorising late takeovers only if the probability that the start-up makes the offer is sufficiently high, as indicated in Proposition 1, claim *ii.(a)*.

In our model the amount of internal resources start-ups can rely upon, A, can be interpreted as a proxy for the pervasiveness of financial constraints: the higher A, the lower start-ups' external needs, the less likely financial constraints are to arise. A can be high in industries intensive in collateralisable assets. We show in the Appendix that, if A is sufficiently close to K, condition 8 is not satisfied: authorising late takeovers relaxes financial constraints by a limited extent when they are modest to start with, and the sacrifice of allocative efficiency prevails. Hence, authorising late takeovers is not optimal in economies/industries with well-developed financial markets.

Let us turn to the case in which the incumbent develops. We start from the policy targeting late takeovers. Looking at Figure 3 and Figure B.1 (top panels) it is apparent that there is nothing to gain from authorising late takeovers: expected welfare would always be as low as in the case in which a high-price early takeover occurs because a start-up that manages to obtain funding and develop independently is acquired at the later stage. Hence, in case of development, the optimal merger policy regarding late takeovers is always strict: any $\bar{H}_2 \leq W^d - W^M$ is optimal.

Regarding early takeovers, Lemma 3 shows that, for given standards of review, the AA is more likely to approve a high-price takeover when I develops than in the case of shelving. This is because the early takeover now absorbs the inefficiency caused by financial frictions, when the start-up is constrained, and does not kill the innovation, when the start-up is unconstrained. Therefore, in order to prevent high-price early 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 upper bound of the values of $\bar{H}_1$ such that high-price early takeovers are prohibited at the equilibrium – that is $\bar{H}_{1,i}^{\circ,d}$ such that $F_W = F_i$ (with $i = I, S$ depending on who makes the offer) – might be negative, as depicted in the left panel of Figure 3. In turn, the upper bound that characterises the optimal policies irrespective of who makes the offer – that is $\bar{H}_1^{\circ,d} \equiv \min(\bar{H}_{1,I}^{\circ,d}, \bar{H}_{1,I}^{\circ,s}) = \bar{H}_{1,I}^{\circ,d}$ – may also be negative (Proposition 1, part *i.(a)*). When this is the case the optimal merger policy commits to prohibiting early takeovers that are welfare beneficial, if their expected welfare gain is low enough.

Why is it optimal to commit to prohibiting a takeover that, when evaluated, increases welfare? Under the optimal policy, if the incumbent has the bargaining power, it will anticipate that high-price takeovers will not be authorised. Hence, it will have no other option than offering a low price. If the start-up has the bargaining power, the constrained start-up will switch to a low-price offer, while the unconstrained start-up will refrain from making an offer.[18] In either case, expected welfare at $t = 0$ will be higher, because the start-up will be acquired only when unable to raise external funds, and society will benefit from intensified competition when the start-up is, instead, unconstrained.

Under the assumption that it can compute the relevant cut-offs in the various cases, at $t = 0$ the AA (or the Government) can also commit to an "information-free" merger policy regarding early takeovers. This policy is not contingent on the incumbent's decision to shelve or develop, on the allocation of bargaining power, and on the policy regarding late takeovers, as indicated in Proposition 1, part *i.(c)*.

7 Equilibria in mixed strategies

The previous analysis showed that, when we focus on pure-strategy equilibria, there cannot exist an equilibrium in which the unconstrained start-up formulates a higher price offer than the constrained one, and the incumbent accepts both offers, because the constrained start-up would always have an incentive to mimic the unconstrained start-up. The only way to avoid the constrained start-up's incentive to mimic the unconstrained one is to have the latter refrain from making an offer. Hence, the equilibrium comes with an inefficiency from the firms' perspective: the unconstrained start-up is not acquired even though the takeover would increase the joint profits of target and acquirer.

Such an inefficiency is alleviated when one allows for equilibria in mixed strategies, whose analysis is the object of this section. Lemma 6 below shows that an equilibrium may exist where the unconstrained start-up offers the high price P_H with certainty, while the constrained one randomises between P_H and a lower price P_L. When observing P_H the incumbent cannot be sure that the offer originates from an unconstrained start-up, and does not always accept. This reduces the constrained start-up's incentive to mimic the unconstrained one.

In the next Section we will show that allowing for mixed strategies does not modify the

[18] Recall that the set of feasible values of $\bar{H}_1$ is such that $\bar{H}_1 \geq -(W^M - K - W^m)$. This ensures that, under the optimal policy, low-price takeovers are authorised.

conclusions reached in Section 6: the merger policy delineated in Proposition 1 will still be the optimal one.

DEFINITION 2 (Perfect Bayesian equilibrium in mixed strategies).
Let $\gamma_k^H = \Pr(P_{S_k} = P_H)$ *and* $1-\gamma_k^H = \Pr(P_{S_k} = P_L)$ *be the probability that* S_k *assigns to actions* $P_S = P_H$ *and* $P_S = P_L$*, respectively, with* $k \in \{f, nf\}$ *and* $P_H, P_L \in \mathbb{R}$*. Then,* $(\gamma_f^H, \gamma_{nf}^H)$ *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,* (β^H, β^L) *is the mixed-strategy profile of agent* I*. A perfect Bayesian equilibrium in mixed strategies is denoted by* $\{\gamma_{nf}^H, \gamma_f^H, \beta^H, \beta^L; \phi(P_H), \phi(P_L)\}$*.*

Lemma 6 describes the equilibria in mixed strategies and specifies the conditions for their existence.

LEMMA 6 (Mixed-strategies PBE of the bargaining game when S makes the offer).
If $\pi_I^A = \pi_I^M - K$*,* $\bar{H}_2 \leq W^d - W^M$ *and* $F(\bar{B}(\bar{H}_2)) \equiv F(\bar{B}_L) \leq F_S$*, there exists a hybrid PBE featuring:*

- $P_L = \pi_I^M - K - \pi_I^m$ *and* $P_H \in (\pi_S^d - K, \bar{P}(\bar{H}_1)]$*, with* $P_H > P_L > 0$*,* $\phi(P_H) \leq F_W$ *and* $\bar{P}(\bar{H}_1) < \pi_I^M - K - \pi_I^d$ *increasing in* $\bar{H}_1$*;*
- S_{nf} *offering* P_H *with probability:*

$$\gamma_{nf}^H(P_H) = \frac{F(\bar{B}_L)}{(1-F(\bar{B}_L))} \frac{(\pi_I^M - K - \pi_I^d - P_H)}{(P_H - \pi_I^M + K + \pi_I^m)} \in (0,1)$$

  (strictly) decreasing in P_H*;*
- S_f *offering* P_H *with probability* $\gamma_f^H = 1$*;*
- I *accepting* P_H *with probability* $\beta^H(P_H) = \frac{P_L}{P_H} \in (0, \beta^L)$*, (strictly) decreasing in* P_H*, and accepting* P_L *with probability* $\beta^L = 1$*;*
- *posterior beliefs:*

$$\phi(P_H) = \frac{F(\bar{B}_L)}{\gamma_{nf}^H(P_H)(1-F(\bar{B}_L)) + F(\bar{B}_L)} = \frac{P_H - \pi_I^M + K + \pi_I^m}{\pi_I^m - \pi_I^d} \in (0,1) \text{ and } \phi(P_L) = 0.$$

  with $\phi(P_H) > F(\bar{B}_L)$*, and* $\phi(P_H)$ *(strictly) increasing in* P_H*.*

Proof. See Appendix A.8. Q.E.D.

Mixed-strategy equilibria feature a unique low price P_L, which is the same price $\underline{P}$ sustained in the pure-strategy equilibrium of Lemma 5, part 3. Instead, the high price P_H belongs to an interval whose lower bound is $\pi_S^d - K$, and whose upper bound $\bar{P}(\bar{H}_1)$ is determined by the merger policy regarding early takeovers.

When it observes a high takeover price P_H, the AA (as well as I) updates the priors $F(\bar{B}_L)$, and assigns a higher probability $\phi(P_H)$ to the start-up being unconstrained. For the takeover to be approved the posterior probability $\phi(P_H)$ must be lower than the threshold that governs the AA's decision F_W. Lemma 6 shows that $\phi(P_H)$ is strictly increasing in P_H. The posterior probability makes the incumbent indifferent between accepting and rejecting an offer involving the price P_H. The higher the price, the less profitable for the incumbent to accept the offer, the less profitable it must be to reject, so as to ensure indifference. Rejecting the offer is less profitable the higher the (posterior) probability that the start-up is unconstrained, because the incumbent has higher chances to face competition in the final market. Hence, given $\bar{H}_1$, for the deal to be approved the price P_H must be sufficiently low. Moreover, a more stringent merger policy (i.e. a lower $\bar{H}_1$), by decreasing the threshold for approval F_W, also decreases the upper bound $\bar{P}(\bar{H}_1)$ of the prices P_H that can be supported at the equilibrium in mixed strategies. These are key considerations for the analysis of the optimal merger policy of the next Section.

7.1 The optimal merger policy

The earlier analysis has shown that multiple equilibria may arise when S makes the offer, late takeovers are blocked, I plans to develop and $F(\bar{B}_L) \leq F_S$. Namely, the pure-strategy equilibrium in Lemma 5 (part 3.) and mixed-strategy equilibria in Lemma 6.

The equilibrium in pure strategies in which a low-price takeover occurs exists for any feasible $\bar{H}_1$. Since a start-up is acquired only if it is financially constrained, expected welfare at $t = 0$ is given by:

$$EW^{ps} = F(\bar{B}_L)(W^d - K) + (1 - F(\bar{B}_L))(W^M - K).$$

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

$$\begin{aligned} EW^{ms} &= F(\bar{B}_L)[W^d - K - \beta^H(P_H)(W^d - W^M)] \\ &+ (1 - F(\bar{B}_L))[W^M - K - \gamma^H_{nf}(P_H)(1 - \beta^H(P_H))(W^M - K - W^m)]. \end{aligned}$$

The first term in the expression of EW^{ms} refers to the case in which the start-up is unconstrained, which occurs with probability $F(\bar{B}_L)$: in that case expected welfare is given by $W^d - K$ – i.e. 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 β^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 constrained, which occurs with probability $1 - F(\bar{B}_L)$: 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 constrained start-up offers a high price and that offer is rejected (which occurs with probability $\gamma^H_{nf} \times (1 - \beta^H)$) and the project cannot be developed because of financial constraints.

The comparison between EW^{ps} and EW^{ms} shows that the equilibrium in pure strategies dominates, in terms of welfare, any equilibrium in mixed strategies: first, because an unconstrained start-up is never acquired and competition never suppressed; second, because a constrained 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:

LEMMA 7. *In the low-price equilibrium in pure strategies expected welfare is higher than in any mixed-strategy equilibrium.*

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

Hence, the optimal merger policy regarding early takeovers must also 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 $\bar{H}_1$ 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 P_p – i.e. whenever the posterior probability $\phi(P_p) = F(\bar{B}_L) > F_S$ – the AA blocks the transaction because $\phi(P_p) = F(\bar{B}_L) > F_W$. F_S is the cut-off value of the posterior that makes the incumbent indifferent between accepting and rejecting the offer $P_p = \pi_S^d - K$ (see the proof of Lemma 5). The standards of review $\bar{H}_1$ that are optimal irrespective of the value of α and π_I^A are stricter and a fortiori ensure that $F_W < F_S$.

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 2 (The optimal merger policy)**.** *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. See Appendix A.9. Q.E.D.

8 Concluding remarks

The acquisition of potential competitors has been a particularly debated issue in the last few years, due especially 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 jurisdictions. For instance, the US agencies have announced the review of the Horizontal Merger Guidelines,[19] and that they may challenge acquisitions of potential competitors, a departure from previous policy.[20] In the UK, the CMA issued revised merger guidelines in July 2021,[21] announcing a stricter merger enforcement across sectors. In November 2021 it also prohibited Facebook's acquisition of Giphy, the first time a merger by one of the Big Tech companies has ever been blocked.

While much of the emphasis in this debate has arguably been on such mergers being "killer acquisitions", we have investigated an environment in which they may in principle have both detrimental and beneficial effects. The former consist in the possible suppression of innovation, and the elimination of competition. The latter in higher (potential) ability to invest due to the acquirer's larger financial resources, and possible wider access to credit for a potential competitor which may otherwise be financially constrained – since investors anticipate that a future acquisition will give it higher rents.

From a policy perspective, the main result of our analysis is that the optimal merger policy should *not* be lenient towards acquisitions of potential competitors. The optimal merger policy commits to standards of review that are sufficiently strict to prohibit high-price takeovers, that is takeovers where the start-up might be able to invest and compete with the incumbent, even though ex-post they may be welfare-beneficial. Such a policy exerts a selection effect: it pushes towards acquisitions that target only financially-constrained start-ups and that, therefore, increase welfare more. The policy does not imply blocking all acquisitions of potential competitors: low-price merger transactions can involve only start-ups which would not have access to credit, and hence would not be able to become independent competitors. Such takeovers should be approved.

Moreover, our analysis suggests that AAs should use the information conveyed by the takeover price when reviewing acquisitions of potential competitors, both for the initial screening, to identify mergers that deserve a closer look, and for the investigation, to assess the counterfactual to the merger and the effects on competition.

To sum up, our analysis confirms that the laissez-faire approach towards acquisition of potential competitors, which AAs around the world have been following for a long time, should be scrapped, and it supports the current proposals towards stricter enforcement of these mergers.

Finally, it may seem paradoxical that, contrary to the current merger practice, the optimal policy prescribes a possibly more lenient treatment towards *acquisitions of committed entrants* – that is, of start-ups which have already developed an innovation allowing them to compete with

[19] See, e.g., https://www.ftc.gov/news-events/press-releases/2022/01/ftc-and-justice-department-seek-to-strengthen-enforcement-against-illegal-mergers.

[20] See e.g. the speech delivered by AAG Vanita Gupta at Georgetown Law's 15th Annual Global Antitrust Enforcement Symposium Washington, DC, September 14, 2021.

[21] Competition and Markets Authority, "Merger Assessment Guidelines", 18 March 2021.

the incumbent – than acquisitions of potential competitors. This is because of the anticipation of a future takeover may relax the start-up's financial constraint. Nevertheless, the optimal policy establishes a lenient treatment of takeovers of committed entrants only when a number of cumulative conditions hold. In particular, (i) the incumbent is expected to shelve; (ii) the sacrifice of allocative efficiency is dominated by the gain in "dynamic efficiency"; (iii) start-ups have sufficient power in bargaining over the takeover.

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A Appendix

A.1 Proof of Lemma 1

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:

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

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):

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

with $\bar{B}(\bar{H}_2 < W^d - W^M) > 0$ by Assumption A3 and $A \geq 0$. If $B < \bar{B}(\bar{H}_2)$, the start-up is not funded (S_{nf}) and cannot develop the project even though the NPV of the project is positive (part (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_f) – we will say that it is unconstrained. Substituting $R_l = K - A$ in equations (1) and (2), one obtains the net payoff indicated in part (ii).

In Section 3, we showed that, if $\bar{H}_2 \geq W^d - W^M$, $\Pi_S^{\emptyset}(S_f, \bar{H}_2) = \mathbb{1}\pi_S^d + (1-\mathbb{1})(\pi_I^M - \pi_I^d)$, where $\mathbb{1}$ is an indicator function equal to 1 when the incumbent makes the offer in the takeover game; if $\bar{H}_2 < W^d - W^M$, $\Pi_S^{\emptyset}(S_f, \bar{H}_2) = \pi_S^d \leq \mathbb{1}\pi_S^d + (1-\mathbb{1})(\pi_I^M - \pi_I^d)$. 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 $\bar{H}_2$.

A.2 Proof of Lemma 2

If the incumbent did not acquire the start-up at $t = 1(b)$, and the start-up does not obtain financing, i.e. if $B > \bar{B}(\bar{H}_2)$, then the investment cannot be undertaken and the payoff of the start-up is nil. If, instead, $B \leq \bar{B}(\bar{H}_2)$, the start-up anticipates that by developing the project it will obtain $\Pi_S^{\emptyset}(S_f, \bar{H}_2) - K \geq \pi_S^d - K$. By Assumption A3, $\pi_S^d \geq K$, and the unconstrained start-up always invests.

If the start-up has been acquired at $t = 1(b)$, the incumbent obtains π_I^m by not investing and $\pi_I^M - K$ by investing. The increase in expected profits is $\pi_I^M - \pi_I^m$. By Assumption A2,

$\pi_I^M - \pi_I^m < \pi_S^d$. Then, the gains from investing for I are smaller than those for S_f. As a consequence, I does not necessarily want to develop the project. It does so if (and only if) condition (4) is satisfied.

A.3 Proof of Lemma 3

Two cases must be considered.[22]

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 $H = (1 - \phi)[W^m - (W^M -$

[22] For simplicity, throughout this proof, we omit the functional notation for ϕ_{AA}.

$K)] < 0$, 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 the cut-off levels of the probability that the start-up is unconstrained, denoted by F_W, in the different cases reveals that:

i. Given π_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 $W^d > W^M$.

ii. 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 $\pi_I^A = \pi_I^M - K$.

A.4 Proof of Corollary 1

(i) Since $F_W(\pi_I^M - K, \bar{H}_1, \bar{H}_2) \geq 0$, condition (5) is always satisfied when $\phi_{AA}(\Omega) = 0$. (ii) Since $F_W(\pi_I^m, \bar{H}_1, \bar{H}_2) < 0$ when $\bar{H}_1 < 0$, condition (5) is never satisfied.

A.5 Proof of Lemma 4

If $S = S_{nf}$, the start-up's payoff when rejecting I's offer is $\pi_S^{\emptyset}(S_{nf}) = 0$; if $S = S_f$, it is $\pi_S^{\emptyset}(S_f, \bar{H}_2) = \pi_S^d - K > 0$ from Assumption A3.[23] The incumbent with full bargaining power will then offer either a low price $P_I = 0$, and only the constrained start-up $S = S_{nf}$ 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 3, 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:

$$F(\bar{B}_L)\pi_I^{\emptyset}(S_f, \bar{H}_2) + (1 - F(\bar{B}_L))\pi_I^m. \tag{9}$$

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 1 (i)), I's expected profit (gross of the

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

transaction cost) is:

$$F(\bar{B}_L)\pi_I^{\emptyset}(S_f, \bar{H}_2) + (1 - F(\bar{B}_L))\pi_I^A. \tag{10}$$

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:

$$\pi_I^A - (\pi_S^d - K). \tag{11}$$

By comparing the expressions in equations (10) and (11) 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 is defined in equation (6). 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 (9) and (10) 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 part 1. of the lemma.

If, instead, $F(\bar{B}_L) \in (F_I, \max(F_W, F_I)]$, 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 part 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 part 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 A3 implies that $\pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2) > 0$ 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 A1 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_f is the same irrespective of whether the takeover occurs early or at a later stage and $F_I = 1$.

A.6 Proof of Lemma 5

Consider a candidate equilibrium in which the start-up, irrespective of whether it is constrained or not, offers $P_{S_{nf}} = P_{S_f} = P$. For this to be an equilibrium, P must satisfy the start-ups' participation constraints:[24]

$$P > \pi_S^{\emptyset}(S_{nf}) = 0 \quad (12)$$
$$P > \pi_S^{\emptyset}(S_f, \bar{H}_2). \quad (13)$$

P must also satisfy the incumbent's participation constraint:

$$\pi_I^A - P \geq F(\bar{B}(\bar{H}_2))\pi_I^d + [1 - F(\bar{B}(\bar{H}_2))]\pi_I^m, \quad (14)$$

where the incumbent's posterior beliefs on the probability that the start-up is unconstrained coincide with the priors. Since constraint (13) is more binding than constraint (12), P must satisfy:

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

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

$$F(\bar{B}(\bar{H}_2)) > F_S, \quad (15)$$

where F_S is defined in equation (7).

Finally, it must be that the AA authorises the deal, if the offer $P = P_p$ 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 part 2. of the lemma. An equilibrium with $P \in (\pi_S^{\emptyset}(S_f, \bar{H}_2), P_p)$ does not exist because $S \in \{S_f, S_{nf}\}$ would have an incentive to deviate and increase the price: following an out-of-equilibrium offer $P' \leq P_p$, 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 $P' \leq P_p$, I would accept. The deviation would be profitable. Hence, $P = P_p$ is the unique equilibrium price such that $P_{S_f} = P_{S_{nf}}$.

Consider now a candidate equilibrium in which $S = S_{nf}$ offers $P_{S_{nf}} = \underline{P} = \pi_I^A - \pi_I^m$, $S = S_f$ does not make any offer, and the incumbent accepts $\underline{P}$. From Assumptions A2 and A3, $\pi_I^A - \pi_I^m < \pi_S^d - K \leq \pi_S^{\emptyset}(S_f, \bar{H}_2)$. 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 $\underline{P}$. For this to be an equilibrium, S must have no incentive to deviate.

To start with, $S = S_{nf}$ must find it unprofitable not to make an offer:

$$\underline{P} > \pi_S^{\emptyset}(S_{nf}) = 0 \quad (16)$$

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 $\underline{P} = \pi_I^M - K - \pi_I^m > 0$. Since $\pi_S^{\emptyset}(S_f, \bar{H}_2) > \underline{P}$,

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

then $S = S_f$ has no incentive to deviate and offer $\underline{P}$. Clearly, $S = S_{nf}$ has no incentive to decrease its offer. Has it an incentive to offer $P' > \underline{P}$? As long as $P' \leq \pi_S^{\emptyset}(S_f, \bar{H}_2)$, the incumbent infers that the start-up is constrained and rejects the deviation offer. The deviation is unprofitable. If, instead, $P' > \pi_S^{\emptyset}(S_f, \bar{H}_2)$, 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 $\pi_S^{\emptyset}(S_f, \bar{H}_2) \geq P_p$ 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 $P' \geq \pi_S^{\emptyset}(S_f, \bar{H}_2)$. Of course, S_f has no incentive to deviate and offer $P' < \pi_S^{\emptyset}(S_f, \bar{H}_2)$. 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 part 3. of the lemma.

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

Let us consider now the case in which I shelves. Since $\pi_I^A = \pi_I^m$, then $\underline{P} = 0$. Hence, condition (16) 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 part 1. of the lemma.

Note that $\pi_I^m > \pi_I^d$, $\pi_S^{\emptyset}(S_f, \bar{H}_2) \geq \pi_S^d - K > 0$ (from the analysis in Section 3 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 $F_S = 1$.

A.7 Proof of Proposition 1

Case 1: The incumbent plans to develop (i.e. $\pi_I^A = \pi_I^M - K$).[25]

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 5.2.1).

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

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

type $S = S_{nf}$, and the acquisition is authorised by the AA. A start-up of the type $S = S_f$ 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 4 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 $S = S_{nf}$ accepts. Expected welfare is $E(W) = F(\bar{B}_L)(W^d - K) + (1 - F(\bar{B}_L))(W^M - K) > W^M - K$.

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 $S = S_f$ and $S = S_{nf}$ accept. Expected welfare is $E(W) = W^M - K$. This case arises if and only if $F_W > F_I$.

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 $\bar{H}_2 < W^d - W^M$, $F_I = \frac{\pi_S^d - K}{\pi_I^M - K - \pi_I^d} \in (0, 1)$ from Assumptions A3 and A1. Since F_W is strictly increasing in $\bar{H}_1$ (from Lemma 3 (i)), $F_W = 0$ 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 $H_{1,I}^{\circ,d} \in (-(W^M - W^m - K), W^d - W^M)$ such that $F_W \leq F_I$ for all $\bar{H}_1 \leq H_{1,I}^{\circ,d}$. Hence, all $\bar{H}_1 \leq \bar{H}_{1,I}^{\circ,d}$ 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 $H_{1,I}^{\circ,d}$ is not necessarily positive. Indeed, $H_{1,I}^{\circ,d} < 0$ 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 5 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 $\bar{H}_1 \leq \bar{H}_{1,S}^{\circ,d}$ in the set of admissible values are optimal, where $\bar{H}_{1,S}^{\circ,d} \in (-(W^M - W^m - K), W^d - W^M)$ is such that, when $\pi_I^A = \pi_I^M - K$ and $\bar{H}_2 < W^d - W^M$, $F_W = F_S = \frac{\pi_S^d - \pi_I^M + \pi_I^m}{\pi_I^m - \pi_I^d}$, with $F_S \in (0, 1)$ from Assumptions A2 and A1.

Optimal $\bar{H}_1$ and $\bar{H}_2$:
If I develops, $\pi_I^M - K > \pi_I^m$. Hence $F_S > F_I$ and $H_{1,I}^{\circ,d} < H_{1,S}^{\circ,d}$. A policy $\bar{H}_1 \leq \bar{H}_1^{\circ,d} \equiv H_{1,I}^{\circ,d}$ in the set of admissible values ensures that high-price early takeovers are blocked for any value of α, and is optimal irrespective for any value of α, as stated in Proposition 1 (i.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 α, as stated in Proposition 1 (ii.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 5.2.1).

Lemma 4 implies that two sub-cases must be considered:

1.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.

2.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 $S = S_f$ and $S = S_{nf}$ accept. Expected welfare is $E(W) = W^m$. This case arises if and only if $F_W > F_I$.

Comparing sub-cases 1.a and 2.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 $\bar{H}_2 < W^d - W^M$, $F_I = \frac{\pi_S^d - K}{\pi_I^m - \pi_I^d} \in (0,1)$ from Assumptions A3 and A1. 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 $H_{1,I}^{\circ,s(b)} \in (0, W^d - W^m - K)$ such that $F_W \leq F_I$ for all the values of $\bar{H}_1 \leq H_{1,I}^{\circ,s(b)}$. 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 $\bar{H}_2 \geq W^d - W^M$, $F_I = \frac{\pi_S^d - K}{\pi_I^m - (\pi_I^M - \pi_S^d)} \in (0,1)$ from Assumptions A3 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 $H_{1,I}^{\circ,s(a)} \in (0, W^M - W^m - K)$ such that $F_W \leq F_I$ for all the values of $\bar{H}_1 \leq H_{1,I}^{\circ,s(a)}$. 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 5 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 1.

Therefore,

1.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.

2.b If $F(\bar{B}(\bar{H}_2)) \in (F_S, \max(F_W, F_S)]$, both types $S = S_f$ and $S = S_{nf}$ offer P_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 1.b and 2.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 $\bar{H}_2 < W^d - W^M$, $F_S = F_I = \frac{\pi_S^d - K}{\pi_I^m - \pi_I^d} \in (0,1)$ from Assumptions A1 and A3. As shown above, setting any value of $\bar{H}_1$ such that $\bar{H}_1 \leq \bar{H}_{1,I}^{\circ,s(b)}$ 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 A1, 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 $H_{1,S}^{\circ,s(a)} \in (0, W^M - W^m - K)$ such that $F_W \leq F_S$ for all $\bar{H}_1 \leq H_{1,S}^{\circ,s(a)}$.

Optimal $\bar{H}_1$ and $\bar{H}_2$:

Note that the cut-off levels $\bar{H}_{1,I}^{\circ,s(b)}$, $\bar{H}_{1,I}^{\circ,s(a)}$ and $\bar{H}_{1,S}^{\circ,s(a)}$ are all positive. Hence the policy $\bar{H}_1 \leq \bar{H}_1^{\circ,s} = \min(\bar{H}_{1,I}^{\circ,s(b)}, \bar{H}_{1,I}^{\circ,s(a)}, \bar{H}_{1,S}^{\circ,s(a)}) > 0$ ensures that high-price early takeovers are blocked and is, therefore, optimal, irrespective of the value of α and of $\bar{H}_2$, as stated in Proposition 1 (i.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 α, 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 (8) 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 α, as stated in Proposition 1 (ii.b).

When, instead, condition (8) 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 (8) is satisfied, $\Delta(1) < 0$ and $\Delta(\alpha)$ is strictly decreasing in α, there exists a threshold level of α, $\hat{\alpha} \in (0,1)$, such that $\Delta(\alpha) > 0$ if (and only if) $\alpha < \hat{\alpha}$.

To sum up, when $\pi_I^A = \pi_I^m$, condition (8) holds and $\alpha < \hat{\alpha}$, the optimal policy is to authorise late takeovers, as stated in Proposition 1 (ii.a). In all the other cases, the optimal policy is to block late takeovers, as stated in Proposition 1 (ii.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 (8) is equal to 1, and condition (8) 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 π_S^d, whereas $F(\bar{B}_L) < 1$ and decreases as A decreases. Hence, the l.h.s. of condition (8) increases as A decreases $[K - (\pi_I^M - \pi_I^d - \pi_S^d), K]$ and condition (8) 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 $\bar{H}_1 \leq \min(\bar{H}_1^{\circ,d}, \bar{H}_1^{\circ,s})$ in the set of admissible values are optimal irrespective of the value of π_I^A, α and $\bar{H}_2$, as stated in Proposition 1 (i.c).

A.8 Proof of Lemma 6

We construct the equilibrium through a sequence of intermediate results.

Lemma A.1.
In any mixed-strategy PBE, the probability γ_{nf}^H is given by:

$$\gamma_{nf}^H(P_H) = \frac{\gamma_f^H F(\bar{B}(\bar{H}_2))}{(1 - F(\bar{B}(\bar{H}_2)))} \frac{(\pi_I^A - \pi_I^\emptyset(S_f, \bar{H}_2) - P_H)}{(P_H - \pi_I^A + \pi_I^\emptyset(S_{nf}))}. \tag{17}$$

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

$$\phi(P_H) = \frac{\gamma_f^H F(\bar{B}(\bar{H}_2))}{\gamma_{nf}^H(1 - F(\bar{B}(\bar{H}_2))) + \gamma_f^H F(\bar{B}(\bar{H}_2))}.$$

We will drop the notation, and simply use ϕ in what follows. I is indifferent between accepting and rejecting a price offer featuring P_H if and only if:

$$\pi_I^A - P_H = \phi \pi_I^\emptyset(S_f, \bar{H}_2) + (1-\phi)\pi_I^\emptyset(S_{nf}).$$

Plugging the formula for ϕ, and simplifying, we obtain the expression for $\gamma_{nf}^H(P_H)$ in equation

(17). Since $\pi_I^{\emptyset}(S_{nf}) > \pi_I^{\emptyset}(S_f, \bar{H}_2)$, $\gamma_{nf}^H(P_H) > 0$ if (and only if) $\pi_I^A - \pi_I^{\emptyset}(S_{nf}) < P_H < \pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2)$. Q.E.D.

We next define β^H.

Lemma A.2.
In any mixed-strategy PBE, the probability β^H is given by $\beta^H(P_H) = \frac{P_L \beta^L}{P_H}$.

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

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

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

In the next lemma, we show 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_f 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 unconstrained must be (weakly) higher than the a priori probability. Moreover the posterior probability is strictly increasing in P_H.

Lemma A.3.
In any mixed-strategy PBE:

1. *S_f offers P_H with certainty (i.e., $\gamma_f^H = 1$) for all $P_H > P_L > 0$ and $P_H > \pi_S^{\emptyset}(S_f, \bar{H}_2)$.*

2. *If $\pi_I^A = \pi_I^m$, there does not exist a mixed-strategy PBE in which I acquires S.*

3. *If $\pi_I^A = \pi_I^M - K$, I accepts any offer featuring a price $P_L \leq \pi_I^A - \pi_I^{\emptyset}(S_{nf})$ with probability $\beta^L > \beta^H$.*

4. *When P_H is observed, it cannot be that $\phi(P_H) < F(\bar{B}(\bar{H}_2))$.*

5. *$\phi(P_H)$ is strictly increasing in P_H and $\phi(P_H) < 1$ for any $\pi_S^{\emptyset}(S_f, \bar{H}_2) < P_H < \pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2)$.*

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

$$P_H \beta^H + (1 - \beta^H)\pi_S^{\emptyset}(S_f, \bar{H}_2) > \pi_S^{\emptyset}(S_f, \bar{H}_2) \iff P_H > \pi_S^{\emptyset}(S_f, \bar{H}_2).$$

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

$$\begin{aligned} P_H \beta^H + (1 - \beta^H)\pi_S^{\emptyset}(S_f, \bar{H}_2) &> P_L \beta^L + (1 - \beta^L)\pi_S^{\emptyset}(S_f, \bar{H}_2) \\ \iff \beta^H &> \frac{\beta^L (P_L - \pi_S^{\emptyset}(S_f, \bar{H}_2))}{P_H - \pi_S^{\emptyset}(S_f, \bar{H}_2)}, \end{aligned}$$

which is always satisfied if $P_H > P_L$ and $P_H > \pi_S^{\emptyset}(S_f, \bar{H}_2)$. Hence, $\gamma_f^H = 1$ for all $P_H > P_L > 0$ and $P_H > \pi_S^{\emptyset}(S_f, \bar{H}_2)$.

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

$$\pi_I^A - P_L \geq \pi_I^{\emptyset}(S_{nf}) \iff P_L \leq \pi_I^A - \pi_I^{\emptyset}(S_{nf}). \tag{18}$$

If $\pi_I^A = \pi_I^m$, $\pi_I^A - \pi_I^{\emptyset}(S_{nf}) = 0$. 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, $\pi_I^A - \pi_I^{\emptyset}(S_{nf}) > 0$ is the upper bound of P_L such that I will be willing to accept, with $\pi_I^A - \pi_I^{\emptyset}(S_{nf}) < \pi_S^{\emptyset}(S_f, \bar{H}_2)$. From this it follows that $P_H > P_L$ and $\beta^H < \beta^L$ (claim *3.*).

From claim *1.* (i.e. $\gamma_f^H = 1$), it follows that:

$$\phi(P_H) = \frac{F(\bar{B}(\bar{H}_2))}{\gamma_{nf}^H(1 - F(\bar{B}(\bar{H}_2))) + F(\bar{B}(\bar{H}_2))}. \tag{19}$$

Since $\gamma_{nf}^H(1 - F(\bar{B}(\bar{H}_2))) + F(\bar{B}(\bar{H}_2)) \leq 1$, then $\phi(P_H) \geq F(\bar{B}(\bar{H}_2))$ (claim *4*).

From claim *1.* it also follows that:

$$\gamma_{nf}^H(P_H) = \frac{F(\bar{B}(\bar{H}_2))}{(1 - F(\bar{B}(\bar{H}_2)))} \frac{(\pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2) - P_H)}{(P_H - \pi_I^A + \pi_I^{\emptyset}(S_{nf}))}, \tag{20}$$

which is strictly decreasing in P_H when $\pi_S^{\emptyset}(S_f, \bar{H}_2) < P_H < \pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2)$, where $\pi_S^{\emptyset}(S_f, \bar{H}_2) > \pi_I^A - \pi_I^{\emptyset}(S_{nf})$. Hence, $\phi(P_H)$ is strictly increasing in P_H (claim *5*).

Since $\gamma_{nf}^H(P_H) > 0$ for any $\pi_S^{\emptyset}(S_f, \bar{H}_2) < P_H < \pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2)$, $\phi(P_H) < 1$ for any $\pi_S^{\emptyset}(S_f, \bar{H}_2) < P_H < \pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2)$. 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 A.4.
Let $\pi_I^A = \pi_I^M - K$.

1. *If $\bar{H}_2 \geq W^d - W^M$, a mixed-strategy PBE does not exist.*
2. *If $\bar{H}_2 < W^d - W^M$ and $F(\bar{B}(\bar{H}_2)) \leq F_S$, there exists a continuum of hybrid PBE featuring: $P_L = \pi_I^M - K - \pi_I^m$ and $P_H \in (\pi_S^d - K, \bar{P}(\bar{H}_1)]$, with $P_H > P_L > 0$, $\phi(P_H) \leq F_W(\bar{H}_1)$ and $\bar{P}(\bar{H}_1) < \pi_I^M - K - \pi_I^d$ increasing in $\bar{H}_1$;*
3. *$\gamma_{nf}^H(P_H) \in (0, 1)$, $\beta^L \in (0, 1]$ and $\beta^H(P_H) \in (0, \beta^L)$.*

Proof. First, a mixed-strategy PBE exists if the high-price offer is approved by the AA, which occurs iff $\phi(P_H) \leq F_W$.[26]

[26]Whenever possible, in what follows, we drop the functional notation for F_S and F_W.

Consider an offer $P_L \in (0, \pi_I^A - \pi_I^{\emptyset}(S_{nf}))$. Those offers cannot be sustained in equilibrium because S_{nf} would have an incentive to deviate and offer $P' \in (P_L, \pi_I^A - \pi_I^{\emptyset}(S_{nf}))$. Since $P' < \pi_I^A - \pi_I^{\emptyset}(S_{nf}) < \pi_S^{\emptyset}(S_f, \bar{H}_2)$, I would attribute the deviation offer to S_{nf} with certainty and would accept. The AA would authorise the deal (see Corollary 1(i)). The deviation would be profitable.

Consider $P_L = \pi_I^A - \pi_I^{\emptyset}(S_{nf})$. S_{nf} has no incentive to deviate and offer $P' \in (P_L, \pi_S^{\emptyset}(S_f, \bar{H}_2)]$: I would attribute the deviation offer to S_{nf} with certainty and would reject. S_{nf} has no incentive to deviate and offer $P' > \max\{P_p, \pi_S^{\emptyset}(S_f, \bar{H}_2)\}$ (with $P' \neq P_H$ and P_p defined in Lemma 5): I would attribute the deviation offer to S_f with probability $F(\bar{B}(\bar{H}_2))$ and would reject. Consider now $P' \in (\pi_S^{\emptyset}(S_f, \bar{H}), P_p]$, a possibility that arises if (and only if) $F(\bar{B}(\bar{H}_2)) > F_S$. I would attribute the deviation offer to S_f with probability $F(\bar{B}(\bar{H}_2))$ and would accept. From Lemma A.3 (part 4), $F(\bar{B}(\bar{H}_2)) \leq \phi(P_H)$. Hence, from $\phi(P_H) \leq F_W$ it follows that $F(\bar{B}(\bar{H}_2)) \leq F_W$: the deal would be authorised by the AA and the deviation would be profitable. The mixed-strategy PBE exists only if $F(\bar{B}(\bar{H}_2)) \leq F_S$.

Consider now an offer $P_H \in (\pi_S^{\emptyset}(S_f, \bar{H}_2), \pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2))$. For it to be sustained at the equilibrium S must not have an incentive to deviate and offer $P' > P_H$. Since $P' > \pi_S^{\emptyset}(S_f, \bar{H}_2)$, I attributes the deviation offer to S_f with probability $F(\bar{B}(\bar{H}_2))$. Moreover, from $F(\bar{B}(\bar{H}_2)) \leq F_S$ it follows that $\pi_S^{\emptyset}(S_f, \bar{H}_2) \geq P_p$. Therefore $P' > P_p$ and I would reject the deviation offer.

Note that when $\pi_I^A = \pi_I^M - K$ and $\bar{H}_2 \geq W^d - W^M$, $\pi_I^{\emptyset}(S_f, \bar{H}_2) + \pi_S^{\emptyset}(S_f, \bar{H}_2) = \pi_I^A = \pi_I^M - K$. Hence, the set of values of P_H that can be sustained at the equilibrium is empty. The mixed-strategy PBE does not exist, as stated in part *1*.

Consider now the case in which $\pi_I^A = \pi_I^M - K$ and $\bar{H}_2 < W^d - W^M$. From Assumption *A*2, $\pi_S^{\emptyset}(S_f, \bar{H}_2) = \pi_S^d - K < \pi_I^M - K - \pi_I^d = \pi_I^A - \pi_I^{\emptyset}(S_f, \bar{H}_2)$. Let us identify 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 3, when $\pi_I^A = \pi_I^M - K$ and $\bar{H}_2 < W^d - W^M$, $F_W = \frac{\bar{H}_1 + W^M - W^m - K}{W^d - K - W^m}$. Substituting (20) in (19), one obtains:

$$\phi(P_H) = \frac{P_H - \pi_I^M + K + \pi_I^m}{\pi_I^m - \pi_I^d}, \tag{21}$$

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

Therefore, we can distinguish the following three cases:

1. $\bar{H}_1 \geq W^d - W^M$. 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. $\bar{H}_1 < W^d - W^M$. In this case $F_W < 1$. Moreover, $F_W \geq 0$ for any feasible value of $\bar{H}_1$, i.e. for any $\bar{H}_1 \geq -(W^M - K - W^m)$. 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 $\bar{H}_1 \in [-(W^M - K - W^m), W^d - W^M)$ there exists a $\bar{P}_H(\bar{H}_1) \in [\pi_I^M - K - \pi_I^m, \pi_I^M - K - \pi_I^d)$ such that $\phi(P_H) \leq F_W$ for any $P_H \leq \bar{P}_H(\bar{H}_1)$. Moreover, since F_W is strictly increasing in

$\bar{H}_1$, $\bar{P}_H$ is strictly increasing in $\bar{H}_1$.

Note that, when $\bar{H}_1 = -(W^M - K - W^m)$, $F_W = 0$ and $\bar{P}_H(\bar{H}_1) = \pi_I^M - K - \pi_I^m < \pi_S^d - K$ (from assumption A2). Since $\pi_S^d - K < \pi_I^M - K - \pi_I^d$ and $\bar{P}_H(\bar{H}_1)$ is strictly increasing in $\bar{H}_1$, there exists a cut-off level of $\bar{H}_1$, $\bar{H}_1^{\circ,m} \in (-(W^M - K - W^m), W^d - W^M)$ such that $\bar{P}_H(\bar{H}_1) \leq \pi_S^d - K$ for any $\bar{H}_1 \leq \bar{H}_1^{\circ,m}$. Therefore:

2.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 $\bar{H}_1 \leq \bar{H}_1^{\circ,m}$, i.e. when the standard of review regarding early takeovers is sufficiently strict.

2.b any $P_H \in (\pi_S^d - K, \bar{P}_H(\bar{H}_1)]$ can be supported at the PBE in mixed strategies when $\bar{H}_1 \in (\bar{H}_1^{\circ,m}, W^d - W^M)$.

We conclude with claim *3*. Given $\gamma_f^H = 1$ and $P_H > \pi_S^{\emptyset}(S_f, \bar{H}_2) > P_p$, $\gamma_{nf}^H < 1$. Therefore $\phi(P_H) > F(\bar{B}(\bar{H}_2))$. Moreover, $0 < P_L < P_H$ and $\beta^L \in (0, 1]$ implies $\beta^H \in (0, \beta^L)$. Q.E.D.

A.9 Proof of Proposition 2

From the proof of Lemma A.4, it follows that when S makes the offer, $\pi_I^A = \pi_I^M - K$, $\bar{H}_2 < W^d - W^M$ and $F(\bar{B}(\bar{H}_2)) \leq F_S$, setting $\bar{H}_1 \leq \bar{H}_1^{\circ,m}$, with $\bar{H}_1^{\circ,m} \in (-(W^M - K - W^m), W^d - W^M)$, ensures that no hybrid PBE exists. Therefore only an equilibrium featuring a low-price exists, which is superior in terms of welfare:

$$\begin{aligned}
EW^{ps} &= F(\bar{B}_L)(W^d - K) + (1 - F(\bar{B}_L))(W^M - K) > \\
EW^{ms} &= F(\bar{B}_L)[W^d - K - \beta^H(P_H)(W^d - W^M)] \\
&+ (1 - F(\bar{B}_L))[W^M - K - \gamma_{nf}^H(P_H)(1 - \beta^H(P_H))(W^M - K - W^m)].
\end{aligned}$$

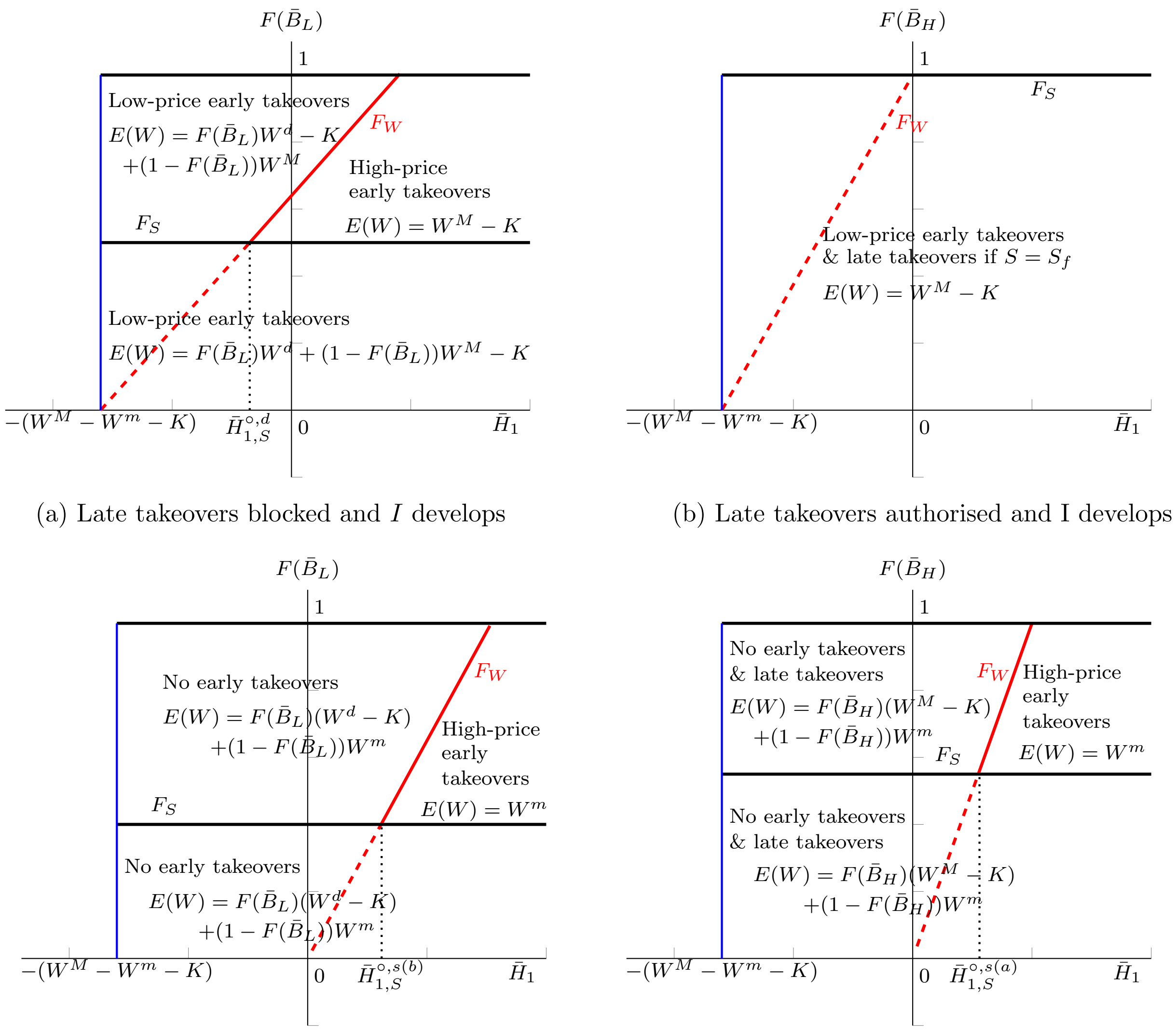
From the proof of Lemma A.4, $\bar{H}_1^{\circ,m}$ is such that $\bar{P}_H = \pi_S^d - K$ and, therefore, $F_W = \phi(P_H = \pi_S^d - K)$. From equation (21), $\phi(P_H = \pi_S^d - K) = \frac{\pi_S^d - \pi_I^M - \pi_I^m}{\pi_I^m - \pi_I^d} = F_S$. From the proof of Proposition 1, $\bar{H}_{1,S}^{\circ,d}$ is such that $F_W = F_S$. Hence, $\bar{H}_{1,S}^{\circ,d} = \bar{H}_1^{\circ,m}$.

It follows that when S makes the offer and the incumbent develops, setting $\bar{H}_1 \leq H_{1,S}^{\circ,d}$ prevents high-price takeovers from arising not only at the equilibrium in pure strategies, but also at the hybrid PBE. Hence, when S makes the offer and the incumbent develops all $\bar{H}_1 \leq H_{1,S}^{\circ,d}$ and $\bar{H}_2 < W^d - W^M$ are optimal, also when one allows for equilibria in mixed strategies.

The proof of Proposition 1 shows that $\bar{H}_1^{\circ,d} = \bar{H}_{1,I}^{\circ,d} < \bar{H}_{1,S}^{\circ,d}$. Hence, when the incumbent develops, setting $\bar{H}_1 \leq H_1^{\circ,d}$ 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 $\bar{H}_1 \leq H_1^{\circ,d}$ and $\bar{H}_2 < W^d - W^M$ are optimal for any value of α, also when one allows for equilibria in mixed strategies at $t = 1(a)$. It also follows that $\bar{H}_1 \leq \min(\bar{H}_1^{\circ,d}, \bar{H}_1^{\circ,s})$ is optimal for any value of π_I^A.

B Additional Figures

Figure B.1: 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. $\bar{H}^{\circ,d}_{1,S}$ 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 $\bar{H}^{\circ,s(j)}_{1,S}$, 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. $\bar{H}^{\circ,s(j)}_{1,S}$ is necessarily positive.