MONASH University

MONASH BUSINESS SCHOOL

Department of Economics
ISSN number 1441-5429

Acquisition-induced kill zone

Discussion Paper no. 2022-24

Christopher Teh, Dyuti Banerjee and Chengsi Wang

Abstract:

We study the impact of a dominant incumbent's acquisition on entry and R&D incentives in a model with multiple start-ups. The incumbent's acquisition directly suppresses entry and can distort the non-target start-up's R&D incentives by creating a kill zone. The reduced threat of entry can also cause the incumbent to shelve the acquired technology. Despite these negative effects, acquisitions generally affect consumer welfare ambiguously due to synergy benefits. We study the design of merger policies aimed at minimizing acquisition-related harms. We also show that entry-for-buyout may not be a valid defense for start-up acquisitions when accounting for non-target start-ups.

Keywords: Acquisitions, Innovation, Start-ups, Merger Policy, Remedies

JEL Classification: G34, L12, L41, O31

Christopher Teh: UNSW Sydney (email: chris.teh@unsw.edu.au); Dyuti Banerjee: Department of Economics, Monash University (email: dyuti.banerjee@monash.edu); Chengsi Wang: Department of Economics, Monash University (email: chengsi.wang@monash.edu).

© The authors listed. All rights reserved. No part of this paper may be reproduced in any form, or stored in a retrieval system, without the prior written permission of the author.

monash.edu/business/economics

ABN 12 377 614 012 CRICOS Provider Number: 00008C

AACSB ACCREDITED EQUIS ACCREDITED ASSOCIATION OF MBAS ACCREDITED

Acquisition-induced kill zone[*]

Christopher Teh[†], Dyuti Banerjee[‡], and Chengsi Wang[§]

November 22, 2022

Abstract

We study the impact of a dominant incumbent's acquisition on entry and R&D incentives in a model with multiple start-ups. The incumbent's acquisition directly suppresses entry and can distort the non-target start-up's R&D incentives by creating a kill zone. The reduced threat of entry can also cause the incumbent to shelve the acquired technology. Despite these negative effects, acquisitions generally affect consumer welfare ambiguously due to synergy benefits. We study the design of merger policies aimed at minimizing acquisition-related harms. We also show that entry-for-buyout may not be a valid defense for start-up acquisitions when accounting for non-target start-ups.

Keywords: Acquisitions, Innovation, Start-ups, Merger Policy, Remedies
JEL Classification: G34, L12, L41, O31

[*]We thank Arthur Campbell, Florian Ederer, Nisvan Erkal, Simon Loertscher, Jose Luis Moraga, Lijun Pan, Martin Peitz, Emanuele Tarantino, Jun Xiao, and participants at the 2021 Competition Policy Challenges in the Digital Era Conference, the 2021 Asia-Pacific Industrial Organisation Conference, the 2022 Society for the Advancement of Economic Theory Annual Conference, and seminars at Durham University, Monash University, UNSW Sydney, and University of Melbourne for providing insightful comments. Alistair Cameron provided superb research assistance. Chengsi Wang thanks the Australian Research Council Discovery Project DP210102015 for the generous financial support. Additional material relegated to the online appendix can be found at here.

[†]UNSW Sydney, Australia, E-mail: chris.teh@unsw.edu.au

[‡]Monash University, Australia, E-mail: dyuti.banerjee@monash.edu

[§]Monash University, Australia, E-mail: chengsi.wang@monash.edu

1 Introduction

The recent decade has seen a frenzy of start-up acquisitions by tech giants.[1] Much concern has been raised about whether such acquisitions suppress potential competition and distort innovation (Cabral, 2021, Scott-Morton et al., 2019, Crémer et al., 2019, Furman et al., 2019). The attention, however, has been devoted almost exclusively towards understanding how acquisitions change the behavior of acquirers and targeted start-ups. In reality, start-ups acquired by incumbent firms, while plentiful, form only a small proportion of all start-ups.[2] Many major technological breakthroughs can be attributed to small, independent start-ups. Thus, the externalities imposed by acquisitions onto non-target start-ups can also play an important role in an incumbent's acquisition decision. As stated by Facebook CEO Mark Zuckerberg in an email to his Chief Financial Officer David Ebersman regarding Facebook's acquisition of Instagram (D.D.C, 2021):

"...It's possible someone beats Instagram by building something that is better to the point that they get network migration, but this is harder as long as Instagram keeps running as a product...Even if some new competitors spring up... if we incorporate the social mechanics [Instagram] were using, those new products won't get much traction since we'll already have their mechanics deployed at scale. "

The U.S. Fair Trade Commission concluded that Facebook's acquisition of Instagram and WhatsApp intended not only to neutralize the direct threat these startups posed on Facebook, but also to "build a protective moat" around Facebook and significantly hinder other start-ups from entering the market of personal social networking.

These observations emphasize the importance of understanding how acquisitions affect the R&D activities of both target *and* non-target start-ups. Our paper contributes to this understanding in three ways. First, in an environment with possible entry by both types of start-ups, we explore the incumbents's incentive to develop the acquired technology, and tie it, together with market structure, to start-ups' R&D incentives. Second, we provide different rationales for the incumbent's acquisition decision for different market structures. Crucially, we identify the conditions under which the incumbent's acquisition induces the non-target start-ups to deviate their innovation direction away from the incumbent's core business, which is defined as the kill zone effect. Finally, we analyse how acquisitions affect consumer welfare

[1] Recent acquisition patterns by GAFAM (Google, Amazon, Facebook, Apple, Microsoft) are documented in Argentesi et al. (2019) and Gautier and Lamesch (2021).

[2] For example, GAFAM have made over 500 acquisitions in the decade leading up to 2020, with many of which being start-ups. Meanwhile, an annual average of 800 start-ups were founded in Silicon Valley from 2010-2020 (Silicon Valley Indicators, 2021).

in the presence of multiple start-ups. We also offer an in-depth comparison between coarse merger policies and *ex ante* remedies in reducing consumer harm caused by acquisitions. Under a coarse merger policy, an antitrust authority reviews mergers only by controlling the clearance rate. When remedies are allowed, the acquisition will be approved, but the incumbent is required to transfer some profits to the non-target start-ups, e.g., in the form of patent transfers or data sharing, contingent on both being successful in R&D.

We consider a framework where an incumbent firm (I) faces the threat of potential entry by an early-stage start-up ($E1$) and a late-stage start-up ($E2$). $E1$ is the non-target start-up and faces a two-stage innovation process. First, it chooses either a threatening project (hereafter referred to as the *type-0 project*), which conditional on being successfully developed generates a superior substitute to I's product, or an adventurous project (hereafter referred to as the *type-X project*) that stochastically generates either a superior substitute or an independent product if successfully developed. $E1$ then makes its investment decision. That is, $E1$ decides whether to invest to develop its project. Meanwhile, E2 only possesses a type-0 project, thereby directly threatening I, and hence is the incumbent's acquisition target.[3] When there is no acquisition, $E2$'s only decision is whether to develop its project.

I makes its acquisition decision after $E1$ chooses its project type, but prior to the start-ups' project development decisions. If I acquires $E2$, it has the sole right use to $E2$'s technology and decides whether to develop the acquired project upon observing $E1$'s development outcome.[4] After R&D and acquisition decisions are made, the remaining firms compete in the product market.

The profit asymmetry between the incumbent and a start-up plays a crucial role in our analysis. When both $E1$ and I produce a superior substitute, competition is tilted in favour of the incumbent, compared to when competition is between two start-ups. This reflects how incumbents often capitalize on advantages such as established reputation, large distribution networks, and existing customer bases. Anticipating tough competition against I, $E1$ becomes more reluctant to enter I's market, compared to when acquisitions are banned. This chilling effect on $E1$, combined with the intent of removing the threat of $E2$, strongly motivates I to acquire $E2$.

Our main result revolves around the way in which I's acquisition of $E2$ affects the non-target start-up $E1$'s innovation activities. The fact that I holds the acquired

[3]Holding everything else equal, it is reasonable to assume I prefers acquiring $E2$ rather than $E1$ as $E2$ already imposes a direct threat. We discuss the complementary scenario where $E1$ is the acquisition target in Section 5.1.

[4]This timing reflects the fact that, by holding the acquired project, I may affect $E1$'s R&D without even developing the acquired project. An alternative timing with simultaneous development is considered in Section 5.3.

project and can counter-develop it whenever necessary weakens $E1$'s incentive to enter I's core market. That is, when development costs are not too large such that I counter-develops in response to entry, the acquisition induces a *kill zone*, leading $E1$ to choose type-X project when it may have otherwise chosen type-0 project if acquisitions were banned. Unlike in Kamepalli et al. (2021) and Motta and Sheleiga (2021) where kill zones are created for target start-ups, here, kill zones are created for non-target start-ups through acquiring the target start-up. Meanwhile, if project development costs are large, then I acquires $E2$ only for defensive purposes and never develops the acquired project. In this case, acquisition induces a *safe space*, where I's acquisition, through eliminating competition in I's core market, induces $E1$ to choose the type-0 project. The acquisition also affects firms' decisions to develop the projects they hold. Notably, when development costs are not too small, the acquisition reduces the aggregate frequency of project development. Anticipating I's possible counter-development, $E1$ reduces its development frequency. As such, I, facing a smaller threat of entry, often shelves the acquired project.[5]

Our findings regarding kill-zone effects caused by start-up acquisitions are supported by recent empirical evidence. For instance, Affeldt and Kesler (2021) identify apps acquired by GAFAM between 2015 and 2019 and match these to a comprehensive database covering apps available in the Google Play Store. They find that, following these acquisitions, developers less frequently update the existing (non-target) competing apps, and less frequently launch new competing apps. Relatedly, across several product categories, Koski et al. (2020) find a reduction in available venture-capital funding for start-ups and entry following big-tech acquisitions.

Given the possibility for creating kill zones, it is imperative to understand the impact of start-up acquisitions on consumer welfare. We first show that if I's sole purpose is to shelve the acquired project and defend its dominant position, then acquisitions reduce consumer welfare. The effect becomes ambiguous when I does not always shelve the acquired project. In this case, despite possible perverse kill-zone effects, acquisitions may benefit consumers due to the associated efficiency gains stemming from I's advantage in resource and R&D capabilities.

We further consider how an antitrust authority (AA) can use common instruments available to it to maximize consumer welfare. First, under a *coarse merger policy*, the AA can commit to approving a fraction of proposed mergers prior to startups' project choice. We show that if non-target start-ups' project choices remain the same with and without the acquisition, then the AA either approve or block all

[5]We use the word "shelving" as in Fumagalli et al. (2022) rather than "killing" as in Cunningham et al. (2021) to emphasize the fact that the acquired projects are often not fully terminated. They will be kept running at a small scale so that the incumbent can use it as an entry-deterrence device.

acquisitions. On the other hand, if acquisition diverts the start-up's R&D direction away from the incumbent's core business, then the optimal coarse policy can take on a probabilistic form, akin to Gilbert and Katz (2021). Such a merger approval rule reflects the trade-off between realizing the efficiency gains from acquisition, and reducing the chilling effects of kill zones.

One way to mitigate the kill-zone problem without sacrificing efficiencies generated by acquisitions is to approve the acquisition while imposing a remedy that restores start-ups' incentive to compete with I. These remedies may take on many forms in reality, such as requiring divestiture, interoperability, data sharing, or mandatory licensing. We consider such remedies which, in their reduced form, enable a profit transfer from I to $E1$ if both successfully develop a superior substitute and compete. We provide sufficient conditions for a remedy to direct the non-target start-up's R&D towards the incumbent's core business, while ensuring the incumbent counter-develops, outperforming coarse merger policy in increasing consumer welfare. We also show that by increasing $E1$'s development frequency, even a small amount of profit transfer may outperform coarse merger policies.

Many Silicon valley start-ups view acquisitions as their primary exit strategy. When attention is restricted only to the acquisition target, it is widely recognized that acquisitions encourage start-ups to innovate, particularly in the incumbent's core market (e.g. Rasmusen, 1988, Letina et al., 2021, Callander and Matouschek, 2022, Cabral, 2021). We extend the model by allowing $E2$ instead of $E1$ to choose its innovation direction, enabling us to discuss such entry-for-buyout effects when both target and non-target start-ups are present. The entry-for-buyout effect arises as choosing a type-0 project not only threatens I's core business, but also helps I deter for $E2$, if acquired. The latter effect, unique to our multiple-entrant environment, means acquisitions have at most an ambiguous effect on consumer welfare as they encourage entry by target start-ups but deter entry by non-target start-ups.

We examine the robustness of our findings in two alternative settings. First, we revise the counterfactual such that competition for the primary market in the absence of acquisition is tough and only one start-up is willing to enter. Acquisitions affect the R&D direction and development incentives in a similar fashion as the main model, but to a lesser degree. Second, we allow $E1$ and I to make development decisions simultaneously. This increases I's development probability for small development costs, but also expands the range of development costs under which I only acquires $E2$ to shelve its project.

Related literature. Our paper is related to the recent surge of literature studying the acquisition of potential competitors. Cunningham et al. (2021) provide empirical evidence in the pharmaceutical industry for incumbents acquiring potential competitors solely to discontinue them. Such *killer acquisitions* are the result of both the *replacement effect* (Arrow, 1962), and *preemption effect* (Gilbert and Newbery, 1982). The replacement effect implies that incumbents have weaker incentives to further develop an acquired project than entrants, due to profit cannibalization. The preemption effect implies that incumbents' bids for acquisitions always exceed entrants' reservation prices as incumbents want to protect their existing profits. Motta and Peitz (2021) applied these insights to big tech mergers. They find that due to the suppression of potential competition, an acquisition can be anti-competitive even if the acquired project is developed.[6] We extend this discussion about innovation and competition to a broader landscape with both target and non-target start-ups, and characterize the chilling effect that acquisitions exert on non-target start-ups.

A key question we explore in this paper is how the prospect of selling to the incumbent affects start-ups' pre-acquisition innovations. This has also been the focus of the recent literature on start-up acquisitions (Cabral, 2018, Cabral, 2021, Dijk et al., 2021, Gilbert and Katz, 2021, Katz, 2021, Letina et al., 2021, Hollenbeck, 2020). In a similar spirit to Rasmusen (1988), Cabral (2021), Katz (2021), and Hollenbeck (2020) find that acquisitions generally incentivise start-ups to engage in costly innovation activities, except when start-ups can choose how drastic (Cabral, 2018) or how forward-looking (Katz, 2021) their innovations are. We in addition show that non-target start-ups' innovation incentives are depressed by the chilling effect created by the acquisition of competing start-ups.

Acquisitions and mergers affect not only the level of investment made in R&D, but also the R&D direction. The relation between acquisitions and innovation direction has been considered in several recent studies. In Bryan and Hovenkamp (2020), an upstream start-up's innovation is distorted in favor of the market leader by the prospect of acquisition. Moraga-González et al. (forthcoming) model the choice of innovation direction as allocating resources over multiple R&D projects aiming at different markets. This approach is adopted by Dijk et al. (2021) to explore start-up acquisitions, which shows that a more restrictive merger policy can distort the project portfolio choice in either direction. Letina et al. (2021) allow firms to choose a variety of R&D projects with one of which may eventually succeed, and find that prohibiting all acquisitions can increase the duplication of project portfolios and decrease welfare. However, Callander and Matouschek (2022) and Gilbert and Katz (2021) show that acquisitions suppress the novelty of innovation as the entrant tends to choose technologies that are too close to the incumbent's existing technology. This in turn implies a more restrictive merger policy can encourage

[6] Fumagalli et al. (2022) provide a defence for incumbents' acquisitions by showing that they alleviate the financial constraints start-ups face, allowing for more innovations to be introduced to the market.

more novel innovations.

The idea of kill zones created by acquisitions is discussed in Kamepalli et al. (2021). By focusing on the platform market, they show that the anticipation of acquisition can dissuade early adoption of a start-up's product which exhibits positive network effects. This depresses the acquisition value of the start-up and disincentivizes ex-ante start-up investments. Motta and Sheleiga (2021) discuss the complementarity between kill-zone-inducing incumbent behaviour and acquisitions. They show that the incumbent's ability to imitate the start-up's product creates a kill zone for producing substitutes, diverting the start-up to develop complements. Similarly, Katz (2021) finds that the incumbent may invest to reduce entrant profits to induce it to agree to be bought. Finally, Denicolo and Polo (2021) study the impact of acquisitions in a dynamic model where an incumbent's captive consumer base expands with prior sales. Repeated acquisitions initially spur innovation but can subsequently entrench the incumbent's monopoly power. The latter effect discourages future entry, stifling innovation.

A sizable portion of our paper is devoted to studying policy design that balances pre- and post-acquisition innovation incentives. Gilbert and Katz (2021) show that approving an acquisition with a positive probability can benefit consumers even if ex post all acquisitions harm consumers. We also derive an optimal merger approval rule that is probabilistic, but for a very different reason. We defer the more detailed comparison with Gilbert and Katz (2021) to the end of Section 4.2. In Fumagalli et al. (2022) and Wickelgren (2021), there exists imperfect information about acquisitions and the AA's approval decision can be conditional on some observed signals such as the bid for the target. Our paper also studies the impact of ex ante remedies that require a profit transfer from the incumbent to the non-target start-up once they compete. Letina et al. (2021) consider behavioural remedies involving restricting the use of acquired technologies or prohibiting incumbents from terminating the acquired R&D projects.

The rest of the paper is organized as follows. Section 2 introduces the model setup. A benchmark case where start-up acquisitions are banned is analyzed in Section 3.1, followed by a full analysis of the main model in Section 3.2. A discussion of welfare and policy aspects of start-up acquisitions can be found in Section 4. Entry-for-buyout and robustness checks are pursued in Section 5. Section 6 concludes. All proofs and some omitted details are located in Appendix A-B.

2 The model

An incumbent I monopolizes the *primary market* by producing an *existing primary product*. Two start-ups, $E1$ and $E2$, can potentially enter the primary market.

R&D projects. Start-ups create new products through pursuing R&D projects. There are two types of projects: type-0 and type-X. If the start-up chooses and successfully develops the type-0 project, then the project yields a *superior substitute* to the existing primary product. Thus, this choice reflects the start-up focusing its R&D efforts entirely on entry into the incumbent's market. Meanwhile, the type-X project reflects the start-up directing its R&D efforts towards a more uncertain direction, which may eventually depart from the primary market. If this project is chosen and successfully developed, it yields either an *independent product* (i.e., independent from the primary market), which happens with probability $x \in [0, 1]$, or a superior primary product, which happens with probability $1 - x$. The value of x is unknown before start-ups' choices of project type, although it is common knowledge that x is drawn from a continuous distribution $F(x)$ with support $[0, 1]$.[7]

The R&D process consists of two stages: choosing a project type (described above), and then developing the project to generate a new product. The choice of project type is assumed to be costless. Meanwhile, regardless of project type, each project costs $K > 0$ to develop, and the development of either project is successful with a probability $p \in (0, 1)$. A failed project always yields zero profit.[8]

We assume that $E2$ is a late-stage startup, whose project choice is fixed at 0, and $E1$ is an early-stage start-up, who chooses its project type t_{E1} from $\{0, X\}$.[9] The alternative, i.e., where $E2$ chooses projects while $E1$'s project is fixed at 0, is examined when discussing entry-for-buyout in Section 5.1.

Acquisition. After start-ups' choice of projects and prior to their development decision, I can offer to acquire $E2$. We assume that $E2$ accepts the offer so long as $E2$ is compensated with an amount equal to its reservation value. Upon acquiring $E2$, I can then decide whether to develop the type-0 project, with the identical cost

[7] We use the parameter x to capture the uncertainty involved with taking on a riskier R&D direction. We provide a more concrete interpretation as follows. After initially choosing the more risky type-X project, the start-up obtains additional information about what the independent product could be, e.g. through prototyping and market research. Based on this additional information, it pursues further development of the independent product with probability $x \in [0, 1]$. The greater the extent to which the information obtained favours development of the independent product, the larger the realised value of x.

[8] Our main insights do not rely on the assumption that K and p are identical across R&D projects, which is only done to simplify the exposition.

[9] We can also interpret $E1$ as a potential competitor to I, who has not entered the primary market, and $E2$ as a nascent competitor, who is in the market but has not imposed any competition constraint on I yet.

K and success probability p.

Payoffs. In the primary market, each firm's profits in the competition stage depend on the number and identity of firms which have successfully developed a superior primary product. The corresponding payoffs are summarized in Table 1.

Table 1: Firms' profits in the primary market

Firms with a superior product	I's profit	$E1$'s profit	$E2$'s profit
None	π_m	0	0
Only I	π_M	0	n/a
Only $E1$	0	π_M	0 or n/a
Only $E2$	0	0	π_M
I and $E1$	π_D^I	π_D^E	n/a
$E1$ and $E2$	0	π_D	π_D

We assume innovation is drastic such that if any of the start-ups successfully enter the primary market with a superior substitute when I only sells the existing primary product, I's profit is driven down to zero.[10]. The superior primary product yields the monopolist of the primary market a higher monopoly profit than had the monopolist owned the existing product, i.e., $\pi_M > \pi_m$. If the primary market is duopolized by two firms equipped with the superior primary product, each firm's profits depend on their identity. When the duopolists are $E1$ and $E2$, they earn a symmetric duopoly profit $\pi_D < \pi_M$. When the duopolists are I and $E1$, I earns $\pi_D^I > \pi_D$ and $E1$ earns $\pi_D^E < \pi_D$. The latter assumption reflects the fact that I is better in commercializing the product, e.g., due to the incumbent's advantages in production, marketing, service provision, and its existing consumers' switching costs. Thus, competing against the incumbent is harder than competing against the other start-up. If $E1$ successfully develops an independent product, it expects a profit of $\pi_X(x)$, which we assume to be weakly increasing in x.[11]

Timing. The timing of the game is as follows:

- **Stage 1: Project choice.** $E1$ chooses $t_{E1} \in \{0, X\}$. If X is chosen, x is realized and observed by all players.
- **Stage 2: Acquisition.** I decides whether to make an offer to acquire $E2$. If an offer is made, $E2$ decides to accept or reject it.
- **Stage 3: Project development.**

[10]We briefly discuss non-drastic innovation, following our main results, in Footnote 14.

[11]This is consistent with our interpretation of the parameter x in Footnote 7. After gaining additional information, R&D effort is expended to develop an independent product with high probability only if the information indicates sufficiently large profits.

– **Stage 3A.** Existing start-ups simultaneously decide whether to incur cost K to develop their projects. The success or failure of $E1$ and $E2$'s projects are observed by all players.

– **Stage 3B.** If I has acquired $E2$, I decides whether to incur cost K to develop its project. The outcome is publicly observed.

- **Stage 4: Commercialization.** Depending on project development outcomes, firms compete and obtain their profits.

Our solution concept is that of subgame-perfect Nash equilibrium.

Assumptions. First, we assume that the prospect of monopolizing the primary market with a new product always incentivizes the start-up to pursue project development. Additionally, we assume that for any x, the type-X project is sufficiently lucrative to entice start-ups to invest in it, but not as lucrative as monopolizing the primary market.

Assumption 1. *For all* $x \in [0, 1]$, $K \leq p\pi_X(x) < p\pi_M$.

Next, we assume the *Arrow Replacement Effect*: the incumbent's has less of an incentive than start-ups to develop the type-0 project, even when $E1$ faces competition from the incumbent.

Assumption 2. $\pi_M - \pi_m < \pi_D^E$.

Finally, to fix ideas, we assume that both start-ups incur cost K to develop their projects in the absence of acquisitions. We relax this assumption in Section 5.2.

Assumption 3. $K \leq p\Pi := p[p\pi_D + (1-p)\pi_M]$.

3 Equilibrium analysis

3.1 Benchmark: No Acquisitions

We begin our analysis by considering the benchmark case where I cannot acquire $E2$. Thus, we can ignore stages 2 and 3B of the game, and focus exclusively on stages 3A and 1.

In stage 3A, start-ups simultaneously decide whether to develop their project. Suppose $t_{E1} = 0$. In this symmetric situation, a start-up chooses to develop its project irrespective of the other start-up's choice. This is because even if a start-up

Ej, $j = 1, 2$, develops its project, the other start-up Ei with $i \neq j$ expects a profit of

$$p\Pi - K = p[p\pi_D + (1-p)\pi_M] - K \geq 0, \tag{1}$$

from developing its own project, with the inequality implied by Assumption 3. Thus, both start-ups develop their projects when $t_{E1} = 0$.

Next, suppose $t_{E1} = X$. If $E2$ develops its project, $E1$ also develops its project because the expected profit from doing so is

$$p[x\pi_X(x) + (1-x)\Pi] - K \geq 0,$$

where the inequality holds given Assumptions 1 and 3. Similarly, if $E1$ develops its project, $E2$ also develops its project because its expected profit from doing so is

$$p[(1 - p(1-x))\pi_M + p(1-x)\pi_D] - K = p[\Pi + px(\pi_M - \pi_D)] - K \geq 0,$$

where the inequality holds given $\pi_M > \pi_D$ and Assumption 3. Therefore, both start-ups develop their projects regardless of the realization of x.

In Stage 1, $E1$ chooses its project type. $E1$'s expected profit is $p\Pi - K$ if $t_{E1} = 0$, and $\int_0^1 (p[x\pi_X(x) + (1-x)\Pi])\, dF(x) - K$ if $t_{E1} = X$. Hence, $E1$ selects $t_{E1} = 0$ if and only if

$$p\Pi - \int_0^1 (p[x\pi_X(x) + (1-x)\Pi])\, dF(x) \geq 0 \quad \Leftrightarrow \quad \int_0^1 x\,(\Pi - \pi_X(x))\, dF(x) \geq 0. \tag{2}$$

Intuitively, $E1$ chooses the type-0 project if and only if the expected profit of obtaining the independent product, $\int_0^1 x\pi_X(x)dF(x)$, is sufficiently low.

Proposition 1. *In the absence of acquisitions, $E1$ chooses $t_{E1} = 0$ if (2) holds and $t_{E1} = X$ otherwise. Both start-ups always develop their projects, regardless of $E1$'s choice of project type.*

3.2 Allowing for Acquisitions

In this section, we characterize the equilibrium outcome when acquisitions are allowed, and compare it with Section 3.1.

3.2.1 Project Development

If acquisitions do not occur in stage 2, the analysis of stage 3 mirrors that in Section 3.1 such that start-ups always develop their projects.

Suppose I acquireS $E2$ in stage 2. Let us consider I's development decision in stage 3B. If $E1$ successfully develops a superior primary product in stage 3A, then choosing not to develop the acquired project implies I obtains zero profits. Meanwhile, choosing to invest K to develop the acquired project yields a profit of π_D^I if successful, which occurs with probability p. Hence, I develops the acquired project in response to $E1$'s success if and only if

$$K \leq K_D^I := p\pi_D^I. \tag{3}$$

Meanwhile, suppose $E1$ fails to develop a superior substitute, i.e., does not develop any product, or develops an independent product. Then I's profit is π_m if it does not develop the acquired project, and π_M with probability p if it invests K to develop the acquired project (and 0 with probability $1-p$). Hence, I develops the acquired project if and only if

$$K \leq K_M^I := p(\pi_M - \pi_m). \tag{4}$$

From Assumption 2, we know that $K_D^I \geq K_M^I$. Hence, I has a greater incentive to pursue innovation under the threat of entry.

Next, consider $E1$'s development decision in stage 3A. Suppose that $x \in [0, 1]$ was realized in Stage 1, where $E1$'s choice of a type-0 project is captured by the realization of $x = 0$. First, suppose (3) holds such that $E1$ expects I to pursue development of the acquired project in response to $E1$'s success in developing a superior substitute. If $E1$ is successful in developing its project, which occurs with probability p, then it develops an independent project with probability x and earns $\pi_X(x)$, and develops a superior primary product with probability $1-x$. In the latter case, $E1$ earns π_D^E with probability p (if I succeeds in its development), and π_M with probability $(1-p)$ (if I fails in its development). Hence, $E1$ develops its project if and only if

$$K \leq K_D^{E1}(x) := p[x\pi_X(x) + (1-x)(\Pi + p(\pi_D^E - \pi_D))]. \tag{5}$$

Observe that for all $x \in [0, 1]$, $K_D^{E1}(x) \geq K_M^I$. That is, $E1$ has a greater incentive to pursue innovation than I if I is not under the threat of entry.

If (3) does not hold such that $E1$ does not expect I to respond to $E1$'s success in the primary market, $E1$'s profit from successfully developing a superior substitute is just π_M. Hence, $E1$'s expected profit from developing becomes

$$p(x\pi_X(x) + (1-x)\pi_M) - K \geq 0,$$

We summarize the stage-3 equilibrium following an acquisition in Lemma 1.

Lemma 1. *Suppose that $x \in [0,1]$ was realized in stage 1, and I acquires $E2$ in stage 2. Then, the stage 3 equilibrium development choices of $E1$ and I are as follows.*

- *If $K \leq K_M^I$, $E1$ develops its project. Furthermore, regardless of whether $E1$ successfully develops a superior substitute, I develops the acquired project.*
- *If $K_M^I < K \leq \min\{K_D^{E1}(x), K_D^I\}$, $E1$ develops its project. I develops the acquired project if and only if $E1$ succeeds in developing a superior substitute.*
- *If $K_D^{E1}(x) < K \leq K_D^I$, neither $E1$ not I develop their projects.*
- *If $K_D^I < K$, $E1$ develops its project, while I never develops the acquired project.*

Lemma 1 provides two key insights. First, I always has a weakly lower incentive to develop than $E1$. This is driven by Arrow's replacement effect, and can be seen for moderate K, i.e., $K_M^I < K \leq K_D^I$, where I develops the acquired project only if $E1$ becomes a real threat by successfully developing a superior substitute. Moreover, a larger K, i.e., $K > K_D^I$, causes I to always shelve the acquired project. Second, while I's frequency of developing the acquired project falls in K, $E1$'s development frequency[12] is non-monotonic in K. In particular, once I abandons project development for large K, $E1$ always develops its project.

3.2.2 Acquisition

Given I and $E1$'s equilibrium development decisions in stage 3, one may then wonder whether I can reach an agreement to acquire $E2$ in stage 2. Our next result answers this with a resounding yes.

Lemma 2. *I always acquires $E2$ in stage 2.*

The key force driving Lemma 2 is that acquisitions provide a strong preemptive benefit to the incumbent. Depending on I and $E1$'s behaviour along the equilibrium path in stage 3 (as discussed in Lemma 1), one may categorise I's benefit from (and thus purpose of) acquisition into four possible cases. The first two are also present in the literature (e.g., Gilbert and Newbery, 1982, Motta and Peitz, 2021). First, I may acquire $E2$ simply because $E2$'s project is sufficiently promising and I expects

[12] We define a firm's development frequency as the probability that it pursues development of its project, evaluated at the start of the game. For example, suppose $E1$ always pursues development of its type-X project, and I counter-develops if $E1$ successfully develops a superior substitute. Then, the development frequencies for $E1$ and I are 1 and $p(1-\mathbb{E}[x])$, respectively.

a positive gain from developing it. This corresponds to the case when $K \leq K_M^I$, where I always develops the project after acquisition. Second, I may acquire $E2$ purely to eliminate the threat posed by $E2$. This corresponds to the case with $K > K_D^I$, where I never develops the project after acquisition.

However, I's benefits from the acquisition of $E2$ can also stem from the use of the acquired project to either defend against or deter $E1$'s development. These effects are unique to our setting with entry by multiple start-ups. The case of acquisition for defence corresponds to when $K_M^I < K \leq \min\{K_D^{E1}(x), K_D^I\}$, and involves I developing to protect its profits in response to $E1$'s success in developing a superior substitute. The case of acquisition for deterrence corresponds to when $K_D^{E1}(x) < K \leq K_D^I$, and involves $E1$ terminating its project under the threat of counter-development by I.

3.2.3 Project Choice

We now consider $E1$'s project choice in stage 1. Notably, Lemma 2 implies that one only needs to focus on what occurs in the project development stage following an acquisition, to determine $E1$'s project choice.

First, suppose that $K \leq \min\{K_D^{E1}(0), K_D^I\}$, which implies $K \leq K_D^{E1}(x)$ for all x,[13] such that I always develops in response to $E1$'s successful development of a superior substitute, and I's threat of counter-development is insufficient to deter $E1$'s development, regardless of $E1$'s project choice. $E1$'s project choice only depends on the comparison of expected profits of developing either project. More precisely, $E1$ chooses the type-0 project if and only if

$$\int_0^1 x(\Pi - \pi_X(x) + p(\pi_D^E - \pi_D))dF(x) \geq 0. \tag{6}$$

Next, consider when K is moderately high such that $K_D^{E1}(0) < K \leq K_D^I$. In this case, K is low enough to enable I to counter-develop the acquired project, and high enough such that $E1$ is deterred from developing its type-0 project. Anticipating this, $E1$ chooses a type-X project to avoid competing with I in the primary market. That said, for sufficiently high x, $E1$ will nevertheless develop its project.

Finally, when K is large such that $K_D^I < K$ holds. I never finds it profitable to develop the acquired project. Knowing this, $E1$ always chooses the type-0 project as monopolizing the primary market is always more attractive than developing an independent product.

Proposition 2 formally states the equilibrium outcome of the game, tying each

[13]By Assumption 1, $K \leq p\pi_X(x)$. Together with $K \leq K_D^{E1}(0)$, we have $K \leq xp\pi_X(x) + (1-x)K_D^{E1}(0) = K_D^{E1}(x)$.

possibility to the underlying motivation of I's acquisition in stage 2.[14]

Proposition 2. *When acquisitions are allowed, I always acquires $E2$. The equilibrium project choices and development decisions are as follows.*

- ***For-profit acquisition:*** *When $K \leq K_M^I$, $E1$ chooses $t_{E1} = 0$ if (6) holds and chooses $t_{E1} = X$ otherwise. $E1$ always develops, and I develops the acquired project regardless of $E1$'s project outcome.*

- ***Defensive acquisition:*** *When $K_M^I < K \leq \min\{K_D^{E1}(0), K_D^I\}$, $E1$ chooses $t_{E1} = 0$ if (6) holds and chooses $t_{E1} = X$ otherwise. E_1 always develops, and I develops only if $E1$ successfully develops a superior substitute.*

- ***Deterring acquisition:*** *When $K_D^{E1}(0) < K \leq K_D^I$, $E1$ chooses $t_{E1} = X$. $E1$ develops if and only if x is sufficiently large, and I develops only if $E1$ successfully develops a superior substitute.*

- ***Killer acquisition:*** *When $K > K_D^I$, $E1$ chooses $t_{E1} = 0$. $E1$ always develops, and I does not develop the acquired project.*

We now compare the results of Proposition 2 against the no-acquisition benchmark in Proposition 1. To do so, we say that I's acquisition induces a *kill zone* if the acquisition shifts its project-type choice from $t_{E1} = 0$, when there are no acquisitions, to $t_{E1} = X$ when I is allowed to acquire $E2$. Likewise, I's acquisition induces a *safe space* if it shifts $E1$'s project choice in the opposite direction.

Corollary 1. *Allowing I to acquire $E2$ leads to the following.*

- *IF $K \leq K_M^I$, then the acquisition induces a kill zone if (2) holds and (6) is violated, and has no impact otherwise.*

- *IF $K_M^I < K \leq \min\{K_D^{E1}(0), K_D^I\}$, then the acquisition induces a kill zone if (2) holds and (6) is violated. Furthermore, I shelves the acquired project if $E1$ fails in developing a superior primary product. Otherwise, acquisition has no impact.*

[14] We show in the Online Appendix OD the characterization in Proposition 2 continues to hold if the innovation is sufficiently drastic, i.e., entry by $E1$ or $E2$ significantly reduces I's profits, or, if the innovation is not sufficiently drastic but K is large enough. The difference appears when innovation is not sufficiently drastic and K is not too large. In this case, I, after acquiring $E2$, always counter-develops in response to $E1$'s entry. Moreover, if $E1$ chooses a type-X project, I cannot successfully acquire $E2$ if the realized x is large. Thus, $E1$'s project choice is further biased towards a type-X project, relative to when the innovation is drastic.

- *IF* $K_D^{E1}(0) < K \leq K_D^I$, *then the acquisition induces a kill zone if (2) holds. Furthermore, the acquisition simultaneously deters* $E1$*'s development and leads* I *to shelve the acquired project whenever the realization of* x *is small, and when* x *is large if* $E1$ *fails to develop a superior substitute. Otherwise, the acquisition has no impact.*

- *IF* $K > K_D^I$, *then the acquisition induces a safe space if (2) is violated, and* I *always shelves the acquired project.*

The results of Proposition 1 can be intuitively explained as follows. First, the prospect of I's acquisition of $E2$ does not alter the probability of project development when the development cost is low (i.e., $K \leq K_M^I$). In this case, both projects are developed as in the benchmark case without acquisitions. When the development cost is slightly higher, i.e., $K_M^I < K \leq \min\{K_D^{E1}(0), K_D^I\}$, then I does not develop the acquired project if $E1$ fails in its development. For any $K \leq \min\{K_D^{E1}(0), K_D^I\}$, $E1$ chooses type-X project more frequently because, compared to (2), (6) is more difficult to satisfy as $\pi_D^E - \pi_D < 0$. In particular, whenever (2) holds but (6) fails, the acquisition creates a kill zone. $E1$ makes a smaller profit from competing with I than with $E2$ and thus values a type-0 project less when anticipating the acquisition.

As the development cost increases further, i.e., $K_D^{E1}(0) \leq K < K_D^I$, the expected acquisition affects not only $E1$'s project choice but also its development decision. The larger development cost strengthens the kill-zone effect such that $E1$ always chooses type-X project. In addition, $E1$ now only pursues development if it is sufficiently optimistic about obtaining an independent product, i.e., when x is large, which represents a low likelihood of competition against I in the primary market. I's frequency of developing the acquired project falls further as the development decisions are strategic substitutes.[15]

Finally, when K is large, i.e., $K \geq K_D^I$, acquisitions have the opposite effect on $E1$'s project choice. I acquires only to terminate $E2$'s project. This reduction in competition creates a safe space for $E1$ in the primary market.[16]

Proposition 2 and Corollary 1 bridge a fundamental gap between the creation of kill zones for non-target start-ups and the acquirer's development decision, complementing existing theories of kill-zones (e.g. Motta and Sheleiga, 2021, Scott-Morton et al., 2019, Kamepalli et al., 2021). The acquisition, which leads to a weakly lower development probability of the acquired project, may also create a

[15]As K increases, the threshold level of x under which $E1$ develops increases. In turn, the probability that $E1$ successfully develops any product is falling in K.

[16]The ex-ante development probability of each firm varies differently in K. While I's development probability is monotonically decreasing in K, $E1$'s development probability is single-dipped in K: constant on $K \in (0, K_D^{E1}(0)]$ and $K > K_D^I$, while decreasing on $K \in [K_D^{E1}(0), K_D^I)$.

kill zone that diverts non-target start-ups' R&D direction *away* from the acquirer's market. Crucially, this acquisition-induced kill-zone persist only when I's acquisition is *not* intended to be a pure killer acquisition. An example of this is the defensive- and deterring-acquisition regions $K_M^I < K \leq \min\{K_D^{E1}(0), K_D^I\}$ and $K_D^{E1}(0) < K \leq K_D^I$, where I only terminates the acquired project when $E1$ fails to become a real threat, i.e., by successfully developing a superior primary product, but proceeds with development otherwise. Meanwhile, when the acquisition *is* intended to be a killer-acquisition, i.e., $K > K_D^I$ so I never develops after acquisition, I's acquisition instead induces a safe space, inviting entry into the primary market by $E1$ who then always chooses the type-0 project.

4 Consumer Welfare and Merger Policy

This section analyzes welfare implications of start-up acquisitions with multiple entrants and the related design of merger policies. Additional details are relegated to Appendix B.

4.1 Consumer Welfare Analysis

To evaluate the welfare effects of acquisitions, we assign values to consumer welfare for each scenario as in Table 2. In the primary market, consumer welfare is normalized to zero if I monopolizes the market with the existing product. A monopolist which provides the superior substitute raises consumer welfare to $V_0 > 0$. If this monopolist is I, consumer welfare increases by a further $\delta \geq 0$, capturing either synergies associated with the acquisition or the incumbent's better ability in creating consumer benefits.[17]

Holding other factors fixed, competition benefits consumers. Consumer welfare is $V_0 + \epsilon$ if $E1$ and $E2$ compete in the primary market, and $V_0 + \epsilon + \delta$ if $E1$ competes with I, where $\epsilon \geq 0$ captures the additional benefits to consumers facing a duopoly rather than a monopoly.[18] Consumer welfare in the independent market is $V_X(x) \in [0, \min\{\epsilon, V_0\}]$ for any $x \in [0, 1]$. Again, the upper bound reflects the insignificance of the independent market relative to the primary market.[19]

Given a realization of $x \in [0, 1]$, let the expected consumer welfare in equilibrium

[17]The synergies, i.e., additional benefits to consumers, can take forms of economies of scale, network effects, existing supply and marketing networks, high-quality customer services, and so on.

[18]Our results easily extend to when δ differs between a monopoly and a duopoly.

[19]Assuming $\epsilon < V_X(x)$, which sufficiently simplifies the exposition, has no qualitative effect on our analysis. In particular, it has no effect at all when $K > K_M^I$.

Table 2: Consumer welfare in market 0

Firms with superior primary product	Consumer Welfare
None	0
Only $E1$ or only $E2$	V_0
Only I	$V_0 + \delta$
$E1$ and $E2$	$V_0 + \epsilon$
I and $E1$	$V_0 + \epsilon + \delta$

with and without acquisitions be denoted by $CW^{\mathrm{a}}(x, K)$ and $CW^{\mathrm{b}}(x)$ respectively.[20] Let $\mathcal{W}(K, (t^{\mathrm{b}}, t^{\mathrm{a}}))$ denote the expected change in consumer welfare from allowing for acquisitions over banning acquisitions, where $t^{\mathrm{b}} \in \{0, X\}$ and $t^{\mathrm{a}} \in \{0, X\}$ denote $E1$'s project choice when acquisitions are banned and when acquisitions are allowed, respectively. More specifically,

$$\mathcal{W}(K, (t^{\mathrm{b}}, t^{\mathrm{a}})) = \begin{cases} CW^{\mathrm{a}}(0, K) - CW^{\mathrm{b}}(0), & (t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, 0) \\ CW^{\mathrm{a}}(0, K) - \int_0^1 CW^{\mathrm{b}}(x) dF(x), & (t^{\mathrm{b}}, t^{\mathrm{a}}) = (X, 0) \\ \int_0^1 CW^{\mathrm{a}}(x, K) dF(x) - CW^{\mathrm{b}}(0), & (t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, X) \\ \int_0^1 (CW^{\mathrm{a}}(x, K) - CW^{\mathrm{b}}(x)) dF(x), & (t^{\mathrm{b}}, t^{\mathrm{a}}) = (X, X) \end{cases} \tag{7}$$

Notably, for all K and possible equilibrium pairs of $(t^{\mathrm{b}}, t^{\mathrm{a}})$, the change in consumer welfare can be expressed as a linear function of δ,[21]

$$\mathcal{W}(K, (t^{\mathrm{b}}, t^{\mathrm{a}})) = A(K, (t^{\mathrm{b}}, t^{\mathrm{a}}))\delta + B(K, (t^{\mathrm{b}}, t^{\mathrm{a}})), \quad A(K, (t^{\mathrm{b}}, t^{\mathrm{a}})) \geq 0 \tag{8}$$

In general, acquisitions affect consumer welfare through three channels. First, conditional on I developing the acquired project, consumers obtain the additional benefit δ due synergies generated from the acquisition. Second, the change in ownership of the type-0 project from $E2$ to I weakly reduces the development frequency of both projects, harming consumers. Finally, acquisitions may cause $E1$ to switch project type, which in turn has an ambiguous effect on consumers. Consequently, the overall effect of acquisition on consumer welfare is ambiguous.

There are, however, two notable cases worth mentioning. First, an acquisition benefits consumers if the associated synergy δ is sufficiently large. This is easily observed via the linear form in (8); the term $\mathcal{W}(K, (t^{\mathrm{b}}, t^{\mathrm{a}}))$ is positive if and only if

[20] The superscript a stands for "allowing for acquisitions", while the superscript b stands for "banning acquisitions." Notice $CW^{\mathrm{b}}(x)$ does not vary with K, as $E1$ and $E2$ always develop their projects when acquisitions are banned.

[21] Possible pairs are obtained via Propositions 1 and 2. When $K \leq \min\{K_D^{E1}(0), K_D^I\}$, $(t^{\mathrm{b}}, t^{\mathrm{a}}) \in \{(0, 0), (X, X), (0, X)\}$. When $K_D^{E1}(0) < K \leq K_D^I$, $(t^{\mathrm{b}}, t^{\mathrm{a}}) \in \{(X, X), (0, X)\}$. When $K > K_D^I$, $(t^{\mathrm{b}}, t^{\mathrm{a}}) \in \{(X, 0), (0, 0)\}$. The details of deriving the expression in (8) can be found in Appendix B.

the synergy gain δ is greater than some threshold $\delta(K,(t^{\mathrm{b}},t^{\mathrm{a}}))$. Second, when development costs are either sufficiently small or sufficiently large, we can also directly pin down the impact of acquisitions on consumer welfare.

Corollary 2. *For all $K \leq K_M^I$, $\delta(K,(0,0)) = \delta(K,(X,X)) = 0$. Meanwhile, for all $K > K_D^I$, $\delta(K,(0,0)) = \delta(K,(X,0)) = \infty$.*

The first case in Corollary 2 corresponds to when development costs are sufficiently low, such that $E1$ chooses the same project regardless of whether acquisitions are banned, and both $E1$ and I always develop their projects. In this case, acquisitions always increase consumer welfare through the synergy δ, and therefore should always be approved. The second case in Corollary 2 corresponds to when development costs are sufficiently large. In this safe space situation, I always terminates the acquired project. Despite $E1$ always choosing and developing a type-0 project, the acquisition always decreases consumer welfare due to the loss in development frequency, and should therefore be banned.

4.2 Coarse Merger Policy

Equation (7) and Corollary 2 implicitly characterize the optimal, i.e., consumer-welfare maximizing, merger policy when the policy choice is restricted to banning or allowing for all acquisitions. These policies can be too extreme, failing to balance trade-offs involving project choice, development incentives and synergy gains.

To allow for more flexibility in merger policy design, we explore the probabilistic approval rule studied in Gilbert and Katz (2021). To distinguish the current analysis from a later discussion of remedies, we call a policy that only commits to approving a certain fraction of proposed mergers a *coarse merger policy*. Formally, suppose that AA can commit to approving a proposed acquisition with probability $q \in [0,1]$ (or equivalently, a fraction q of all proposed mergers), with a higher q corresponding to a more lenient coarse policy.[22] For any q, we assume $E1$ chooses the project type that maximizes consumer welfare whenever $E1$ is indifferent between project types. The choice of q is made prior to stage 1, and is observed by all firms. Importantly, AA cannot condition the approval probability on the realization of x if project X is chosen, which would otherwise require it to have extensive knowledge about the R&D process. With a slight abuse of notation, let $\mathcal{W}(q,K)$ denote the change in consumer welfare given approval probability q and development cost K. Let $q^* \in \arg\max_{q\in[0,1]} \mathcal{W}(q,K)$ denote the *optimal coarse merger policy* for the AA.

[22]For instance, AAs can control how likely proposed mergers are cleared through requiring evidence of synergy gains, or deciding how thorough the investigation will be.

Since, when $K \geq K_D^I$, Corollary 2 implies that banning all acquisitions maximizes consumer welfare , the following analysis focuses on $K < K_D^I$.

We begin by computing $\mathcal{W}(q, K)$. First, if $E1$ chooses the type-0 project regardless of whether acquisitions take place, it chooses the type-0 project for all $q \in [0, 1]$. With probability q, acquisitions are approved, in which case the change in consumer welfare is $CW^{\mathrm{a}}(0, K) - CW^{\mathrm{b}}(0)$. Hence, if $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, 0)$,

$$\mathcal{W}(q, K) = q[CW^{\mathrm{a}}(0, K) - CW^{\mathrm{b}}(0)] \tag{9}$$

Similarly, if $E1$ chooses the type-X project regardless of whether acquisitions occur,

$$\mathcal{W}(q, K) = q[\int_0^1 (CW^{\mathrm{a}}(x, K) - CW^{\mathrm{b}}(x))dF(x)]. \tag{10}$$

Finally, suppose $E1$ switches from a type-0 project without acquisitions, to a type-X project with acquisitions, i.e., $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, X)$.[23] $E1$ chooses the type-0 project whenever the coarse merger policy is sufficiently harsh, i.e., when acquisitions are banned frequently, and chooses the type-X project otherwise. Hence, there exists a unique $\overline{q}(K) \in [0, 1]$ such that for all $q < \overline{q}(K)$ (respectively, $q > \overline{q}(K)$), $E1$ chooses the type-0 (respectively, type-X) project. Further denote

$$\begin{aligned} \mathcal{W}^+(q, K) = & \quad q(\textstyle\int_0^1 CW^{\mathrm{a}}(x, K)dF(x) - CW^{\mathrm{b}}(0)) \\ & +(1-q)(\textstyle\int_0^1 CW^{\mathrm{b}}(x)dF(x) - CW^{\mathrm{b}}(0)) \\ \mathcal{W}^-(q, K) = & \; q[CW^{\mathrm{a}}(0, K) - CW^{\mathrm{b}}(0)] \end{aligned} \tag{11}$$

The expected change in consumer welfare in the case with $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, X)$ is

$$\mathcal{W}(q, K) = \begin{cases} \mathcal{W}^-(q, K), & \text{if } q < \overline{q}(K); \\ \mathcal{W}^+(q, K), & \text{if } q > \overline{q}(K); \\ \max\{\mathcal{W}^-(\overline{q}(K), K), \mathcal{W}^+(\overline{q}(K), K)\}, & \text{if } q = \overline{q}(K). \end{cases} \tag{12}$$

Let q^* be the largest q that maximizes consumer welfare. Using (9), (10) and (12), we fully characterize the AA's optimal coarse merger policy in Proposition 3.

Proposition 3. *Suppose $K < K_D^I$.*

1. *If $(t^b, t^a) = (0, 0)$, then $q^* = 1$ if $CW^a(0, K) \geq CW^b(0)$, and $q^* = 0$ otherwise.*
2. *If $(t^b, t^a) = (X, X)$, then $q^* = 1$ if $\int_0^1 CW^a(x, K)dF(x) \geq \int_0^1 CW^b(x)dF(x)$, and $q^* = 0$ otherwise.*

[23] By Proposition 2, this is the only possible type of switching when $K < K_D^I$.

3. If $(t^b, t^a) = (0, X)$*, then*

$$q^* = \begin{cases} 1, & \text{if } \int_0^1 CW^a(x,K)dF(x) \geq \max\left\{CW^b(0), \begin{array}{c} \overline{q}(K)CW^a(0,K) \\ +(1-\overline{q}(K))CW^b(0) \end{array}\right\} \\ 0, & \text{if } CW^b(0) > \max\{\int_0^1 CW^a(x,K)dF(x), CW^a(0,K)\} \\ \overline{q}(K), & \text{otherwise} \end{cases}$$

Proposition 3 provides two key insights regarding how an AA should deal with start-up acquisitions if its only policy tool is the approval rate. First, when project choices are unaffected by acquisitions, then it is optimal for the AA to ban or approve all acquisitions. Given that the project type is unaffected, whether acquisitions benefit consumers only depends on the comparison between the possible gain from synergies and the loss from reduced frequency in project development. Second, when $E1$'s project choice is affected by acquisitions, i.e., $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, X)$, then an interior $\overline{q}(K)$ is optimal if and only if the following conditions hold simultaneously:

$$CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0) \geq 0 \tag{13a}$$

$$\overline{q}(K)(CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0)) > \int_0^1 CW^{\mathrm{a}}(x,K)dF(x) - CW^{\mathrm{b}}(0) \tag{13b}$$

The inequality in (13a) implies that the AA prefers to approve all acquisitions conditional on $E1$ continuing to choose type-0 project. However, too large of an approval rate, i.e., $q > \overline{q}(K)$, induces $E1$ to switch to choosing the type-X project. By (13b), this leaves consumers strictly worse off than when I approves fewer acquisitions but $E1$ chooses the type-0 project. For the range of K identified by (13a) and (13b), $E1$ develops its project and I responds to $E1$'s success in the primary market. Thus, a moderate approval rate $q^* = \overline{q}(K)$ maintains $E1$'s incentive to choose a type-0 project, while leaving non-zero probability for clearing the merger, through which consumers benefit from the resulting synergy.

We conclude by connecting our findings to that in Gilbert and Katz (2021). In Gilbert and Katz (2021), fixing the single start-up's project type, all acquisitions decrease consumer welfare. However, the prospect of acquisitions can induce the start-up to change its project type. Such a change in project type can benefit consumers in the absence of acquisition. The optimal merger approval rate is set just high enough to incentivize the start-up to change their project type, while minimizing the probability that the acquisition actually takes place. This type of reasoning for optimal (coarse) merger policies can arise in our model if we relax the assumption, $V_0 \geq V_X(x)$, such that the independent market becomes more important in the welfare calculation. Instead, we focus on the complementary scenario, where the reverse logic applies to why the optimal approval rate can take a probabilistic form. Given $V_0 \geq V_X(x)$ and the moderate level of development costs implied by (13a) and (13b), the AA aims to maximize the probability that acquisitions occur, conditional on $E1$ *not* moving its R&D direction away from the primary market.

4.3 Remedies

By Proposition 3, the AA may optimally block some or even all mergers if it only controls the approval rate. A natural question then is if it is possible to simultaneously maintain $E1$'s incentive to enter the primary market and I's incentive to counter-develop, without the cost of approving too few acquisitions.

In practice, acquisitions are often approved subject to merging parties making certain commitments to reduce competition harms. In our model, such harms arise due to two advantages of the incumbent over start-ups. First, I can condition its development on $E1$'s development outcome. We discuss the implications of removing this advantage in Section 5.3. Second, I earns a greater profit than $E1$ if the two compete, i.e., $\pi_D^E < \pi_D^I$. In this section, we consider remedies which rectify such profit asymmetries.

We model remedies in a reduced form as a profit transfer from I to $E1$.[24] Specifically, the AA approves the acquisition but sets a transfer value R such that when both $E1$ and I successfully develop a superior primary product, they obtain profits of $\pi_D^E + \gamma R$ and $\pi_D^I - R$ respectively. The parameter $\gamma > 0$ captures the passthrough rate from the decrease of I's profit to the increase of $E1$'s profit, which we treat as a constant in our reduced-form approach but in practice is affected by many aspects of the market structure.[25] Since banning or allowing acquisitions is sufficient for maximizing consumer welfare when $(t^{\mathrm{b}}, t^{\mathrm{a}}) \in \{(0,0), (X,X)\}$ or $K > K_D^I$, we focus on the case where $K \leq K_D^I$ and $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, X)$. We will also require that the transfer is not too excessive, i.e., $R \leq \pi_D^I - \pi_D$, which streamlines the discussion by ensuring that acquisitions always occur in equilibrium. Denote $\widetilde{\mathcal{W}}(R, K)$ the corresponding consumer welfare given transfer value R.

Our goal is to identify circumstances under which remedies outperform the coarse merger policy, i.e., when there exists $R \in [0, \pi_D^I - \pi_D]$ such that

$$\widetilde{\mathcal{W}}(R, K) > \mathcal{W}(q^*, K). \tag{14}$$

[24] In the literature, remedies are often modeled as a divestiture of assets, which helps the non-merging firms to reduce the marginal cost of production. See, for example, Vergé (2010) and Cosnita-Langlais and Tropeano (2012).

[25] We emphasize that such transfers do not need to be direct transfers as any remedy that weakens I's market dominance automatically makes $E1$ more competitive.

Our results are divided into two parts. First, we provide general conditions under which (14) holds by inducing $E1$ to choose the type-0 project, while maintaining I's incentive to counter-develop. Our second result provides an alternative set of conditions which are sufficient for (14) to hold even when the first set of conditions fail. We now state the first set of conditions.

Proposition 4. *Suppose that $(t^b, t^a) = (0, X)$ and $K < K_D^I$. If*

$$CW^a(0, K) > CW^b(0) \text{ for all } K \leq K_D^{E1}(0) \tag{15a}$$

$$\underline{R} := \underbrace{\frac{1}{\gamma p}\left(\int_0^1 x[\pi_X(x) - \Pi - p(\pi_D^E - \pi_D)]dF(x)\right)}_{\text{Min } R \text{ s.t. } E1 \text{ chooses type-0 project and always develops}} \leq \underbrace{\pi_D^I - \max\{\pi_D, \frac{K}{p}\}}_{\text{Max } R \text{ s.t. } I \text{ counter-develops}} \tag{15b}$$

both hold, then under any remedy $R \in [\underline{R}, \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$, $E1$ chooses the type-0 project and always pursues development, while I counter-develops if $E1$ succeeds. Furthermore, (14) holds: the remedy outperforms coarse merger policy.

To understand Proposition 4, first note that whenever both $E1$ and I develop their projects, consumers are better off if $E1$ choose the type-0 project over the type-X project, regardless of whether acquisitions are approved. This follows from the assumption $V_X(x) \leq \min\{V_0, \epsilon\}$. Meanwhile, condition (15a) implies that as long as $E1$ behaves as if it faces a development cost of $K < K_D^{E1}(0)$ and therefore always chooses and develops the type-0 project, consumers strictly prefer I's acquisition to be approved. $E1$ behaves as if it faces $K < K_D^{E1}(0)$ and I counter-develops to $E1$'s success in the primary market if and only if the transfer value $R \in [\underline{R}, \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$. The existence of such a transfer is captured by equation (15b).

Condition (15a) in Proposition 4 is more likely to hold if the synergy benefit δ is sufficiently large. Intuitively, committing to approving all acquisitions benefits consumers if the associated synergies gains are large. Meanwhile, the remedies considered in Proposition 4 are feasible if and only if (15b) holds. This requires a relatively large γ or π_D^I. If the resulting profit transfer is too inefficient, i.e., a small γ, it is impossible for the remedy to induce $E1$ to select and develop a type-0 project without removing I's counter-developing incentives. At the same time, a large π_D^I implies that I has enough room for transferring considerable profits to $E1$.[26]

Even if Proposition 4's conditions are not met, Proposition 5 shows that approving all acquisitions with an associated remedy can still be a preferred option.

[26]In the online appendix, for $K > K_M^I$, we formally prove the existence of a thresholds $\overline{\pi}_D^I, \overline{\delta} \geq 0$ such that for all $(\pi_D^I, \delta) \geq (\overline{\pi}_D^I, \overline{\delta})$, the conditions in Proposition 4 apply.

Proposition 5. *Suppose* $(t^b, t^a) = (0, X)$ *and* $K_D^{E1}(0) < K \leq K_D^I$. *If*

$$\int_0^1 CW^a(x,K)dF(x) \geq CW^b(0) \tag{16}$$

holds, then for any sufficiently small remedy $R > 0$, $E1$ *chooses the type-*X *project and pursues development whenever* x *is high enough, and* I *counter-develops if* $E1$ *obtains a superior substitute. Furthermore, (14) holds: the remedy outperforms coarse merger policy.*

As (16) holds whenever δ is large, Proposition 5 can be interpreted as stating that with large synergies and moderate development costs, even *small* remedies outperform coarse merger policy. Furthermore, (16) can hold even if either of (15a) or (15b) do not. The intuition behind Proposition 5 is as follows. When development costs are moderately high, i.e., $K_D^{E1}(0) < K \leq K_D^I$, the optimal coarse merger policy requires either approving or banning all acquisitions.[27] Approving all acquisitions is optimal whenever (16) holds, which induces $E1$ to choose the type-X project. However, since $K > K_D^{E1}(0)$, competition against the incumbent in the primary market is not profitable. Therefore, $E1$ does not develop its project for small realizations of x. Increasing R increases the expected payoff from competing in the primary market, and so expands the range of x under which $E1$ develops, which in turn increases I's frequency in counter-developing, both of which increase consumer welfare. As a result, requiring a small transfer from I to $E1$, along with approving the acquisition, strictly improves upon optimal coarse merger policy.

5 Extensions

In this section, we extend our baseline model to several directions. Additional details can be found in the Online Appendix.

5.1 Entry-for-buyout

Since becoming a significant threat can raise the acquisition price, the possibility of being accquired encourages start-ups to enter big companies' core business by developing superior substitutes. This is the essence of the theory of *entry-for-buyout* (Rasmusen, 1988, Gilbert and Katz, 2021, Callander and Matouschek, 2022, Motta

[27] The scenarios described in Proposition 5 only arise when $K_D^{E1}(0) < K \leq K_D^I$. This is because when $K \leq K_D^{E1}(0)$, the conditions in Proposition 4 are necessary and sufficient for there to exist a remedy which dominates optimal primitive merger policy, while for $K_D^{E1}(0) < K \leq K_D^I$, they are only sufficient. We prove this formally in Appendix B3.

and Sheleiga, 2021). In this section, we examine such entry-for-buyout effects in the context of multiple start-ups. To allow entry-for-buyout to emerge, we assume the target firm $E2$ can choose its project type, 0 or X, in stage 1, while $E1$'s project type is fixed at 0. In the interest of brevity, we assume $K \leq K_D^I$ holds, leaving the discussion of $K > K_D^I$ to the online appendix.

When acquisitions are banned, the equilibrium is identical to the benchmark case discussed in Section 3.2, swapping the roles of $E1$ and $E2$. Meanwhile, when acquisitions are allowed, I always acquires $E2$. The equilibrium project choices and development decisions are summarized below.

- If $K \leq K_M^I$, $E2$ chooses $t_{E2} = 0$ if

$$\int_0^1 x[\Pi - \pi_X(x) + p(\pi_D^I - \pi_D)]dF(x) \geq 0 \tag{17}$$

  holds, and chooses $t_{E2} = X$ otherwise. $E1$ and I always develop.

- If $K_M^I < K \leq \min\{K_D^{E1}(0), K_D^I\}$, $E2$ chooses $t_{E2} = 0$ if

$$(1-p)\int_0^1 (\max\{-px\pi_m, p(x\pi_X(x) + (1-x)\pi_M - \pi_m) - K\})dF(x) + p^2 \int_0^1 x(\pi_D^I - \pi_X)dF(x) \geq 0 \tag{18}$$

  holds, and chooses $t_{E2} = X$ otherwise. $E1$ always develops, and I develops if either (i) $E1$ successfully develops a superior substitute, or (ii) $t_{E2} = X$, the realized x is large enough, and $E1$ fails to develop a superior substitute.

- If $K_D^{E1}(0) \leq K < K_D^I$, $E2$ chooses $t_{E2} = 0$. Neither I nor $E1$ develops.

Entry-for-buyout occurs whenever $E2$ chooses a type-X project when acquisitions are banned (i.e., (2) does not hold) but a type-0 project when acquisitions are allowed. The latter requirement is met if (17) holds when $K \leq K_M^I$, if (18) holds when $K_M^I < K \leq \min\{K_D^{E1}(0), K_D^I\}$, or whenever $K_D^{E1}(0) \leq K < K_D^I$.

Two channels give rise to entry-for-buyout. First, choosing $t_{E2} = 0$ increases the threat of $E2$ to I, reducing I's no-acquisition profits while increasing $E2$'s payout from the acquisition. This is the pro-innovation effect of start-up acquisitions identified in the literature. The second reason is unique to our environment with multiple start-ups. The type-0 project can be used more effectively by I to compete against $E1$ in the case of entry, which increases I's post-acquisition profits and hence $E2$'s payout. Put differently, $E2$ is incentivised to choose a project-type that helps

I deter $E1$'s entry.[28]

The impact of acquisitions on consumer welfare is at best ambiguous. Akin to Section 4.1, when development costs are small, i.e., $K \leq \min\{K_D^{E1}(0), K_D^I\}$, acquisitions increase consumer welfare when (i) the gain in the primary market, from the additional probability of I successfully developing the superior substitute, offsets the loss from failing to develop the independent product, or (ii) when the synergy from I's development is large enough. However, the analysis differs when development costs are higher, i.e., $K_D^{E1}(0) < K \leq K_D^I$. Since $E2$'s choice of the type-0 project leads to neither $E1$ nor I developing in equilibrium, consumer welfare falls under acquisitions. In this case, the acquisition leaves consumers strictly worse off.

5.2 Alternative Counterfactuals

We have so far focused on the case where $K \leq p\Pi$ and both start-ups develop their projects in the absence of acquisitions. The resulting duopoly profit implies a relatively low acquisition price as start-ups face competition from the other start-up in the no-acquisition counterfactual. We now turn to the complementary scenario with $K > p\Pi$, which further implies $K > K_D^{E1}(0)$. There, we find that I may now not be able to acquire $E2$ in equilibrium, and the effect of acquisitions on $E1$'s project choice is further limited.

In the absence of acquisition, $E1$ and $E2$ no longer pursue development with probability one in equilibrium when x is low. The larger development cost only permits project development by one start-up. There are two possible pure-strategy equilibria at stage 3 with sufficiently low x: one with only $E1$ developing its project, and the other with only $E2$ developing its project. This also implies, when acquisitions are allowed, that the equilibrium outcome will depend on the equilibrium selection when negotiation between I and $E2$ breaks down. If the equilibrium with only $E1$ developing is selected, following the acquisition, the equilibrium development decisions at stage 3 are almost identical to cases 3 (i.e., $K_D^{E1}(0) < K \leq K_D^I$) and 4 (i.e., $K > K_D^I$) in Proposition 2.[29] Notably, $E2$'s reservation price falls to zero if x is small as it would not pursue development when it is not acquired, and remains low for large x as it would face competition from $E1$.

More interesting is the case when the equilibrium with only $E2$ developing a project is selected in the absence of acquisitions (for small x). This has two major effects. First, acquisitions may no longer occur. To see this, suppose $K > K_D^I$ and

[28] This is the dominant reason for why the type-0 project is always chosen by $E2$ when $K_D^{E1}(0) < K \leq K_D^I$. There, choosing the type-0 project guarantees that $E1$ cannot profitably enter, expecting counter-development by I.

[29] Cases and 1 and 2 in Proposition 2 no longer exist when $p\Pi \geq K$.

thus I never counter-develops. Acquiring $E2$ frees up the market for $E1$ to pursue development. Hence, I's benefit from the acquisition lies solely in the reduction in probability of successful development of a superior substitute by $E1$ compared to that of $E2$. When $E1$ chooses a type-0 project or a type-X project but the realized value of x is small, the likelihood that $E1$ successfully enters the primary market is close to that of $E2$ in the absence of acquisitions, and I's benefit from the acquisition is small. Meanwhile, $E2$'s reservation price is $p\pi_M - K > 0$. Consequently, I is unable to acquire $E2$ for sufficiently small x.

Second, when the equilibrium with only $E2$ developing its project is selected in the absence of acquisitions, $E1$ always chooses the type-X project. When acquisitions are banned, this is clearly the case as otherwise $E1$ can never profitably develop its project. Meanwhile, suppose the acquisition is expected to occur. When $K_D^{E1}(0) < K \leq K_D^I$, one can show that I always acquires $E2$. Consequently, the post-acquisition subgame equilibrium is identical to that in Section 3: I always develops in response to $E1$'s entry, and anticipating this, $E1$ never finds it profitable to develop when a type-0 project is chosen. When $K > K_D^I$, as discussed above, acquisition does not occur. However, by the equilibrium selection, $E1$ will never be able to develop its project if the type-0 project is chosen. Hence, larger development costs, i.e., $K > p\Pi$, completely remove $E1$'s incentives to choose the type-0 project, and so the acquisition has no impact on $E1$'s project choice.

5.3 Simultaneous Development

In the main text, we assume that I decision of whether to pursue project development is in response to the outcome of $E1$'s development. Such assumptions may be valid for a technologically capable and/or well-informed incumbent, who is able to quickly react to a realized threat. In reality, however, I may not possess such reactionary capabilities and has to make a less informed choice. In this section, we investigate this possibility by considering the situation where I and $E1$'s development decisions are simultaneously made in stage 3. To simplify the analysis, we assume $\pi_X(x) = \pi_X$ is a constant for all $x \in [0, 1]$.

Given the alternative timing of development, I can only condition its development decisions on the realized value of x, which measures how likely $E1$ turns into a real threat. The higher the value of x, the lower the threat of entry, and hence the smaller the willingness of I to develop its acquired project. For K sufficiently small (i.e., $K \leq K_M^I$) or large (i.e., $K > K_D^I$), this has no effect on the equilibrium outcome, compared to that in Proposition 2. In the former case, I always finds acquiring and developing $E2$'s project profitable. In the latter case, the large K completely disincentivises I from developing the acquired project regardless of the threat of entry by $E1$, although I is still willing to acquire $E2$ to protect its profit.

With the alternative timing, firms' development frequencies differ from those in the main text when K is at some intermediate level. As an example, suppose $K_M^I < K \leq \min\{K_D^{E1}(0), pK_D^I + (1-p)K_M^I\}$. With either timing, $E1$ always pursues development of its project, regardless of its project type. When I cannot condition its development on $E1$'s development outcome, I develops only when it expects $E1$'s development to yield a superior substitute with a high probability. In particular, there exists a threshold $\overline{x} \geq 0$ such that I develops the acquired project if and only if the realized $x \leq \overline{x}$, and does not develop otherwise. Furthermore, the threshold $\overline{x}$ decreases in K, and converges to 1 when K goes to K_M^I. That is, the frequency of I developing the acquired project is close to 1 when K is within $[K_M^I, \min\{K_D^{E1}(0), pK_D^I + (1-p)K_M^I\}]$ but very close to K_M^I. Meanwhile, in the main text, I's development frequency there is always bounded below 1. This is because I only develops the acquired project in response to $E1$'s successful development, which occurs either with probability p when $t_{E1} = 0$, or $p(1-x)$ when $t_{E1} = X$. Hence, with simultaneous development, I's development frequency is greater than in the main text for small K within this range.

Another implication for intermediate K is that $E1$'s project choice directly affects I's development incentive. For example, if $K_M^I < K \leq \min\{K_D^{E1}(0), pK_D^I + (1-p)K_M^I\}$, I develops with probability one if $t_{E1} = 0$, but possibly with a probability less than one if $t_{E1} = X$. Hence, choosing the type-X project allows $E1$ to remove I's development incentive if the realized x is large. This effect incentivises $E1$ to choose the type-X project over a larger range of parameters, compared to when development decisions are sequentially made. In this sense, the kill zone effect is complemented by $E1$'s own strategic incentive to choose the type-X project to preempt I's project development.

Finally, when $pK_D^I + (1-p)K_M^I < K \leq K_D^I$, I's behaviour is similar to that when K is large, i.e., $K \geq K_D^I$: I always acquires $E2$, but never develops the acquired project. Thus, the acquisition always harms consumers due to the substantial loss in development frequency. However, consumers may benefit from this acquisition for the range of parameters in the main text. That is, allowing I's development decision to depend on $E1$'s development outcome may benefit consumers.

6 Conclusion

This paper complements the literature on start-up acquisitions by studying the impact of acquisitions on both target and non-target start-ups. We show that the incumbent's acquisition can induce a kill zone in its market for non-target star-ups, through the threat of counter-developing the acquired technology. The acquisition simultaneously slows down project development and deters non-target start-ups from entering the incumbent's core market. We have also shown, through investigating entry-for-buyout and a series of robustness analyses, that such effects persist in a broad range of environments.

While recognizing acquisitions can impose a chilling effect on non-target start-ups, we still need to be cautious in advocating for greater scrutiny on start-up acquisitions. Many such acquisitions involve substantial synergies, which can benefit consumers if the technologies acquired are indeed developed. We have shown that an coarse merger policy that optimally balances such post-acquisition incentives of the incumbent against the pre-acquisitions R&D incentives of non-targeted start-ups may involve AAs committing to approving only a fraction of all proposed acquisitions. We further demonstrated that in many situations, imposing an appropriate remedy while approving all acquisitions achieves a better outcome.

The recent discussion of anti-competitive acquisitions places much emphasis on the digital technology sector, where a select few big companies hold substantial market power in providing services such as search, social networking, digital marketplaces, online advertising, and data collection and analysis. In the digital space, it is often observed that acquisition targets are not in the incumbent's own market but instead in adjacent markets (complementary or independent). Although this paper focuses on acquisitions of start-ups attempting to directly enter the incumbent's core market, the basic logic readily extends to studies of start-up acquisitions in adjacent markets, which we discuss next.[30]

Many big technology companies are multi-sided platforms which enable positive cross-group network effects between different user groups. The presence of such strong network effects make it very difficult for start-ups to directly enter these markets even with a superior product, as it is hard for user groups to coordinate and switch to use the start-up's service. If so, then the main competition constraint faced by the incumbent is entry by a start-up who has built a sufficiently large consumer base in an adjacent market. Our paper sheds further light on this scenario. Through acquiring a start-up in each adjacent market, the incumbent can use the threat of developing its acquired project to induce a kill zone in each such market. By doing so, the incumbent prevents start-ups from building a large enough consumer base in these adjacent markets, eliminating the possibility of being challenged by entry from such start-ups. In turn, this entrenches the incumbent's dominant position in its core market.

[30] Relatedly, Motta and Peitz (2021) discuss how, in a single start-up environment, existing insights can be extended to study acquisitions in adjacent markets.

References

Affeldt, Pauline and Reinhold Kesler, "Competitors' Reactions to Big Tech Acquisitions: Evidence from Mobile Apps," *Working Paper*, 2021.

Argentesi, Elena, Paolo Buccirossi, Emilio Calvano, Tomaso Duso, Aessia Marrazzo, and Salvatore Nava, "Merger Policy in Digital Markets: An Ex-Post Assessment," *DIW Berlin Discussion Paper No. 1836 (2019)*, 2019.

Arrow, Kenneth, "Economic Welfare and the Allocation of Resources for Invention," in "The Rate and Direction of Inventive Activity: Economic and Social Factors," National Bureau of Economic Research, Inc, 1962, pp. 609–626.

Bryan, Kevin A and Erik Hovenkamp, "Antitrust limits on startup acquisitions," *Review of Industrial Organization*, 2020, *56* (4), 615–636.

Cabral, Luis, "Standing on the shoulders of dwarfs: Dominant firms and innovation incentives," *Available at SSRN 3235598*, 2018.

Cabral, Luís, "Merger policy in digital industries," *Information Economics and Policy*, 2021, *54*, 100866.

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

Cosnita-Langlais, Andreea and Jean-Philippe Tropeano, "Do remedies affect the efficiency defense? An optimal merger-control analysis," *International Journal of Industrial Organization*, 2012, *30* (1), 58–66.

Crémer, Jacques, Yves-Alexandre de Montjoye, and Heike Schweitzer, *Competition Policy for the digital era : Final report*, Luxembourg: Publications Office of the European Union, 2019.

Cunningham, Colleen, Florian Ederer, and Song Ma, "Killer Acquisitions," *Journal of Political Economy*, 2021, *129* (3), 649–702.

D.D.C, "FTC v Facebook," *1:20-cv-03590-JEB, Retrieved from https://www.ftc.gov/system/files/documents/cases/2021-09-08_redacted_substitute_amended_complaint_ecf_no._82.pdf, accessed 2021-12-08*, 2021.

Denicolo, Vincenzo and Michele Polo, "Acquisitions, innovation and the entrenchment of monopoly," *Working Paper*, 2021.

Dijk, Esmee, Jose Moraga-Gonzalez, and Evgenia Motchenkova, "How Do Start-up Acquisitions Affect the Direction of Innovation?," *Working Paper*, 2021.

Fumagalli, Chiara, Massimo Motta, and Emanuele Tarantino, "Shelving or Developing? The Acquisition of Potential Competitors Under Financial Constraints," *Working Paper*, 2022.

Furman, Jason, Diane Coyle, Amelia Fletcher, Derek McAuley, and

Philip Marsden, "Unlocking digital competition," *Report of the Digital Competition Expert Panel: HM Treasury*, 2019.

Gautier, Axel and Joe Lamesch, "Mergers in the digital economy," *Information Economics and Policy*, 2021, *54*, 100890.

Gilbert, Richard and David Newbery, "Preemptive Patenting and the Persistence of Monopoly," *The American Economic Review*, 1982, *72* (3), 514–526.

_ **and Michael Katz**, "Dynamic Merger Policy and Pre-Merger Product Choice by an Entrant," *Working Paper*, 2021.

Hollenbeck, Brett, "Horizontal mergers and innovation in concentrated industries," *Quantitative Marketing and Economics*, 03 2020, *18.*

Kamepalli, Sai-Krishna, Raghuram Rajan, and Luigi Zingales, "Kill Zone," *Working Paper*, 2021.

Katz, Michael, "Big Tech mergers: Innovation, competition for the market, and the acquisition of emerging competitors," *Information Economics and Policy*, 2021, *54*, 100883. Antitrust in the Digital Economy.

Koski, Heli, Otto Kassi, and Fabian Braesemann, "Killers on the Road of Emerging Start-ups - Implications for Market Entry and Venture Capital Financing," *Working Paper*, 2020.

Letina, Igor, Armin Schmutzler, and Regina Seibel, "Killer Acquisitions and Beyond: Policy Effects on Innovation Strategies," *Working paper*, 2021.

Moraga-González, José L, Evgenia Motchenkova, and Saish Nevrekar, "Mergers and innovation portfolios," *Rand Journal of Economics*, forthcoming.

Motta, Massimo and Martin Peitz, "Big tech mergers," *Information Economics and Policy*, 2021, *54*, 100868.

_ **and Sandro Sheleiga**, "The "Kill Zone": Copying, Acquisition and Start-Ups," *CEPR Discussion Paper No. DP16151*, 2021.

Rasmusen, Eric, "Entry for Buyout," *The Journal of Industrial Economics*, 1988, *36* (3), 281–299.

Scott-Morton, Fiona, Pascal Bouvier, Ariel Ezrachi, Bruno Jullien, Roberta Katz, and Gene Kimmelman, "Committee for the study of digital platforms: Market structure and antitrust subcommittee report," *Chicago: Stigler Center for the Study of the Economy and the State, University of Chicago Booth School of Business*, 2019.

Silicon Valley Indicators, "Number of New Startup Companies, Silicon Valley, San Francisco, and California," *Retrieved from https://siliconvalleyindicators.org/data/economy/innovation-entrepreneurship/startups/number-of-seed-or-early-stage-startups-and-total-number-of-startup-companies/, accessed 2021-12-08*, 2021.

Vergé, Thibaud, "Horizontal mergers, structural remedies, and consumer welfare in a Cournot oligopoly with assets," *The Journal of Industrial Economics*, 2010, *58* (4), 723–741.

Wickelgren, Abraham, "Optimal merger standards for potential competition: the effect of ex ante investment incentives," *Working Paper*, 2021.

Appendix A: Proofs for Section 3

Proof of Proposition 1 Follows from the in-text discussion. □

Proof of Lemma 1 We consider each of the four parameter ranges discussed in the main text (which exhausts all parameter possibilities).

Case 1: Suppose $K \leq K_M^I$, which further implies $K < K_D^I$. Thus, by the in-text discussion, it is optimal for I to develop regardless of the outcome of $E1$'s development. Furthermore, since $K_D^{E1}(x) \geq K_M^I$ for all x, it is also optimal for $E1$ to develop knowing that I develops in response to $E1$'s successful development.

Case 2: Suppose $K_M^I < K \leq \min\{K_D^I, K_D^{E1}(x)\}$. The claim follows analogously from the discussion of Case 1.

Case 3: Suppose $K_D^{E1}(x) < K \leq K_D^I$. Here, it is optimal for I to develop if and only if $E1$ successfully develops a superior primary product. However, anticipating I's development decision, $E1$ (strictly) prefers not to develop its project. Hence, $E1$ never develops a superior primary product, and so I never develops.

Case 4: Suppose $K_D^I < K$. Here, I never develops regardless of whether $E1$ is successful in developing a superior primary product. Anticipating this, as per the in-text discussion, $E1$ finds it optimal to develop its project. □

Proof of Lemma 2 We show that an acquisition occurs for an arbitrary type-x project ($x = 0$ accommodates when a type-0 is chosen in stage one) under each of the four parameter ranges listed in Lemma 1. This exhausts all possibilities. Further note that I's and $E2$'s expected profit without an acquisition are always $[px + (1-p)](1-p)\pi_m$ and $p[p(1-x)\pi_D + (1-p(1-x))\pi_M] - K = p[\Pi + px(\pi_M - \pi_D)] - K$ respectively.

Case 1: Suppose $K \leq K_M^I$. By Lemma 1, both I and $E1$ always develop with acquisitions. Thus, I's expected profit is given by $[px + (1-p)][p\pi_M + (1-p)\pi_m] + p^2(1-x)\pi_D^I$, which implies that I's gain from acquisition is $p[x_M - p(1-x)(\pi_M - \pi_D^I)] - K$. Observe that $E2$'s reservation price can be rewritten as $p[x_M - p(1-$

$x)(\pi_M - \pi_D)] - K$, which is clearly smaller than I's gain from the acquisition. Hence, an acquisition occurs.

Case 2: Suppose $K_M^I < K \leq \min\{K_D^I, K_D^{E1}(x)\}$. By Lemma 1, $E1$ always develop with acquisitions, while I develops if and only if $E1$ is successful in developing a superior primary product. Thus, I's expected profit is $(1-p+px)\pi_m + p(1-x)(p\pi_D^I - K)$, and I's gain from acquisition is $p[(1-p+px)\pi_m + (1-x)(p\pi_D^I - K)]$. The difference in I's gain and $E2$'s reservation value is linear in x and at $x = 0$, equal to

$$\begin{aligned}&\left[p(p\pi_D^I - K) + (1-p)\pi_m - (1-p)^2\pi_m\right] - [p\Pi - K] \\ =&p^2(\pi_D^I - \pi_D) + (1-p)[K - p(\pi_M - \pi_m)] > 0\end{aligned}$$

because $K \geq p(\pi_M - \pi_m)$. Meanwhile, for $x = 1$, I's gain, $p\pi_m$, is greater than $E2$'s reservation price, $p\pi_M - K$. By linearity, I's gain is greater than $E2$'s reservation price for any $x \in [0,1]$. Hence, an acquisition occurs.

Case 3: Suppose $K_D^{E1}(x) < K \leq K_D^I$. By Lemma 1, neither I nor $E1$ develop with acquisitions. Thus, I's expected profit is π_m, and I's gain from the acquisition is $[1 - px(1-p) - (1-p)^2]\pi_m$. I's gain is greater than $E2$'s reservation price when $x = 0$ as then, the difference is

$$[1-(1-p)^2]\pi_m - [p\Pi - K] = -p(1-p)(\pi_M - \pi_D - \pi_m) + K - p(\pi_D - \pi_m) > 0.$$

as $-p(1-p)(\pi_M - \pi_D - \pi_m) > 0$ and $K > p(\pi_M - \pi_m) > (\pi_D - \pi_m)$. Meanwhile, at $x = 1$, this difference is given by $p\pi_m - (p\pi_M - K) = K - p(\pi_M - \pi_m) > 0$ by assumption on K. By linearity, this implies that I's gain is greater than $E2$'s reservation price for any $x \in [0,1]$. Hence, an acquisition occurs.

Case 4: Suppose $K_D^I < K$. By Lemma 1, $E1$ always develops its project, while I never develops its project. Hence, I's expected profit is $[1 - p(1-x)]\pi_m$, and I's gain from the acquisition is $p(1-p+px)\pi_m$. The difference in I's gain and $E2$'s reservation value is linear in x. Furthermore, when $x = 0$, this difference is

$$p(1-p)\pi_m - [p\Pi - K] = p(K - p\pi_D) + (1-p)(K - p(\pi_M - \pi_m)) > 0$$

as $K \geq \pi_D^I > \pi_D$ and $K > p(\pi_M - \pi_m)$. Furthermore, the difference in I's gain and $E2$'s reservation price at $x = 1$ is $p\pi_m - (p\pi_M - K) = K - p(\pi_M - \pi_m) < 0$, again by assumption on K. By linearity, this implies that I's gain is greater than $E2$'s reservation price for any $x \in [0,1]$. Hence, an acquisition occurs. □

Proof of Proposition 2 We now identify $E1$'s optimal project choice under each of the four ranges of K listed in the statement of the proposition.

Case 1: Suppose $K \leq K_M^I$. Anticipating that I will acquire $E2$ and always develop the project, $E1$'s expected profit from choosing $t_{E1} = 0$ is $p[p\pi_D^E + (1-p)\pi_M] - K$, and its expected profit from choosing $t_{E1} = X$ is $\int_0^1 px\pi_X(x) + p(1-x)[p\pi_D^E + (1-p)\pi_M]dF(x) - K$. Hence, $E1$ chooses $x_1 = 0$ if and only if

$$\int_0^1 x\left(p\pi_D^E + (1-p)\pi_M - \pi_X(x)\right)dF(x) \geq 0 \;\Leftrightarrow\; \int_0^1 x(\Pi - \pi_X(x) + p(\pi_D^E - \pi_D))dF(x) \geq 0. \tag{19}$$

Which is simply condition (6).

Case 2: Suppose $K_M^I < K \leq \min\{K_D^I, K_D^{E1}(0)\}$. By Lemma 1, we know that I always acquires, and develops in response to $E1$'s successful development of a type-0 project. Thus, from $E1$'s perspective, the equilibrium plays out identically to Case 1, and so $E1$'s expected profit from choosing either project type in stage 1 is identical to Case 1. Hence, following the proof of Case 1, $E1$ chooses $x_1 = 0$ if and only if (6) holds.

Case 3: Suppose $K_D^{E1}(0) < K \leq K_M^I$. By Lemmas 1 and 2, $E1$ will never develop in the case that a type-0 project is chosen. Hence, $E1$'s expected profit from choosing a type-0 project is 0. Meanwhile, consider choosing a type-X project. Observe that $K_D^{E1}(0) < K$, $K_D^{E1}(1) = p\pi_X(1) \geq K$ by Assumption 1. Also, $(K_D^{E1})'(x) = px\pi_X'(x) + [px\pi_X(x) - K_D^{E1}(0)] > K$, where the latter inequality holds as $x\pi_X'(x) \geq 0$, since $\pi_X(x)$ is increasing in x, and $px\pi_X(x) \geq K > K_D^{E1}(0)$ in this region of K. Hence, there exists a unique $\overline{x} \in [0,1]$, which solves $p(\overline{x}\pi_{\overline{x}} + (1-\overline{x})(p\pi_D^E + (1-p)\pi_M)) = K$, such that for all $x \geq \overline{x}$, $E1$ develops its project. Thus, $E1$'s expected profit from choosing $t_{E1} = X$ is equal to

$$\begin{aligned}&\int_0^1 \max\{p[x\pi_X(x) + (1-x)(\Pi + p(\pi_D^E - \pi_D))] - K, 0\}dF(x)\\ =&\int_{\overline{x}}^1 \left(x\pi_X(x) + (1-x)(\Pi + p(\pi_D^E - \pi_D)) - K\right)dF(x) > 0\end{aligned}$$

So, $E1$ will choose $t_{E1} = X$.

Case 4: Suppose $K_D^I < K$. By Lemmas 1 and 2, an acquisition always occurs, and $E1$ always develops its project regardless of project type. By choosing $t_{E1} = 0$, $E1$'s expected profit is $p\pi_M - K$. Meanwhile, choosing $t_{E1} = X$ yields

$$\int_0^1 p[x\pi_X(x) + (1-x)(\Pi + p(\pi_D^E - \pi_D))]dF(x) - K \leq p\pi_M - K$$

by Assumption 1. Thus, $E1$ chooses $t_{E1} = 0$. □

Proof of Corollary 1 Follows from Propositions 1 and 2. □

Appendix B: Proofs for Section 4

In the welfare analysis, we assume firms play the equilibrium that maximizes consumer welfare when indifferent.

B1: Consumer welfare analysis

We first characterize the impact of acquisitions on consumer welfare and Corollary 2. The expression of $CW^{\mathrm{b}}(x)$ and $CW^{\mathrm{a}}(x,K)$ for any $x \in [0,1]$ are given below. The full derivation is provided in the online appendix.

$$CW^{\mathrm{b}}(x) = V_X(x)px + V_0(p^2 + p(1-p)(2-x)) + p^2(1-x)\epsilon \tag{20}$$

$$CW^{\mathrm{a}}(x,K) = \begin{cases} CW^{\mathrm{b}}(x) + p\delta, & K \leq K_M^I \\ pxV_X(x) + p(1-x)V_0 + p^2(1-x)(\delta+\epsilon), & K_M^I < K \leq \min\{K_D^{E1}(x), K_D^I\} \\ 0, & K_D^{E1}(x) < K \leq K_D^I \\ p(1-x)V_0 + xpV_X(x), & K > K_D^I \end{cases} \tag{21}$$

Since we assume $V_X(x) \leq \min\{\epsilon, V_0\}$ for all x, $CW^b(x) \leq CW^b(0)$ for all x, so $\int_0^1 CW^{\mathrm{b}}(x)dF(x) \leq CW^{\mathrm{b}}(0)$.

In all cases, observe that $CW^{\mathrm{a}}(x,K)$ is linear in δ, where the coefficient in front of δ is always non-negative. Consequently, it is straightforward to apply (7), rearranging the expression to isolate δ such as to obtain $\mathcal{W}(K,(t^{\mathrm{b}},t^{\mathrm{a}}))$ in the form of equation (8), where $A(K,(t^b,t^a)) \geq 0$. The claims in Corollary 2 are proven below.

- **Case 1:** Suppose $K \leq K_M^I$ and $(t^{\mathrm{b}},t^{\mathrm{a}}) \in \{(0,0),(X,X)\}$. Then, $\mathcal{W}(K,(t^{\mathrm{b}},t^{\mathrm{a}})) = p\delta \geq 0$. Hence, consumer welfare always increases.

- **Case 2:** Suppose $K > K_D^I$. Here, $(t^{\mathrm{b}},t^{\mathrm{a}}) \in \{(0,0),(X,0)\}$. However, for all $x \in [0,1]$, $CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(x) = -pxV_X(x) - p(1-p)(1-x)V_0 - p^2(1-x)\epsilon < 0$. Thus, if $(t^{\mathrm{b}},t^{\mathrm{a}}) = (0,0)$, $\mathcal{W}(K,(0,0)) = CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0) < 0$. If $(t^{\mathrm{b}},t^{\mathrm{a}}) = (X,0)$, $\mathcal{W}(K,(X,0)) = CW^{\mathrm{a}}(0,K) - \int_0^1 CW^{\mathrm{b}}(x)dF(x) < 0$. Hence, regardless of project choice, consumer welfare always falls under acquisitions. So we set $\delta(K,(0,0)) = \delta(K,(X,0)) = \infty$.

B2: Merger Policy

To begin, note that by Lemma 2, I always acquires $E2$ when acquisitions are allowed. Thus, for any $q \in [0,1]$ and $x \in [0,1]$, I always acquires $E2$. We now take several steps to prove the results in Proposition 3.

We begin by considering $E1$'s project choice. Suppose $K < \min\{K_D^{E1}(0), K_D^I\}$. With probability q, I acquires $E2$ and competes with $E1$. $E1$'s incremental benefit of choosing the type-0 over the type-X project is given in (6). With probability $1-q$, the acquisition is blocked and $E1$ competes with $E2$. $E1$'s incremental benefit is given in (2). Combining the two, $E1$ chooses the type-0 over type-X project if and only if Condition (22) below holds, which we observe is linear in q.

$$\int_0^1 x(\Pi - \pi_X(x) + pq(\pi_D^E - \pi_D))dF(x) \geq 0 \tag{22}$$

We now consider each of the three claims in Proposition 3.

Case 1: Suppose $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0,0)$ such that both (2) and (6) are satisfied, and $E1$ chooses the type-0 project with and without acquisitions. Then, for any $q \in [0,1]$, (22) holds, and $E1$ chooses the type-0 project. From here, the first claim of Proposition 3 follows from the linearity of $\mathcal{W}(q,K)$ in q implied by (9) and (10).

Case 2: Suppose $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (X,X)$ such that both (2) and (6) are violated, and $E1$ chooses the type-X project with and without acquisitions. Then, for any $q \in [0,1]$, (22) is violated and $E1$ chooses the type-X project. Following the logic of Case 1, it is straightforward to verify the second claim of Proposition 3.

Case 3: Suppose $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0,X)$, so (2) holds but (6) fails. Then, there exists a unique $\overline{q}(K)$ such that (22) holds if and only if $q \leq \overline{q}(K)$. A similar logic implies the existence of a $\overline{q}(K)$ for the range $K_D^{E1}(0) < K \leq K_D^I$, i.e., $E1$ chooses the type-0 project if and only if q is sufficiently low.

We now verify the third claim of Proposition 3. First, since $\mathcal{W}(q,K)$ is linear in q on $[0, \overline{q}(K))$, the condition

$$\mathcal{W}(1,K) > \max\{\mathcal{W}(0,K), \lim_{q \to \overline{q}(K)^-} \mathcal{W}(q,K)\} \tag{23}$$

implies $\mathcal{W}(1,K) \geq \max_{q \in [0,\overline{q}(K))} \mathcal{W}(q,K)$. Adding $CW^{\mathrm{b}}(0)$ to both sides of (23) yields an equivalent condition of

$$\int_0^1 CW^{\mathrm{a}}(x,K)dF(x) \geq \max\{CW^{\mathrm{b}}(0), \overline{q}(K)CW^{\mathrm{a}}(0,K) + (1-\overline{q}(K))CW^{\mathrm{b}}(0)\}. \tag{24}$$

If (24) holds, then $\int_0^1 CW^{\mathrm{b}}(x)dF(x) < CW^{\mathrm{b}}(0) \leq \int_0^1 CW^{\mathrm{a}}(x,K)dF(x)$, with the first inequality following from the assumption $V_X(x) \leq V_0$ for all x. As a result, taking any $q \in (\overline{q}(K), 1]$, we have

$$\begin{aligned}\mathcal{W}(q,K) &= q(\int_0^1 CW^{\mathrm{a}}(x,K)dF(x) - CW^{\mathrm{b}}(0)) + (1-q)(\int_0^1 CW^{\mathrm{b}}(x)dF(x) - CW^{\mathrm{b}}(0)) \\ &\leq q(\int_0^1 CW^{\mathrm{a}}(x,K)dF(x) - CW^{\mathrm{b}}(0)) + (1-q)(\int_0^1 CW^{\mathrm{a}}(x,K)dF(x) - CW^{\mathrm{b}}(0)) = \mathcal{W}(1,K),\end{aligned}$$

which also implies $\lim_{q\to\overline{q}(K)^+} \mathcal{W}(q,K) \leq \mathcal{W}(1,K)$. Hence, when (24) holds, $\mathcal{W}(1,K) = \max_{q\in[0,1]} \mathcal{W}(q,K)$, and $q^* = 1$.

Next, if $\mathcal{W}(0,K) \geq \max\{\mathcal{W}(1,K), \lim_{q\to\overline{q}(K)^-} \mathcal{W}(q,K)\}$, the linearity of $\mathcal{W}(q,K)$ on $[0,\overline{q}(K))$ implies $\mathcal{W}(0,K) \geq \max_{q\in[0,\overline{q}(K))} \mathcal{W}(q,K)$. If we add $CW^{\mathrm{b}}(0)$ to both sides of the former inequality, it becomes

$$CW^{\mathrm{b}}(0) \geq \max\{\int_0^1 CW^{\mathrm{a}}(x,K)dF(x), CW^{\mathrm{a}}(0,K)\}. \tag{25}$$

Moreover, (20) immediately implies that $\int_0^1 CW^{\mathrm{b}}(x)dF(x) < CW^{\mathrm{b}}(0)$, which is equivalent to $\mathcal{W}(0,K) \geq \mathcal{W}(\overline{q}(K),K)$. As $\mathcal{W}(q,K)$ is linear on $(\overline{q}(K),1]$, $\mathcal{W}(0,K) \geq \max_{q\in(\overline{q}(K),1]} \mathcal{W}(q,K)$. Thus, when (25) holds, $q^* = 0$.

Finally, suppose neither (24) nor (25) hold. There are two subcases to consider. First, if $CW^{\mathrm{b}}(0) > \int_0^1 CW^{\mathrm{a}}(x,K)dF(x)$, then (25) not holding implies $CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0) \geq 0$. Hence, $\mathcal{W}(q,K)$ is increasing on $[0,\overline{q}(K))$. Meanwhile,

$$\mathcal{W}(1,K) = \int_0^1 CW^{\mathrm{a}}(x,K)dF(x) - CW^{\mathrm{b}}(0) < 0 \leq \overline{q}(K)[CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0)]$$

While at $\overline{q}(K)$, since $\int_0^1 CW^{\mathrm{b}}(x)dF(x) \leq CW^{\mathrm{b}}(0)$ (see Section 4.1),

$$\overline{q}(K)[CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0)] > \begin{array}{c}\overline{q}(K)(\int_0^1 CW^{\mathrm{a}}(x,K)dF(x) - CW^{\mathrm{b}}(0)) \\ +(1-\overline{q}(K))(\int_0^1 CW^{\mathrm{b}}(x)dF(x) - CW^{\mathrm{b}}(0))\end{array}$$

we have $q = \overline{q}(K)$, $\lim_{q^-\to\overline{q}(K)} \mathcal{W}(q,K) > \lim_{q^+\to\overline{q}(K)} \mathcal{W}(q,K)$ so $\mathcal{W}(\overline{q}(K),K) = \overline{q}(K)[CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0)]$. Combined with the linearity of $\mathcal{W}(q,K)$ on $(\overline{q}(K),1]$, this implies $\mathcal{W}(\overline{q}(K),K) > \mathcal{W}(q,K)$ on $(\overline{q}(K),1]$. Thus, $q^* = \overline{q}(K)$. Second, if $CW^{\mathrm{b}}(0) \leq \int_0^1 CW^{\mathrm{a}}(x,K)dF(x)$, then

$$\begin{aligned}\overline{q}(K)[CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0)] &> \int_0^1 CW^{\mathrm{a}}(x,K)dF(x) \\ &\geq \begin{array}{c}\overline{q}(K)[\int_0^1 CW^{\mathrm{a}}(x,K)dF(x) - CW^{\mathrm{b}}(0)] \\ +(1-\overline{q}(K))[\int_0^1 CW^{\mathrm{b}}(x)dF(x) - CW^{\mathrm{b}}(0)]\end{array}\end{aligned}$$

which implies $\lim_{q^-\to\overline{q}(K)} \mathcal{W}(q,K) > \lim_{q^+\to\overline{q}(K)} \mathcal{W}(q,K)$, so $\mathcal{W}(\overline{q}(K),K) = \overline{q}(K)[CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0)]$. Furthermore, that (24) does not hold implies $\overline{q}(K)CW^{\mathrm{a}}(0,K) + (1 -$

$\overline{q}(K))CW^{\mathrm{b}}(0) > \int_0^1 CW^{\mathrm{a}}(x,K)dF(x) \geq CW^b(0)$. This has two consequences. The first inequality implies $\mathcal{W}(1,K) < \mathcal{W}(\overline{q}(K),K)$. That $\mathcal{W}(q,K)$ is linear on $(\overline{q}(K),1]$ then implies $\mathcal{W}(\overline{q}(K),K) > \max_{q\in(\overline{q}(K),1]}\mathcal{W}(q,K)$. The second inequality implies $CW^{\mathrm{b}}(0) < \overline{q}(K)CW^{\mathrm{a}}(0,K) + (1-\overline{q}(K))CW^{\mathrm{b}}(0)$. Thus, $CW^{\mathrm{a}}(0,K) > CW^{\mathrm{b}}(0)$, which by linearity implies $\mathcal{W}(q,K)$ is increasing on $[0,\overline{q}(K)]$. Hence, $q^* = \overline{q}(K)$.

B3: Remedies

Recall that we focus on the case with $(t^{\mathrm{b}},t^{\mathrm{a}}) = (0,X)$ when analyzing remedies. The AA always approves the proposed acquisitions but requires a transfer R. A close inspection of the proof of Lemma 2 reveals that Lemma 2 holds as long as the profit ordering $\pi_M > \pi_D^I - R \geq \pi_D \geq \pi_M - \pi_m$ and Assumptions 1 and 3 hold. Assumptions 1 and 3 are unaffected by R. Then, I always acquires $E2$ in equilibrium when a remedy with transfer $R \in [0, \pi_D^I - \pi_D]$ is imposed.

We now provide a combined proof of both Proposition 4 and Proposition 5, splitting the analysis according to whether K is greater than or less than $K_D^{E1}(0)$.

Part I: $\boldsymbol{K \leq K_D^{E1}(0)}$. When $K \leq K_D^{E1}(0)$, $E1$ always develops its project regardless of R. We will establish that if so, then (15b) and $CW^a(0,K) > CW^b(0)$ are (jointly) necessary and sufficient for there to exist a remedy which outperforms coarse merger policy, beginning with proving an auxiliary fact.

Existence of remedy: Fix any $x \in [0,1]$. Conditional on I counter-developing, $E1$'s profit from developing a project with parameter $x \in [0,1]$ is

$$p\left(x\pi_X(x) + (1-x)(p(\pi_D^E + \gamma R) + (1-p)\pi_M)\right) = K_D^{E1}(x) + p^2(1-x)\gamma R.$$

Choosing the type-0 project in stage 1 yields $K_D^{E1}(0) + p^2\gamma R$, while choosing the type-X project yields $\int_0^1 K_D^{E1}(x) + p^2(1-x)\gamma R dF(x)$. Thus, $E1$ chooses the type-0 over the type-X project if and only if

$$K_D^{E1}(0) - \int_0^1 K_D^{E1}(x)dF(x) + \int_0^1 p^2 x\gamma R dF(x) = \int_0^1 x(\Pi - \pi_X(x) + p(\pi_D^E - \pi_D + \gamma R))dF(x) \geq 0$$
$$\iff R \geq \underline{R} := \frac{1}{\gamma p}\left(\int_0^1 x[\pi_X(x) - \Pi - p(\pi_D^E - \pi_D)]dF(x)\right).$$

Next, I counter-develops if and only if $p(\pi_D^I - R) \geq K$, or equivalently, $R \leq \pi_D^I - \frac{K}{p}$. Recall R is bounded above by $\pi_D^I - \pi_D$. Thus, any $R \in [\underline{R}, \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$ induces $E1$ to choose the type-0 project under acquisitions, while maintaining I's willingness to counter-develop. Such an interval exists if and only if (15b) holds.

Sufficiency: We show that (15b) and $CW^a(0,K) > CW^b(0)$ are sufficient for the existence of a remedy that outperforms the optimal coarse merger policy. Suppose both conditions hold. Take any $R \in [\underline{R}, \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$. As noted in the main text, $\widetilde{\mathcal{W}}(R,K) = CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0)$. Also, the proof of Proposition 3 implies $\mathcal{W}(q^*,K)$ can take on one of three values: (i) $\mathcal{W}(q^*,K) = 0$ if $q^* = 0$, (ii) $\mathcal{W}(q^*,K) = \int_0^1 CW^{\mathrm{a}}(x,K)dF(x) - CW^{\mathrm{b}}(0)$ if $q^* = 1$ (because we focus on the case where $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, X)$), and (iii) $\mathcal{W}(q^*,K) = \overline{q}(K)[CW^{\mathrm{a}}(0,K) - CW^{\mathrm{b}}(0)]$ if $q^* = \overline{q}(K)$. Given $CW^{\mathrm{a}}(0,K) > CW^{\mathrm{b}}(0)$, it is obvious that $\widetilde{\mathcal{W}}(R,K)$ is greater than (i) and (iii). Meanwhile, for (ii),

$$\widetilde{\mathcal{W}}(R,K) - \mathcal{W}(q^*,K) = CW^{\mathrm{a}}(0,K) - \int_0^1 CW^{\mathrm{a}}(x,K)dF(x) > 0,$$

This proves sufficiency, and thus the related claim in Proposition 4.

Necessity: Since $E1$ always develops regardless of the project type, for a remedy to outperform coarse merger policy, it necessarily induces $E1$ to switch projects. Such a remedy exists if and only if (15b) holds, implying the necessity of (15b). Meanwhile, if (15b) and $CW^a(0,K) \leq CW^b(0)$ holds, $\max\{\mathcal{W}(0,K), \mathcal{W}(1,K)\} \geq \widetilde{\mathcal{W}}(R,K)$ for any $R \in [0, \pi_D^I - \pi_D]$. So, using a remedy is no better than banning or allowing all acquisitions. This establishes the necessity of $CW^a(0,K) > CW^b(0)$.

Part II: $K > K_D^{E1}(0)$. We break down the proof into two steps.

Auxiliary step: Fixing I's incentive to counter-develop, we first show that $E1$ develops its project for all x when $R \geq \overline{R} = \frac{1}{\gamma p^2}(K - K_D^{E1}(0))$, and develops its project only when x is sufficiently high otherwise. Notice that for all $R \geq \overline{R}$ and $x \in [0,1]$, $E1$'s profit from developing given x is

$$K_D^{E1}(x) - K + p^2(1-x)\gamma R \geq K_D^{E1}(x) - K + (1-x)(K - K_D^{E1}(0)) = x(p\pi_X(x) - K) \geq 0.$$

The equality follows from $K_D^{E1}(x) = xp\pi_X(x) + (1-x)K_D^{E1}(0)$. That is, $E1$ develops for all $x \in [0,1]$ whenever $R \geq \overline{R}$. Further observe that

$$\underline{R} - \overline{R} = \frac{1}{\gamma p^2}\int_0^1 \Big((px\pi_X(x) - K) + (1-x)\pi_D^{E1}(0)\Big)dF(x) \geq 0,$$

as $px\pi_X(x) \geq K$ for all $x \in [0,1]$.

Next, consider $R < \overline{R}$. Take any $x, x' \in [0,1]$, where $x > x'$. Then,

$$\begin{aligned}
&K_D^{E1}(x) + p^2(1-x)\gamma R - (K_D^{E1}(x') + p^2(1-x')\gamma R) \\
=&p^2\left(\frac{1}{p}x\pi_X(x) - \frac{1}{p}x'\pi_X(x') - (x-x')\left(\frac{1}{p^2}K_D^{E1}(0) + \gamma R\right)\right) \\
\geq&p^2\left((x-x')\frac{1}{p}\pi_X(x) - (x-x')\left(\frac{1}{p^2}K_D^{E1}(0) + \gamma R\right)\right) \\
\geq&p^2(x-x')\left(\frac{1}{p^2}\left(K - K_D^{E1}(0)\right) - \gamma R\right) > 0.
\end{aligned}$$

The first inequality holds as $\pi_X(x)$ is increasing in x, and the second inequality holds as $p\pi_X(x) \geq K$. Thus, $K_D^{E1}(x) + p^2(1-x)R$ is strictly increasing in x. Furthermore, notice that $K_D^{E1}(1) \geq K$ by Assumption 1, and $K_D^{E1}(0) + p^2\gamma R < K$. Thus, there exists a unique $x(R) \in (0,1]$ which solves $K_D^{E1}(x(R)) = K - p^2(1-x(R))\gamma R$ such that $E1$ develops its project if and only if $x \geq x(R)$. Consequently, assuming I always counter-develops, choosing any $R < \overline{R}$ yields

$$\widetilde{\mathcal{W}}(R,K) = \int_{x(R)}^{1} (pxV_X(x) + p(1-x)V_0 + p^2(1-x)(\delta+\epsilon))dF(x), \tag{26}$$

which is strictly increasing in R as $x(R)$ is strictly decreasing in R.

Proof: We now prove Proposition 4 and Proposition 5 for this parameter range.

Proposition 4: Suppose (15a) and (15b) hold. Take any $R \in [\underline{R}, \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$. First, for any $x \in [0,1]$, $E1$'s profit from development is

$$\underbrace{p(x\pi_X(x) + (1-x)(p\pi_D^{E1} + (1-p)\pi_M))}_{\text{Expected profit}} - \underbrace{(K - \gamma p^2 R)}_{\text{Effective development cost}}. \tag{27}$$

Notice $E1$ develops whenever (27) is greater than zero. As a result, $E1$'s decision of whether to develop, is the same as if it faces a development cost of $K - \gamma p^2 R \leq K - \gamma p^2 \overline{R} \leq K_D^{E1}(0)$. By Proposition 2, $E1$ then always develops its project. Hence, following the logic of Part I, choosing any remedy $R \in [\underline{R}, \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$ implies (i) $E1$ chooses the type-0 project, and (ii) the resulting gain in consumer welfare satisfies $\widetilde{\mathcal{W}}(R,K) > \mathcal{W}(q^*,K)$. That is, any such remedy outperforms optimal coarse merger policy. This proves the claim.

Proposition 5: Suppose $\int_0^1 CW^{\text{a}}(x,K)dF(x) \geq CW^{\text{b}}(0)$ holds, which implies $\mathcal{W}(q^*,K) = \mathcal{W}(1,K) = \widetilde{\mathcal{W}}(0,K)$. Take any $R \in (0, \min\{\overline{R}, \pi_D^I - \max\{\pi_D, \frac{K}{p}\}\}]$, implying that $E1$ chooses the type-X project and develops it only if $x \geq x(R)$, and I always counter-develops if $E1$ succeeds in the primary market. Consequently, $\widetilde{\mathcal{W}}(R,K)$ is as defined in (26), which is strictly increasing in R by the discussion in the auxiliary step. Hence, $\widetilde{\mathcal{W}}(R,K) - \mathcal{W}(q^*,K) = \widetilde{\mathcal{W}}(R,K) - \widetilde{\mathcal{W}}(0,K) > 0$. □

Acquisition-induced kill zones - Online appendix

Christopher Teh[*], Dyuti Banerjee[†], and Chengsi Wang[‡]

November 22, 2022

Contents

OA: Deriving $CW^b(x)$ and $CW^a(x, K)$ **2**

OB: Remedies and optimal coarse merger policy **4**

OB1: Sufficient condition for Proposition 4 to apply 4

OB2: Sufficient condition for Proposition 4 not to apply 6

OC: Extensions **7**

OC1: Entry-for-buyout 7

OC1a: Equilibrium Analysis 7

OC1b: Consumer Welfare Analysis 12

OC2: Alternative Counterfactuals 14

OC2a: Equilibrium analysis: Adversarial Selection 14

OC2b: Consumer Welfare Analysis: Adversarial Selection 15

OC3: Simultaneous development 18

OD: Non-Drastic Innovation **24**

OD1: Equilibrium Analysis 24

OD2: Discussion 32

[*]UNSW Sydney, Australia, E-mail: chris.teh@unsw.edu.au

[†]Monash University, Australia, E-mail: dyuti.banerjee@monash.edu

[‡]Monash University, Australia, E-mail: chengsi.wang@monash.edu

OA: Deriving $CW^b(x)$ and $CW^a(x, K)$

This section provides the full derivation of $CW^{\mathrm{b}}(x)$ and $CW^{\mathrm{a}}(x, K)$, used in the derivation of consumer welfare values in Appendix B of the main text.

Benchmark: Consumer welfare without acquisitions. Fix any $x \in [0, 1]$. There are the following possible events (set $x = 0$ when $t_{E1} = 0$):

- With probability $p^2 x$, $E1$ develops the independent product, while $E2$ develops a superior primary product. Hence, consumer welfare is $V_X(x) + V_0$.
- With probability $p^2(1-x)$, $E1$ and $E2$ both develop the superior primary product. Hence, consumer welfare is $V_0 + \epsilon$.
- With probability $p(1-p)x$, $E1$ develops the independent product, while $E2$ fails in its development. Hence, consumer welfare is $V_X(x)$.
- With probability $p(1-p)(1-x)$, $E1$ develops the superior primary product, and $E2$ fails in its development. Hence, consumer welfare is V_0.
- With probability $p(1-p)$, $E1$ fails in its development, and $E2$ develops the superior primary product. Hence, consumer welfare is V_0
- With probability $(1-p)^2$, $E1$ and $E2$ both fail in development. consumer welfare is zero.

Combined, these imply

$$CS^{\mathrm{b}}(x) = V_X(x)px + V_0(p^2 + p(1-p)(2-x)) + p^2(1-x)\epsilon$$

Consumer welfare with acquisitions Fix any $x \in [0, 1]$. We consider the change in consumer welfare across each of the four thresholds, summarizing $CW^{\mathrm{a}}(x)$ at the end.

Case 1: Suppose $K \leq K_M^I$. We note that there are five possibilities:

- With probability $p^2 x$, $E1$ develops the independent product, while I develops a superior primary product. Hence, consumer welfare is $V_X(x) + V_0 + \delta$.
- With probability $p^2(1-x)$, $E1$ and I both develop the superior primary product. Hence, consumer welfare is $V_0 + \epsilon + \delta$.
- With probability $p(1-p)x$, $E1$ develops the independent product, while I develops nothing. Hence, consumer welfare is $V_X(x)$.
- With probability $p(1-p)(1-x)$, $E1$ develops the superior primary product, and I develops nothing. Hence, consumer welfare is V_0.
- With probability $p(1-p)$, $E1$ develops nothing, and I develops the superior primary product. Hence, consumer welfare is $V_0 + \delta$.
- With probability $(1-p)^2$, $E1$ and $E2$ develop nothing. consumer welfare is zero.

Combined, these imply

$$CS^{\mathrm{a}}(x,K) = \underbrace{V_X(x)px + V_0(p^2 + p(1-p)(2-x)) + p^2(1-x)\epsilon}_{CW^{\mathrm{b}}(x)} + p\delta$$

Case 2: Suppose $K_M^I < K \leq \min\{K_D^{E1}(x), K_D^I\}$. We note that there are four possibilities:

- With probability px, $E1$ develops the independent product, and thus I develops nothing. Hence, consumer welfare is $V_X(x)$.
- With probability $p^2(1-x)$, $E1$ develops the superior primary product, and I develops the superior primary product successfully in response. Hence, consumer welfare is $V_0 + \epsilon + \delta$.
- With probability $p(1-x)(1-p)$, $E1$ develops the superior primary product, and I fails to develop in response. Hence, consumer welfare is V_0.

- With probability $(1-p)$, $E1$ fails to develop any product, and so I does not develop in response. Hence, consumer welfare is 0.

Combined, these imply

$$CW^{\mathrm{a}}(x,K) = pxV_X(x) + p(1-x)V_0 + p^2(1-x)(\delta+\epsilon)$$

Case 3: Suppose $K_D^{E1}(x) < K \leq K_D^I$. Here, neither $E1$ nor I develop anything. Hence, consumer welfare is 0.

Case 4: Suppose $K > K_D^I$. Here, $E1$ always develops, either obtaining the superior primary product with probability $p(1-x)$, generating consumer welfare V_0, or the independent product with probability px, generating consumer welfare $V_X(x)$. Hence, $CW^{\mathrm{a}}(x,K) = p(1-x)V_0 + xpV_X(x)$

OB: Remedies and optimal coarse merger policy

In this section, we provide sufficient conditions under which remedies dominate optimal coarse merger policy and vice versa, detailed in the discussion following Proposition 4 in Section 4. Throughout, we assume that $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, X)$.

OB1: Sufficient condition for Proposition 4 to apply

As discussed in the main text, the conditions of Proposition 4 hold, i.e., remedies dominate optimal coarse merger policy whenever (i) K is moderately high, and either (i) both δ and π_D^I are sufficiently large. We formally prove this below.

Remark 1. *Suppose that $(t^b, t^a) = (0, X)$ and $K > K_M^I$. Then, there exists a threshold $(\overline{\pi}_D^I, \overline{\delta}) \geq 0$ such that for all $(\pi_D^I, \delta) \geq (\overline{\pi}_D^I, \overline{\delta})$, approving all acquisitions with an attached remedy dominates optimal coarse merger policy.*

To prove Remark 1, we note that for sufficiently large π_D^I, $K_D^I \geq K$ holds such that I always counter-develops. Hence, we assume this throughout. We break the proof into two parts.

Part I: First, suppose $K \leq K_D^{E1}(0)$ (the latter is entirely independent of π_D^I and δ). Here both I and $E1$ always develop, regardless of the outcome of $E1$'s development. There are two possibilities to consider.

Case 1: Suppose $\underline{R}(\gamma) > \pi_M - \max\{\pi_D, \frac{K}{p}\}$. If so, then for any π_D^I, there does not exist a feasible remedy which induces $E1$ to switch to the type-0 project. As a result, under any feasible remedy, $E1$ chooses the type-X project, yielding a payoff of $\tilde{\mathcal{W}}(0, K) = \mathcal{W}(1, K) \leq \mathcal{W}(q^*, K)$. Consequently, approving all acquisitions with an attached remedy never dominates optimal merger policy. Hence, letting $(\pi_D^I, \delta) = (\pi_M + \epsilon, 0)$, i.e., such that the threshold is never met, proves the claim.

Case 2: Suppose $\underline{R}(\gamma) \leq \pi_M - \max\{\pi_D, \frac{K}{p}\}$. First consider remedies. The assumption implies that there exists $\overline{\pi}_D^I \in (0, \pi_M]$ such that for $\pi_D^I > \overline{\pi}_D^I$ close to π_M, $\underline{R}(\gamma) \leq \pi_D^I - \max\{\pi_D, \frac{K}{p}\}$ is satisfied. If so, then any $R \in [\underline{R}(\gamma), \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$ induces $E1$ into choosing the type-0 project (and developing with probability one). Using the expressions for consumer welfare in Appendix B1 of the main text, one can write consumer welfare under R as

$$\tilde{\mathcal{W}}(R, K) = C + p^2\delta \tag{1}$$

where C contains terms which do not vary with δ.

Next, consider merger policy. We note that (i) $\mathcal{W}(0, K)$ is constant in δ, while both $\mathcal{W}(\overline{q}(K), K)$ and $\mathcal{W}(1, K)$ are increasing in δ and, for large enough δ, can be expressed as

$$\mathcal{W}(\overline{q}(K), K) = A + p^2\overline{q}(K)\delta, \quad \mathcal{W}(1, K) = B + p^2(1 - \mathbb{E}[x])\delta \tag{2}$$

where both A and B are constant in δ. Since both $\mathcal{W}(\overline{q}(K), K)$ and $\mathcal{W}(\overline{q}(K), K)$ are strictly increasing in δ, for large enough δ, either $q^* = \overline{q}(K)$ or $q^* = 1$.

Finally, comparing (1) and (2), the coefficient in front of δ in (1) is larger than either of that in (2). Hence, there exists $\hat{\delta}$ such that for all $\delta > \hat{\delta}$ (and $\pi_D^I > \overline{\pi}_D^I$) $\tilde{\mathcal{W}}(R, K) > \max\{\mathcal{W}(\overline{q}(K), K), \mathcal{W}(1, K)\} = \mathcal{W}(q^*, K)$ for any $R \in [\underline{R}(\gamma), \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$. This proves Remark 1 with respect to $K \leq K_D^{E1}(0)$.

Part II: Now, suppose $K > K_D^{E1}(0)$. There are two possibilities to consider.

Case 1: Suppose $\underline{R}(\gamma) > \pi_M - \max\{\pi_D, \frac{K}{p}\}$. By an identical logic to Case 1 in Part I, approving all acquisitions with an attached remedy never dominates optimal merger policy. Hence, letting $(\pi_D^I, \delta) = (\pi_M + \epsilon, 0)$, i.e., such that the threshold is never met, proves the claim.

Case 2: Next, suppose $\underline{R}(\gamma) \leq \pi_M - \max\{\pi_D, \frac{K}{p}\}$. First consider remedies. By a similar logic to Case 2 in Part I, there exists $\overline{\pi}_D^I \in (0, \pi_M]$ such that for $\pi_D^I > \overline{\pi}_D^I$, $\underline{R}(\gamma) \leq \pi_D^I - \max\{\pi_D, \frac{K}{p}\}$ is satisfied. If so, then any $R \in [\underline{R}(\gamma), \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$ induces $E1$ into choosing the type-0 project (and developing with probability one), which yields the consumer welfare value given in (1).

Next, consider merger policy. Proposition 3 in the main text implies that when $q^* \in \{0, 1\}$, i.e., either banning or approving all acquisitions is optimal. We note that $\mathcal{W}(0, K)$ is constant in δ, while

$$\mathcal{W}(1, K) = B + p^2\left(\int_{\overline{x}(K)}^{1} (1 - x)dF(x)\right)\delta \tag{3}$$

Here, $\overline{x}(K)$ is the threshold value of x under which $E1$ develops, and $\int_{\overline{x}(K)}^{1}(1-x)dF(x)$ captures the unconditional probability that (i) x is sufficiently high such that $E1$ develops, and (ii) conditional on developing, $E1$ develops a type-0 product. As the second term is strictly increasing in δ, there exists some $\tilde{\delta}$ where for all $\delta > \tilde{\delta}$ we have $\mathcal{W}(1, K) > \mathcal{W}(0, K)$, and so $q^* = 1$.

Finally, comparing (1) and (3), the coefficient in front of δ in (1) is larger than in (3). Hence, there exists $\hat{\delta}$ such that for all $\delta > \hat{\delta}$ (and $\pi_D^I > \overline{\pi}_D^I$) $\tilde{\mathcal{W}}(R, K) > \mathcal{W}(1, K) = \mathcal{W}(q^*, K)$ for any $R \in [\underline{R}(\gamma), \pi_D^I - \max\{\pi_D, \frac{K}{p}\}]$. This proves Remark 1 with respect to $K > K_D^{E1}(0)$, and thus completes our proof. □

OB2: Sufficient condition for Proposition 4 not to apply

As discussed in the main text, Proposition 4's conditions do not hold whenever either γ or π_D^I is sufficiently low. We prove an example of this below, for when K is not too large.

Remark 2. *Suppose that $(t^b, t^a) = (0, X)$ and $K \in (K_M^I, K_D^{E1}(0)]$. Then, there exists a threshold $(\underline{\pi}_D^I, \underline{\gamma}) \geq 0$ such that for all (π_D^I, γ) such that $\gamma < \underline{\gamma}$ or $\pi_D^I < \underline{\pi}_D^I$, optimal* *coarse merger policy dominates approving all acquisitions with an attached remedy.*

To prove the claim, we first observe that whenever $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (0, X)$,

$$\underline{R}(\gamma) = \frac{1}{\gamma p}\bigg(\int_0^1 x[\pi_X(x) - \Pi - p(\pi_D^E - \pi_D)]dF(x)\bigg) > 0$$

Additionally, $\underline{R}(\gamma)$ is strictly decreasing in γ, with $\lim_{\gamma\to 0}\underline{R}(\gamma) = \infty$. Meanwhile, $\pi_D^I - \max\{\pi_D, \frac{K}{p}\} \in [\min\{0, \pi_D - \frac{K}{p}\}, \pi_M - \max\{\pi_D, \frac{K}{p}\}]$. Hence, defining

$$\underline{\pi_D^I} = \max\{\pi_D, \frac{K}{p}\}$$

And $\underline{\gamma}$ as any value of γ which satisfies $\underline{R}(\underline{\gamma}) > \pi_M - \max\{\pi_D, \frac{K}{p}\}$, it is straightforward to verify that for all (π_D^I, γ) such that $\gamma < \underline{\gamma}$ or $\pi_D^I < \underline{\pi_D^I}$, $\underline{R}(\gamma) > \pi_D^I - \max\{\pi_D, \frac{K}{p}\}$. By Proposition 4, this implies that approving all acquisitions with an attached remedy (strictly) does not dominate optimal merger policy. This proves Remark 2. □

Finally, we note that when $K > K_D^{E1}(0)$, having Remark 2 hold implies that remedies can only dominate coarse merger policy through increasing $E1$'s development probability whenever approving all acquisitions is optimal under coarse merger policy. The conditions under which this holds have been are discussed in Proposition 5.

OC: Extensions

In this section, we provides the full derivation of the extensions results for Section 5 of the main text, alongside additional discussion and comments.

OC1: Entry-for-buyout

Here, we further elaborate upon the impact of acquisitions in the environment where (i) $E1$'s project type is fixed, and (ii) $E2$ chooses between project types (I still only decides whether to acquire $E2$). Our analysis is split into two components: (i) deriving equilibrium behaviour by firms, and (ii) analysis of consumer welfare under a specific parameter range. As noted in the main text, our analysis incorporates the case $K > K_D^I$ (which is not discussed in the main text).

OC1a: Equilibrium Analysis

As noted in the main text, when acquisitions are banned, that the game plays out identically to that discussed in the main text, swapping the roles of $E1$ and $E2$. Hence, we derive the equilibrium when acquisitions are allowed below, where the steps mirror that in Section 3.

Stage 3B. Fix any $x \in [0,1]$ ($x > 0$ implies I acquired a type-x project). Suppose that acquisition occurs. If $E1$ had failed prior, then I develops if and only if

$$K \leq p(x\pi_X(x) + (1-x)(\pi_M - \pi_m)) := K_M^I(x).$$

If $E1$ had succeeded prior, then I innovates if and only if

$$p(x\pi_X(x) + (1-x)\pi_D^I) := K_D^I(x) \geq K.$$

Stage 3A. If I holds a type-x project and develops in response to successful development of a superior primary product by $E1$, then $E1$ develops if and only if

$$p((1-x)p\pi_E^D + (1-(1-x)p)\pi_M) := \overline{K}_D^{E1}(x) \geq K,$$

which is increasing in x, where we note that $\overline{K}_D^{E1}(0) = K_D^{E1}(0)$. Meanwhile, if I does not develop the project that it holds, then $E1$ always develops as its profit from doing so is $p\pi_M - K > 0$.

Stage 2. I's expected profit without an acquisition is $[p(1-p)x + (1-p)^2]\pi_m$, while $E2$'s reservation value without an acquisition is $p(x\pi_X(x) + (1-x)\Pi) - K$. Acquisitions occur so long as I's gain from acquisitions weakly exceeds $E2$'s reservation value.

Case 1: Suppose $K_M^I(0) \geq K$. Both I and $E1$ always develop their projects. I's expected profit from acquisitions is

$$p(x(\pi_X(x) + (1-p)\pi_m) + (1-x)(p\pi_D^I + (1-p)\pi_M)) + (1-p)^2\pi_m - K.$$

Thus, I's gain from acquisitions is

$$p(x\pi_X(x) + (1-x)(p\pi_D^I + (1-p)\pi_M)) - K \geq p(x\pi_X(x) + (1-x)(p\pi_D + (1-p)\pi_M)) - K,$$

the latter of which is $E2$'s reservation value. Hence, an acquisition always occurs.

Case 2: Suppose $K_M^I(0) \leq \min\{\overline{K}_D^{E1}(0), K_D^I(0)\}$. I always develops in response to $E1$'s successful development of a superior primary product, but develops whenever $E1$ is unsuccessful if and only if $K_M^I(x) \geq K$. Then the analysis mirrors case 1, under which an acquisition occurs, whenever $K_M^I(x) \geq K$. If $K_M^I(x) < K$, I's profit is

$$p[p(x\pi_X(x) + (1-x)\pi_D^I) - K] + (1-p)\pi_m,$$

which implies that I's gain is given by

$$p[p(x\pi_X(x) + (1-x)\pi_D^I) - K] + p(1-p)(1-x)\pi_m.$$

Hence, the difference in profits for I is given by

$$\begin{aligned}-px(1-p)\pi_X(x) + p^2(1-x)(\pi_D^I - \pi_D) - p(1-x)(1-p)\pi_M + p(1-x)(1-p)\pi_m + (1-p)K \\ = (1-p)(K - p(x\pi_X(x) + (1-x)(\pi_M - \pi_m))) + p^2(1-x)(\pi_D^I - \pi_D) \geq 0.\end{aligned}$$

Therefore, an acquisition occurs.

Case 3: $\overline{K}_D^{E1}(0) < K \leq K_D^I(0)$. In this case, there are two possibilities. We first consider $\overline{K}_D^{E1}(x) \geq K$. I's gain from acquisitions then is $p(K_D^I(x) - K) + (1-p)\pi_m - (1-p(1-x))(1-p)\pi_m$. Hence, acquisitions occur if and only if

$$\begin{aligned} p(1-x)(\pi_D^I - \Pi) + p(1-x)(1-p)\pi_m + (1-p)K \geq 0 \\ \iff p(1-x)(\pi_D^I - \pi_D) + (1-p)(K - (1-x)K_M^I) \geq 0\end{aligned}$$

The last line holds as $K > K_D^{E1}(0) > K_M^I$.

We now consider $\overline{K}_D^{E1}(x) < K$. I's gain from acquisitions is now $\pi_m - (1 - p(1 -$

$x))(1-p)\pi_m = p(1+(1-x)(1-p))\pi_m$. Thus, acquisitions occur if and only if

$$p(1+(1-x)(1-p))\pi_m \geq p(x\pi_X + (1-x)\Pi) - K.$$

This is true as $p(1+(1-x)(1-p))\pi_m$ under Assumption 2, and so

$$p(x\pi_X(x) + (1-x)\Pi) - K \leq p\Pi - p(p\pi_D^E + (1-p)\pi_M) = p^2(\pi_D - \pi_D^E) < p^2(\pi_M - \pi_D^E).$$

Case 4: $K > K_D^I(0)$, which implies $\pi_X > \pi_D^I$ and so $K_D^I(x)$ is increasing in x. Here, we have two cases to consider: $K_D^I(x) < K$ or $K_D^I(x) \geq K$. If the latter case holds, then one is back in Case 3 where an acquisition occurs. Thus, suppose $K_D^I(x) < K$. Here, I's profit from acquisitions is $(1-p)\pi_m$, which implies that I's gain from acquisitions is $(1-p)p(1-x)\pi_m$. Hence, I's gain, less $E2$'s reservation value, is given by

$$\begin{aligned}
&K + (1-p)p(1-x)\pi_m - p(x\pi_X + (1-x)\Pi) \\
&\geq p(1-x)\pi_D^I + (1-p)p(1-x)\pi_m - p(1-x)\Pi \\
&= p(1-x)(p[\pi_D^I - \pi_D] + (1-p)(\pi_D^I + \pi_m - \pi_M)) \geq 0
\end{aligned}$$

And so, an acquisition occurs.

Stage 1. We move on to $E2$'s project choice. Since acquisitions always occur in stage 2, $E2$ compares its gain from acquisition from choosing either project type, each of which are equivalent to I's (positive) gain from acquisition.

Case 1: Suppose $K_M^I(0) \geq K$. Choosing the type-0 project yields an expected gain of $p(p\pi_D^I + (1-p)\pi_M) - K$. Meanwhile, choosing a type-X project yields an expected gain of $p(\int_0^1 [x\pi_X(x) + (1-x)(p\pi_D^I + (1-p)\pi_M)])dF(x) - K$. Hence, $E2$ chooses a type-0 project if and only if

$$\int_0^1 x[p\pi_D^I + (1-p)\pi_M - \pi_X(x)]dF(x) = \int_0^1 x[\Pi - \pi_X(x) + \underbrace{p(\pi_D^I - \pi_D)}_{\geq 0}]dF(x) \geq 0.$$

Case 2: $K_M^I(0) \leq \min\{\overline{K}_D^{E1}(0), K_D^I(0)\}$. Choosing the type-0 project yields an expected gain of $p(p\pi_D^I - K) + p(1-p)\pi_m$. Meanwhile, since $p\pi_X(x) \geq K > K_M^I(0)$, $\pi_X(x) > \pi_M - \pi_m$ for all x, and so $K_M^I(x)$ is strictly increasing in x. Hence, I develops unconditionally for high enough x, and only develops in response to $E1$'s successful development for low x. The expected gain from choosing the type-X project is

$$\int_0^1 [p(p(x\pi_X(x) + (1-x)\pi_D^I) - K) + (1-p)\max\{p(1-x)\pi_m, p(x\pi_X(x) + (1-x)\pi_M) - K\}]dF(x).$$

Hence, $E2$ chooses the type-0 project if and only if

$$p^2 \int_0^1 x(\pi_D^I - \pi_X(x))dF(x) + (1-p)\int_0^1 (\max\{-px\pi_m, p(x\pi_X(x) + (1-x)\pi_M - \pi_m) - K\})dF(x) \geq 0.$$

Case 3: Suppose $\overline{K}_D^{E1}(0) < K \leq K_D^I(0)$. Choosing a type-0 project yields an expected gain of $p(1+(1-x)(1-p))\pi_m$. Meanwhile, choosing a type-X project yields the same expected gain for low x, i.e., such that $E1$ is still completely deterred from developing knowing I will develop in response, and an expected gain of $p(p(x\pi_X(x) + (1-x)\pi_D^I) - K) + (1-p)p(1-x)\pi_m$ when x is high, i.e., $E1$ develops knowing I will develop in response. We further note that

$$\begin{aligned}
&p(1+(1-x)(1-p))\pi_m - [p(p(x\pi_X(x) + (1-x)\pi_D^I) - K) + (1-p)p(1-x)\pi_m] \\
&= p(K + \pi_m - p(x\pi_X(x) + (1-x)\pi_D^I)) \\
&\geq p(K + \pi_m - p\pi_M) = p(K - p(\pi_M - \pi_m) + (1-p)\pi_m) \geq 0,
\end{aligned}$$

since $K > \pi_M^I(0)$. Hence, the type-0 project is always (at least weakly) better for $E2$ than the type-X project, and so $E2$ always chooses the type-0 project.

Case 4: $K > K_D^I(0)$. Choosing the type-0 project yields a gain of $p(1-p)\pi_m$. Meanwhile, choosing the type-X project yields a gain of $p(1-p)(1-x)\pi_m$ when x is low, and either $p(1+(1-x)(1-p))\pi_m$ (if $\overline{K}_D^{E1}(x) < K$) or $p(p(x\pi_X + (1-x)\pi_D^I) - K) + (1-p)p(1-x)\pi_m$ (if $\overline{K}_D^{E1}(x) \geq K$) when x is high, both of which will be weakly greater than $p(1-p)(1-x)\pi_m$ (for that range of x). Hence, let x^{E1} and x^I be the smallest values of $x \in [0,1]$ such that $p(p(1-x^{E1})\pi_D^E + (1-(1-x^{E1})p)\pi_M) \geq K$ and $p(x^I\pi_X + (1-x^I)\pi_D^I) \geq K$ respectively. Then, $E2$ chooses $t_{E2} = 0$ if either of the following conditions holds:

$$1)\ x^{E1} \geq x^I: \quad \int_0^{x^I} xp(1-p)\pi_m dF(x) - \int_{x^I}^{x^{E1}} p(1-x+xp)\pi_m dF(x)$$

$$- \int_{x^{E1}}^{1} (p(p(x\pi_X + (1-x)\pi_D^I) - K) - xp(1-p)\pi_m) dF(x) \geq 0$$

$$2)\ x^I \geq x^{E1}: \quad \int_0^{x^I} xp(1-p)\pi_m dF(x)$$

$$- \int_{x^I}^{1} (p(p(x\pi_X + (1-x)\pi_D^I) - K) - xp(1-p)\pi_m) dF(x) \geq 0$$

and chooses $t_{E2} = X$ otherwise.

Remark Since the intuition behind Cases 1-3 have been covered in the corresponding section on entry-for-buyout in the main text, we briefly discuss Case 4 here, i.e., $K > K_D^I(0)$. Notably, $E2$ faces a trade-off between choosing the type-0 project, and the type-X project. Akin to the entry-for-buyout effect, the type-0 project reduces I's no-acquisition profit by more than the type-X project. Hence, for the values of x under which I does not develop the acquired project post-acquisitions, i.e., for $x < x^I$, choosing the type-0 project is more preferred. However, choosing the type-0 project implies that I never counter-develops against $E1$ if the latter successfully develops a type-0 product. Meanwhile, I is able to develop profitably if it acquires a type-X project and obtains a sufficiently high value of x. Hence, for large values of x, the type-X project is preferred over the type-0 project. The net of these two effects thus determines which of the two projects $E2$ chooses.

OC1b: Consumer Welfare Analysis

As noted in the main text, we focus on the case where $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (X, 0)$ (when $K \leq \min\{K_D^{E1}(0), K_D^I\}$), and when $(t^{\mathrm{b}}, t^{\mathrm{a}}) \in \{(X,0),(0,0)\}$ (when $K_D^{E1}(0) < K \leq K_D^I$).

Case 1: Suppose $K \leq K_M^I$. Then, when $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (X, 0)$, the change in consumer welfare, given that K lies within this range, is given by

$$\mathcal{W}(K,(X,0)) = p\delta - \int_0^1 (V_X(x)x(p^2 + (1-p)p) - xV_0p(1-p) - xp^2\epsilon)dF(x)$$

Thus, $\mathcal{W}(K,(X,0)) \geq 0$ if and only if the efficiency benefit is sufficiently large, i.e., $\delta \geq \delta(K,(X,0))$, where

$$\delta(K,(X,0)) := \frac{1}{p}\bigg(\int_0^1 (pV_X(x)x - xV_0p(1-p) - xp^2\epsilon)dF(x)\bigg) = -\delta(K,(0,X))$$

Where the last inequality comes from the definition of $\delta(K,(0,X))$ provided in Appendix B1 (when $K \leq K_M^I$). That is, when development costs are sufficiently low, acquisitions increase consumer welfare whenever development in market 0 is preferred over market X, i.e., whether $\delta(K,(0,X)) \geq 0$ holds, or, if not, when the efficiency gain is large.

Case 2: Suppose $K_M^I < K \leq \min\{K_D^{E1}(0), K_D^I\}$. Then, when $(t^{\mathrm{b}}, t^{\mathrm{a}}) = (X, 0)$, the change in consumer welfare given K within this range is

$$\mathcal{W}(K,(X,0)) = p^2\delta + \int_0^1 p[px\epsilon - (1-p)(1-x)V_0 - pV_X(x)x]dF(x)$$

Thus, $\mathcal{W}(K,(X,0)) \geq 0$ if and only if $\delta \geq \delta(K,(X,0))$, where

$$\begin{aligned}\delta(K,(X,0)) &:= \frac{\Big(\int_0^1 (V_X(x)x + (1+px-p-x)V_0 - xp\epsilon)dF(x)\Big)}{p} \\ &= -[\int_0^1 (1-x)dF(x)]\delta(K,(0,X)) - \frac{V_0\int_0^1 x(2-p)dF(x)}{p}\end{aligned}$$

That is, when development costs are sufficiently low, acquisitions increase consumer welfare whenever development in market 0 is preferred over market X, i.e., whether $\delta(K,(X,0)) \geq 0$, or if not, when the efficiency gain is large.

Case 3: Suppose $K_D^{E1}(0) < K \leq K_D^I$. We note that $CW^{\text{a}}(0, K) = 0$ for any K within this range. Hence, the change is consumer welfare is given by $-\int_0^1 CW^{\text{b}}(x)dF(x) < 0$ (when $t^{\text{b}} = X$), or $CW^{\text{b}}(0)$ (when $t^{\text{b}} = 0$). Either way, $\mathcal{W}(K, (t^{\text{b}}, t^{\text{a}})) < 0$.

OC2: Alternative Counterfactuals

We assume $p\Pi - K < 0$ holds, which implies $K_D^{E1}(0) < K$ throughout.

Preliminary remark: We first note of the possibility for multiple equilibria in the no-acquisition subgame. To see this, fix $x \in [0, 1]$, and recall that $E1$'s profit is $K_D(x) := p(x\pi_X(x) + (1-x)\Pi)$, where we note that since $p\pi_X(x) \geq K > p\Pi$, $K_D'(x) > 0$ for all $x \in [0, 1]$. Thus, there exists a unique $\underline{x}(K)$ such that for all $x \geq \underline{x}(K)$, $E1$ optimally chooses to enter, provided $E2$ is doing the same, while for all $x < \underline{x}(K)$, the opposite holds. This implies the following:

- For all $x \geq \underline{x}(K)$, there exists a SPNE under which both $E1$ and $E2$ enter in stage 3.
- For all $x < \underline{x}(K)$, there exists a SPNE under which only one of the two firms enter in stage 3.[1]

Evidently, the project choice of $E1$ and the reservation value of $E2$ both depend on the choice of continuation equilibria in stage 3 for all $x < \underline{x}(K)$, both with and without acquisitions, of which there is a continuum of possibilities. As discussed in the main text, we focus on the most-adversarial SPNE where, if $x < \underline{x}(K)$, the benchmark is $E1$ never entering in stage 3.

OC2a: Equilibrium analysis: Adversarial Selection

Benchmark case: no acquisitions First, consider when acquisitions are banned. Choosing the type-0 project yields 0 as we select the equilibrium under which $E2$ enters. Meanwhile, choosing the type-X project yields $\int_{\underline{x}(K)}^1 (K_D(x) - K)dF(x) \geq 0$. Thus, $E1$ always chooses the type-X project in the benchmark. Additionally, $E2$ always develops its project, while $E1$ develops if and only if $x \geq \underline{x}(K)$.

[1] There also exists an SPNE under which both $E1$ and $E2$ randomize over entering and not entering in stage 3. For expositional simplicity, we focus on pure-strategy SPNE.

Acquisitions allowed Consider when acquisitions are not banned. We know that in equilibrium, fixing $E1$'s project choice, Stage 3 plays out in the same way described in Lemma 1 of the main text. From here, stages 1 and 2 play out depending on whether $K > K_D^I$ holds. We detail both possibilities below

Case 1: $K \leq K_D^I$. We recall from Lemma 2 that if $x \geq \underline{x}(K)$ such that both $E1$ and $E2$ enter, I acquires $E2$. Thus, suppose that $x < \underline{x}(K)$. If so, $E2$'s reservation value is now $p\pi_M - K$. Meanwhile, I's gain is given by $p\pi_m > p\pi_M - K$, since $K > p\Pi > p(\pi_M - \pi_m)$. Hence, an acquisition occurs. From here, it is immediate, following Proposition 2 of the main text, that $E1$ chooses the type-X project.

Case 2: $K > K_D^I$. Again, by Lemma 2, if $x \geq \underline{x}(K)$ such that both $E1$ and $E2$ enter, I acquires $E2$. Thus, suppose that $x < \underline{x}(K)$. I's gain is given by $(1 - p(1 - x))\pi_m - (1-p)\pi_m = xp\pi_m$, while $E2$'s reservation value is $p\pi_M - K$. hence, acquisitions occur only when $xp\pi_m - p\pi_M + K \geq 0$, which is strictly increasing in x. Thus, for all $x \in [0, \min\{\underline{x}(K), \frac{p\pi_M - K}{p\pi_m}\}]$, where $\min\{\underline{x}(K), \frac{p\pi_M - K}{p\pi_m}\} > 0$, no acquisitions occur. Noting that when no acquisitions occur, $E1$'s profit is zero, it is immediate that $E1$ now always chooses the type-X project.

Remark Observe that in both cases, acquisitions have a smaller impact on the equilibrium outcome, as compared to the main text. First, acquisitions do not distort $E1$'s project choice. $E1$ always chooses the type-X project with and without acquisitions, the former to avoid direct competition with $E2$, while the latter to avoid competition with I (when $K_D^I \geq K$), or to induce I into acquiring $E2$ to allow $E1$ to enter (when $K_D^I < K$). Additionally, in case 1, the equilibrium outcome plays out identically to that in the main-text, and so any differences between the case of $p\Pi - K \geq 0$ and $p\Pi - K < 0$ lies with the difference in the development probabilities between the acquisition- and no-acquisition subgames. Noting that the probability of $E1$ developing drops when $p\Pi - K < 0$ in comparison to $p\Pi - K \geq 0$, this difference is hence smaller in the former case when acquisitions are allowed.

OC2b: Consumer Welfare Analysis: Adversarial Selection

We now study the impact of acquisitions on consumer welfare in this environment, once again assuming that the incumbent-adversarial equilibrium is selected in the no-acquisition subgame.

Let $\widehat{CW}^b(x, K)$ and $\widehat{CW}^a(x, K)$ denote the consumer welfare values without and with acquisitions given realization $x \in [0, 1]$ and development cost K. Notice that even when acquisitions are banned, consumer welfare is now dependent on K; this is as K determines the threshold $\underline{x}(K)$ discussed previously. As with Section 4 in the main text, let $\widehat{\mathcal{W}}(K, (t^b, t^a))$ denote the gain in consumer welfare when project type $t^a \in \{0, X\}$ is chosen when acquisitions are allowed, over that when $t^b \in \{0, X\}$ is chosen and acquisitions are banned, given development cost K.

Before proceeding, it is worth noting that $\underline{x}(K) \leq \overline{x}(K)$, where the latter is the threshold value of x such that, anticipating counter-development by I who has acquired $E2$, $E1$ develops if and only if $x > \overline{x}(K)$. Put differently, $E1$ develops over a wider range of x anticipating competition from $E2$ over that from I. To see this, $\underline{x}(K)$ solves $p(\underline{x}(K)\pi_X(\underline{x}(K)) + (1-\underline{x}(K))\Pi) = K$, while $\overline{x}(K)$ solves $K_D^{E1}(\overline{x}(K)) = K$. The claim then follows from (i) $K_D^{E1}(x) \leq p(x\pi_X(x) + (1-x)\Pi)$ holds for all x whenever $p\Pi - K < 0$, and (ii) both terms are decreasing in x.

Consumer welfare derivations We begin with the no-acquisition subgame. Suppose that for $x < \underline{x}(K)$, $E2$ develops while $E1$ does not. If $x \geq \underline{x}(K)$, then both entrants develop, and so $\widehat{CW}^b(x, K) = CW^b(x)$, where $CW^b(x)$ is defined in Appendix B1. Meanwhile, if $x < \underline{x}(K)$, then only $E2$ develops, which yields consumer welfare of pV_0. Thus, we have

$$\widehat{CW}^b(x, K) = \begin{cases} \begin{array}{c} V_X(x)x(p^2 + p(1-p)) + p^2(1-x)\epsilon \\ +V_0(p^2 + p(1-p)(2-x)) \end{array}, & x \geq \underline{x}(K) \\ pV_0, & x < \underline{x}(K) \end{cases}$$

Now, consider the case where acquistions are allowed. We consider either parameter range separately.

Case 1: First, suppose $K \leq K_D^I$. By the analysis in Section OC2a, acquisitions always occur. Consequently, following Appendix B1, we have

$$\widehat{CW}^a(x,K) = \begin{cases} pxV_X(x) + p(1-x)V_0 + p^2(1-x)(\delta+\epsilon), & K \le K_D^{E1}(x) \\ 0, & K_D^{E1}(x) < K \end{cases}$$

Case 2: Next, suppose $K > K_D^I$. By the analysis in Section OC2a, acquisitions occur whenever $x \ge \min\{\underline{x}(K), \frac{p\pi_M - K}{p\pi_m}\}$. There, we have $\widehat{CW}^a(x,K) = p(1-x)V_0 + xpV_X(x)$. Meanwhile, when $x < \min\{\underline{x}(K), \frac{p\pi_M - K}{p\pi_m}\}$, no acquisitions occur. There, we have $\widehat{CW}^a(x,K) = \widehat{CW}^b(x,K)$

Consumer welfare analysis We break down the comparison of consumer welfare with and without acquisitions into several cases.

Case 1: First, suppose $K \le K_D^I$. Here, $(t^a, t^b) = (X, X)$. Then

$$\begin{aligned} \widehat{\mathcal{W}}(K,(X,X)) = &- \int_0^{\underline{x}(K)} pV_0 dF(x) \\ &- \int_{\underline{x}(K)}^{\overline{x}(K)} \Big(V_X(x)x(p^2 + p(1-p)) + p^2(1-x)\epsilon + V_0(p^2 + p(1-p)(2-x)) \Big) dF(x) \\ &+ \int_{\overline{x}(K)}^{1} \Big((p^2(1-x)\delta - V_0 p(1 - p(1-x))) \Big) dF(x) \end{aligned} \tag{4}$$

Observe that equation (4) bears strong similarity to the change in consumer welfare $\mathcal{W}(K,(X,X))$ when $K_D^{E1}(0) < K \le K_D^I$ in the main text (see Appendix B1). The main difference is that for $x \in [0, \underline{x}(K)]$, the loss in consumer welfare from acquisitions has fallen from $V_X(x)x(p^2 + p(1-p)) + p^2(1-x)\epsilon + V_0(p^2 + p(1-p)(2-x))$ to $p(xV_X(x) + (1-x)V_0)$. This follows from the fact that consumer welfare is now lower when acquisitions are banned, as $E1$ does not develop for small enough x.

Case 2: Next, suppose $K > K_D^I$. Here, $(t^a, t^b) = (X, X)$. For $x < \min\{\underline{x}(K), \frac{p\pi_M - K}{p\pi_m}\}$, acquisitions do not occur, and so the change in consumer welfare is zero. For $\frac{p\pi_M - K}{p\pi_m} \le x < \underline{x}(K)$ (when $\frac{p\pi_M - K}{p\pi_m} \le \underline{x}(K)$) , only $E1$ develops with and without acquisitions. Thus, the change in consumer welfare is zero. Finally, for $x \ge \underline{x}(K)$, both $E1$ and $E2$ develop without acquisitions, while only $E1$ develops with acquisitions.

Discussion As in the main text, the change in consumer welfare when $K < K_D^I$ is negative. There are, however, two key differences. First, since $E1$ always chooses the type-X project with or without acquisitions here, any loss in consumer welfare here is associated with the loss in probability of $E2$ developing the type-0 project. The converse holds in the main text. There, since (i) $E1$ always chooses and develops the type-0 project with acquisitions, and (ii) $E2$ always develops without acquisitions, any loss in consumer welfare there is associated with the loss in probability of $E1$ either developing the type-0 or ype-X project. Second, the loss in consumer welfare is relatively smaller, where it only occurs for large enough x. In the main-text when $E1$ chooses the type-X project without acquisitions, there is a loss in consumer welfare regardless of the realization of x.

OC3: Simultaneous development

We now consider a version of our game under which both I and $E1$ make their development decisions at the same time post acquisition. That is, both I and $E1$ develop simultaneously in stage 3. To simplify exposition, we assume throughout that $\pi_X(x) = \pi_X$ is constant.

Summary The equilibrium outcome can be summarized below:

Remark 3. *Suppose I and $E1$ make their development decisions simultaneously in stage 3. Then, the equilibrium outcome of our game is as follows:*

1. *When $K_M^I \geq K$, then $E1$ chooses the type-0 project if and only if*

$$\int_0^1 x\left[\Pi - \pi_X + p(\pi_D^E - \pi_D)\right]dF(x) \geq 0$$

   And chooses the type-X project otherwise. I acquires $E2$, and both I and $E1$ always pursue development with probability one.

2. *When $K_M^I < K \leq \min\{K_D^{E1}(0), pK_D^I + (1-p)K_M^I\}$, $E1$ chooses the type-*0 *project*

if and only if

$$\int_0^{\overline{x}(K)} x\left[\Pi - \pi_X + p(\pi_D^E - \pi_D)\right]dF(x) + \int_{\overline{x}(K)}^1 \left[\Pi - (x\pi_X + (1-x)\pi_M)\right]dF(x) \tag{5}$$

Where $\overline{x}(K) := \frac{p(p\pi_D^I + (1-p)(\pi_M - \pi_m)) - K}{p^2(\pi_D^I - (\pi_M - \pi_m))} \in (0,1)$ *is decreasing in* K *and converges to* 1 *as* $K \to K_M^I$*, and chooses the type-X project otherwise.* I *acquires* $E2$*.* $E1$ *develops with probability one.* I *develops with probability one if and only if* $x \leq \overline{x}(K)$*, and does not develop otherwise.*

3. *When* $K_D^{E1}(0) < K \leq pK_D^I + (1-p)K_M^I$*,* $E1$ *always chooses the type-X project. Furthermore,*

   - *When* $x \leq \min\{\underline{x}(K), \overline{x}(K)\}$*,* I *and* $E1$ *develop with probabilities* q_I^* *and* q_{E1}^* *respectively, where*

     $$q_{E1}^* = \frac{K - p(\pi_M - \pi_m)}{p^2(1-x)[\pi_D^I - (\pi_M - \pi_m)]}, \quad q_I^* = \frac{p(x\pi_X + (1-x)\pi_M) - K}{p^2(1-x)(\pi_M - \pi_D^E)}$$

     and $\underline{x}(K) := \frac{K - p(p\pi_D^E + (1-p)\pi_M)}{p(\pi_X - (p\pi_D^E + (1-p)\pi_M))} \in [0,1)$.
   - *When* $\underline{x}(K) < x \leq \overline{x}(K)$*, both* I *and* $E1$ *always pursue development with probability one*
   - *When* $x > \overline{x}(K)$*,* $E1$ *develops with probability one while* I *does not develop.*

4. *When* $K > pK_D^I + (1-p)K_M^I$*,* $E1$ *always chooses the type-0 project.* I *acquires* $E2$*.* $E1$ *develops with probability one while* I *does not develop.*

Derivations We now provide the details for Remark 3, noting that the no-acquisition subgame remains unchanged.

Stage 3: Suppose I and $E1$ develop with probabilities q_I and q_{E1} respectively. Then, players' payoffs are given by

$$\text{I's payoff:} \quad q_I\Big(q_{E1}[p^2(1-x)\pi_D^I + (1-p(1-x))(p\pi_M + (1-p)\pi_m)] + (1-q_{E1})[p\pi_M + (1-p)\pi_m] - K\Big)$$
$$+ (1-q_I)\Big(q_{E1}[(1-p(1-x))\pi_m)] + (1-q_{E1})[\pi_m]\Big)$$
$$\text{E1's payoff:} \quad q_{E1}\Big(q_I[p(x\pi_X + (1-x)(p\pi_D^E + (1-p)\pi_M))] + (1-q_I)[p(x\pi_X + (1-x)\pi_M)] - K\Big)$$

Hence, fix $q_{E1} \in [0,1]$. I develops iff

$$q_{E1}\Big[p^2(1-x)\pi_D^I + p(1-p(1-x))(\pi_M - \pi_m)\Big] + (1-q_{E1})\Big[p(\pi_M - \pi_m)\Big] \geq K$$

Which is linearly increasing in q_{E1}. Meanwhile, fix $q_I \in [0,1]$. I develops iff

$$q_I[p(x\pi_x + (1-x)(p\pi_D^E + (1-p)\pi_M))] + (1-q_I)[p(x\pi_X + (1-x)\pi_M)] \geq K$$

Which is linearly decreasing in q_I. Hence, we have three equilibrium possibilities:

- **Case 1:** $(q_I^*, q_{E1}^*) = (1,1)$. This requires

  $$K \leq \min\{p(x\pi_X + (1-x)(p\pi_D^E + (1-p)\pi_M)), p(p(1-x)\pi_D^I + (1-p(1-x))(\pi_M - \pi_m))\}$$

- **Case 2:** $(q_I^*, q_{E1}^*) \in int([0,1]^2)$. This requires

  $$p(x\pi_x + (1-x)(p\pi_D^E + (1-p)\pi_M)) < K \leq p(p(1-x)\pi_D^I + (1-p(1-x))(\pi_M - \pi_m))$$

  Here, one can verify that

  $$q_{E1}^* = \frac{K - p(\pi_M - \pi_m)}{p^2(1-x)[\pi_D^I - (\pi_M - \pi_m)]}, \quad q_I^* = \frac{p(x\pi_X + (1-x)\pi_M) - K}{p^2(1-x)(\pi_M - \pi_D^E)}$$

  We note that here, $E1$ obtains a profit of zero, while I obtains a profit of $(1 - pq_E^*)\pi_m$: this is both players are indifferent between developing and not developing.

- **Case 3:** $(q_I^*, q_{E1}^*) = (0, 1)$. This requires $q_{E1}^* > 1$, i.e.,

$$K > p(p(1-x)\pi_D^I + (1-p(1-x))(\pi_M - \pi_m))$$

Stage 2 We now prove that I always acquires $E2$:

- First, suppose $K \leq \min\{p(x\pi_X + (1-x)(p\pi_D^E + (1-p)\pi_M)), p(p(1-x)\pi_D^I + (1-p(1-x))(\pi_M - \pi_m))\}$. I's gain from acquisition is

$$\begin{aligned} p^2(1-x)\pi_D^I + (1-p(1-x))(p\pi_M + (1-p)\pi_m) - K - (1-p)(1-p(1-x))\pi_m \\ = p(p(1-x)\pi_D^I + (1-p(1-x))\pi_M) - K \end{aligned}$$

  This is clearly highly than $E2$'s profit, which is $p(p(1-x)\pi_D + (1-p(1-x)\pi_M)) - K$. Thus, acquisition always occurs.

- Next, we consider when $p(p(1-x)\pi_D^I + (1-p(1-x))(\pi_M - \pi_m)) < K$. Here, I's gain is equivalent to $p(1-p(1-x))\pi_m$, while $E2$'s profit remains intact. From here, we note

$$\begin{aligned} &p(1-p(1-x))\pi_m - (p(p(1-x)\pi_D + (1-p(1-x)\pi_M)) - K) \\ &= K - p(p(1-x)\pi_D + (1-p(1-x))(\pi_M - \pi_m)) \\ &> K - p(p(1-x)\pi_D^I + (1-p(1-x))(\pi_M - \pi_m)) > 0 \end{aligned}$$

  Hence, acquisition always occurs.

- Finally, suppose

$$p(x\pi_x + (1-x)(p\pi_D^E + (1-p)\pi_M)) < K \leq p(p(1-x)\pi_D^I + (1-p(1-x))(\pi_M - \pi_m))$$

  First, I's profit must be equivalent to $(1 - q_{E1}^* p(1-x))\pi_m$: this is as I must be indifferent between developing and not developing, and his profit under the latter is precisely this value. Hence, I's gain is given by

$$[(1 - q_{E1}^* p(1-x)) - (1-p)(1-p(1-x))]\pi_m = p(1-(1-x)(p + q_{E1}^* - 1))\pi_m$$

Hence, the difference in I's gain and $E2$'s reservation value is

$$G(K) = p(1 - (1 - x)(q^*_{E1} + [1 - p]))\pi_m - p(x\pi_X + (1 - x)\Pi) + K$$

Observe that $G(K)$ is decreasing in K. This is as

$$G'(K) = 1 - \frac{\pi_m}{p(\pi^I_D - (\pi_M - \pi_m))} = \frac{-\pi_m(1 - p) + p(\pi^I_D - \pi_M)}{p(\pi^I_D - (\pi_M - \pi_m))} < 0$$

Hence, let K be equal to its upper bound, which implies $q^*_{E1} = 1$. Note that if $G(K) \geq 0$ holds at the upper bound of K, then it holds for all K within this particular range. Observe then that at the upper bound $K = p(p(1 - x)\pi^I_D + (1 - p(1 - x))(\pi_M - \pi_m))$

$$\begin{aligned} G(K) &= p(1 - p(1 - x))\pi_m - p(x\pi_X + (1 - x)\Pi) + p^2(1 - x)\pi^I_D + p(1 - p(1 - x))(\pi_M - \pi_m) \\ &= p^2(1 - x)(\pi^I_D - \pi_D) + px(\pi_M - \pi_X) > 0 \end{aligned}$$

Thus, acquisitions always occur.

Stage 1 As I always acquires $E2$, we need only focus on the post-acquisition equilibrium in stage 3 when considering $E1$'s project choice. As in the main text, we have four (albeit slightly different) parameter ranges to consider

- **Case 1:** $K^I_M = p(\pi_M - \pi_m) \geq K$. Here, I and $E1$ always pursue development for all $x \in [0, 1]$. Hence, the equilibrium outcome remains identical to that in the main text: $E1$ chooses the type-0 project if and only if

$$\int_0^1 x \left[\Pi - \pi_X + p(\pi^E_D - \pi_D) \right] dF(x) \geq 0$$

  And chooses the type-X project otherwise. I acquires $E2$, and both I and $E1$ always pursue development

- **Case 2:** $K^I_M < K \leq p \min\{p\pi^E_D + (1 - p)\pi_M, p\pi^I_D + (1 - p)(\pi_M - \pi_m)\} =$

$\min\{K_D^{E1}(0), pK_D^I + (1-p)K_M^I\}$. Here, there exists a unique $\overline{x}(K)$,

$$\overline{x}(K) := \frac{p(p\pi_D^I + (1-p)(\pi_M - \pi_m)) - K}{p^2(\pi_D^I - (\pi_M - \pi_m))}$$

Which is decreasing in K, such that for all $x > \overline{x}(K)$, I acquires $E2$, $E1$ develops, and I does not develop regardless of the outcome of $E1$'s development. Meanwhile, for all $x \leq \overline{x}(K)$, I acquires $E2$ and both I and $E1$ pursue development. Thus, $E1$ chooses the type-0 project if and only if

$$\int_0^{\overline{x}(K)} x\Big[\Pi - \pi_X + p(\pi_D^E - \pi_D)\Big]dF(x) + \int_{\overline{x}(K)}^1 \Big[\Pi - (x\pi_X + (1-x)\pi_M)\Big]dF(x)$$

Observe that this is a more difficult condition to satisfy than normal, i.e., with simultaneous development costs, it is easier to convince $E1$ to choose the type-X project, to weaken I's development incentive.

- **Case 3:** $K_D^{E1}(0) < K \leq pK_D^I + (1-p)K_M^I$. Here, there exists a unique

$$\underline{x}(K) := \frac{K - p(p\pi_D^E + (1-p)\pi_M)}{p(\pi_X - (p\pi_D^E + (1-p)\pi_M))}$$

Such that I always acquires $E2$ and (i) for all $x < \min\{\underline{x}(K), \overline{x}(K)\}$, I and $E1$ develop with probabilities q_I^* and q_{E1}^* (such that $E1$ obtains a profit of zero), (ii) for all $\underline{x}(K) < K \leq \overline{x}(K)$, both I and $E1$ always pursue development, (iii) for all $K > \overline{x}(K)$, $E1$ develops and I does not develop regardless of the outcome of $E1$'s development. Noting that, if $E1$ chooses the type-0 project, $E1$ always obtains a profit of zero, $E1$ always chooses the type-X project.

- Finally, suppose $K > pK_D^I + (1-p)K_M^I$. Here, I never develops regardless of the realization of x. $E1$ always chooses the type-0 project as the difference between choosing type-0 and the type-X is

$$p\pi_M - \int_0^1 (x\pi_X + (1-x)\pi_M)dF(x) > 0$$

Combined, these prove Remark 3. □

OD: Non-Drastic Innovation

In the main text, we assume the innovation in the primary market is drastic in the sense that a successful innovation will completely replace the existing technology. Consequently, the incumbent has a strong incentive to acquire $E2$ not only to directly suppress competition, but also to deter entry by $E1$.

In this section, we investigate the implications of relaxing this assumption. More precisely, we assume that the profit of the incumbent if $y \in \{1, 2\}$ number of start-ups successfully develop a superior primary product is $\lambda_y \pi_m$, where $0 \leq \lambda_2 < \lambda_1 < 1$. Our baseline model corresponds to the case with $\lambda_1 = \lambda_2 = 0$. To streamline the analysis, we make the following assumption.

Assumption 1. $\min\{\pi_D^I + \pi_m - \pi_M, p(\pi_D^I - \pi_D)\} \geq \lambda_1 \pi_m$

Assumption 1 can be interpreted as follows. First, $\pi_D^I + \pi_m - \pi_M \geq \lambda_1 \pi_m$, or equivalently, $\pi_D^I - \lambda_1 \pi_m \geq \pi_M - \pi_m$, reflects a variation of the replacement effect: the incumbent's incentive to innovate is greater when faced with potential competition by $E1$ than when faced with no competition. Meanwhile, $p(\pi_D^I - \pi_D) \geq \lambda_1 \pi_m$, or equivalently, $p\pi_D^I - \lambda_1 \pi_m \geq p\pi_D$, states that conditional on anticipating successfully development by $E1$, I's expected gain from developing $E2$'s type-0 project is greater than that of $E2$.

OD1: Equilibrium Analysis

We begin with the formal analysis. Readers may jump ahead to Section OD2 for a summary of the key insights.

Benchmark: no acquisition Suppose that no acquisition occurs. Because λ_1, λ_2 do not affect $E1$ and $E2$'s profits, entrants behaviours (and profits) mirror that in the main text. That is, both entrants always develop, and $E1$ and $E2$'s profits are, respectively, $p(x\pi_X(x) + (1 - x)\Pi) - K$ and $p\Pi - K$.

Stage 3: Post-acquisition subgame.

Stage 3B. Suppose that $E1$ successfully develops a superior primary product. Not developing yields I with a payoff of $\lambda_1 \pi_m$. Developing yields I with a payoff of $p\pi_D^I + (1-p)\lambda_1\pi_m - K$. Hence, I develops iff

$$p(\pi_D^I - \lambda_1 \pi_m) := K_D^I(\lambda_1) \geq K$$

where $K_D^I(\lambda_1) \geq K_M^I$ by Assumption 1.

Next, suppose $E1$ fails in developing a superior primary product. Then, as in the main text, I develops iff $K \leq K_M^I$.

Stage 3A. The subgame plays out identically to that in the main text. If $E1$ expects I to develop in response, then $E1$ develops iff $K \leq K_D^{E1}(x)$. Otherwise, $E1$ always develops.

Stage 2: Acquisition stage. We summarize I's behaviour in this stage via the following remark.

Remark 4. *For all development costs K and realizations $x \in [0,1]$, there exists $\mathcal{L}_K(x) \subseteq [0,1]^2$ such that I acquires $E2$ if and only if $(\lambda_1, \lambda_2) \in \mathcal{L}_K(x)$. Additionally*

- *$\mathcal{L}_K(x)$ always contains pairs (λ_1, λ_2) sufficiently close (or equal) to $(0,0)$. That is, acquisitions always occur when innovation is sufficiently drastic.*

- *For all K and pairs $(\lambda_1, \lambda_2) \in [0,1]^2$, there exists a threshold $\overline{x}_K(\lambda_1, \lambda_2) \in [0,1]^2$ such that $(\lambda_1, \lambda_2) \notin \mathcal{L}_K(x)$ if $x > \overline{x}_K(\lambda_1, \lambda_2)$, and $(\lambda_1, \lambda_2) \in \mathcal{L}_K(x)$ if $x < \overline{x}_K(\lambda_1, \lambda_2)$. Furthermore, $\overline{x}_K(\lambda_1, \lambda_2)$ is decreasing in both λ_1 and λ_2. That is, the range of x values under which acquisition occurs is larger if innovation is more drastic.*

We now prove Remark 4. First, observe that $E2$'s reservation value is $p(p(1-x)\pi_D +$

$(1-p(1-x))\pi_M) - K$, while I's profit without acquisitions is

$$p^2(1-x)\lambda_2\pi_m + ((1-p)p(1-x) + (1-p(1-x))p)\lambda_1\pi_m + (1-p)(1-p(1-x))\pi_m \tag{6}$$

Meanwhile, I's profit from acquisition, and thus I's decision of whether to acquire $E2$, will depend on the value of K. We break this down into four familiar cases:

Case 1: $K < K_M^I$. I's profit following the acquisition is

$$p(1-x)(p\pi_D^I + (1-p)\lambda_1\pi_m) + (1-p(1-x))(p\pi_M + (1-p)\pi_m) - K$$

Hence, I's gain from the acquisition, i.e., subtracting (6) from the above, is given by

$$p^2(1-x)(\pi_D^I - \lambda_2\pi_m) + p(1-p(1-x))(\pi_M - \lambda_1\pi_m) - K$$

Thus, an acquisition occurs iff

$$\begin{aligned} &p^2(1-x)(\pi_D^I - \lambda_2\pi_m) + p(1-p(1-x))(\pi_M - \lambda_1\pi_m) - K \geq p(p(1-x)\pi_D + (1-p(1-x))\pi_M) - K \\ &\iff L_1(\lambda_1,\lambda_2,x) \equiv p^2(1-x)(\pi_D^I - \pi_D) - (p(1-p(1-x))\lambda_1\pi_m + p^2(1-x)\lambda_2\pi_m) \geq 0 \end{aligned} \tag{7}$$

Hence, $\mathcal{L}_K(x) = \{x \in [0,1] : L_1(\lambda_1,\lambda_2,x) \geq 0\}$. Further observe that for all $x \in [0,1]$, (7) holds for (λ_1,λ_2) close (and equal) to $(0,0)$.

Now, for all $(\lambda_1,\lambda_2) \in [0,1]^2$, let[2]

$$\overline{x}_K(\lambda_1,\lambda_2) = \begin{cases} \inf\{x : L_1(\lambda_1,\lambda_2,x) \geq 0 \text{ and } x \in [0,1]\}, & L_1(\lambda_1,\lambda_2,0) > 0 \\ 0, & \text{otherwise} \end{cases} \tag{8}$$

[2]It is worth noting that,

$$\begin{aligned} L_1(\lambda_1,\lambda_2,0) &= p^2(\pi_D^I - \pi_D) - p(1-p)\lambda_1\pi_m - p^2\lambda_2\pi_m \\ &\geq p^2\pi_D^I - \pi_D - p\lambda_1\pi_m \geq 0 \end{aligned}$$

Such that the second possibility for $\overline{x}_K(\lambda_1,\lambda_2)$ does not apply. However, defining $\overline{x}_K(\cdot)$ as in (8) and proving that $\overline{x}_K(\cdot)$ possesses the required properties assuming that $L_1(\lambda_1,\lambda_2,0) \leq 0$ is possible allows us to simplify the following exposition.

To prove the properties of $\overline{x}_K(\lambda_1, \lambda_2)$ stated in Remark 4, first observe that for all $(\lambda_1, \lambda_2) \in [0,1]^2$

$$\frac{\partial L_1}{\partial \lambda_1} = -p(1-p(1-x))\pi_m < 0, \quad \frac{\partial L_1}{\partial \lambda_2} = -p^2(1-x)\pi_m < 0$$
$$\frac{\partial L_1}{\partial x} = -p^2(\pi_D^I - \pi_D) - p^2(\lambda_1 - \lambda_2)\pi_m < 0$$

Hence, there are three possibilities to consider

1. First, suppose $L_1(\lambda_1, \lambda_2, 1) \geq 0$. Then, $L_1(\lambda_1, \lambda_2, x) \geq 0$ for all $x \in [0,1]$, and $\overline{x}_K(\lambda_1, \lambda_2) = 1$, such that all of the properties in Remark 4 trivially apply.
2. Next, suppose $L_1(\lambda_1, \lambda_2, 0) \leq 0$, which implies $L_1(\lambda_1, \lambda_2, x) < 0$ for all $x > 0$, i.e., acquisitions do not occur for any $x > 0$. Then, by (8), $\overline{x}_K(\lambda_1, \lambda_2) = 0$. Furthermore, for any pair $(\lambda_1', \lambda_2') \in [0,1]^2$ such that $\lambda_1' \leq \lambda_1$ and $\lambda_2' \leq \lambda_2$, $L_1(\lambda_1', \lambda_2', x) \leq L_1(\lambda_1, \lambda_2, x) \leq 0$ for all $x \in [0,1]$. Hence, $\overline{x}_K(\lambda_1, \lambda_2) = \overline{x}_K(\lambda_1', \lambda_2')$.
3. Finally, suppose $L_1(\lambda_1, \lambda_2, 1) < 0 < L_1(\lambda_1, \lambda_2, 0)$. Then, it is clear that $\overline{x}_K(\lambda_1, \lambda_2)$ is the unique value of $x \in [0,1]$ such that $L_1(\lambda_1, \lambda_2, x) \geq 0$, i.e., $(\lambda_1, \lambda_2) \in \mathcal{L}_K(x)$, if and only if $x \leq \overline{x}(\lambda_1, \lambda_2)$. From here, similar arguments to the last case imply $\overline{x}_K(\lambda_1, \lambda_2) \leq \overline{x}_K(\lambda_1', \lambda_2')$ for any pair $(\lambda_1', \lambda_2') \in [0,1]^2$ such that $\lambda_1' \leq \lambda_1$ and $\lambda_2' \leq \lambda_2$.

Case 2: $K_M^I < K \leq \min\{K_D^{E1}(x), K_D^I(\lambda_1)\}$**.** I's profit following the acquisition is

$$p(1-x)(p\pi_D^I + (1-p)\lambda_1\pi_m - K) + (1-p(1-x))\pi_m$$

Hence, I's gain from the acquisition, i.e., subtracting (6) from the above, is given by

$$p^2(1-x)(\pi_D^I - \lambda_2\pi_m) + (1-\lambda_1)p(1-p(1-x))\pi_m - p(1-x)K$$

Hence, an acquisition occurs iff

$$p^2(1-x)(\pi_D^I - \lambda_2\pi_m) + (1-\lambda_1)p(1-p(1-x))\pi_m - p(1-x)K \geq p(p(1-x)\pi_D + (1-p(1-x))\pi_M) - K$$

That is,

$$
\begin{aligned}
L_2(\lambda_1,\lambda_2,x) \equiv & p^2(1-x)(\pi_D^I-\pi_D)+(1-p(1-x))(K-p(\pi_M-\pi_m)) \\
& -(p(1-p(1-x))\lambda_1\pi_m+p^2(1-x)\lambda_2\pi_m)\geq 0
\end{aligned} \tag{9}
$$

and so $\mathcal{L}_K(x)=\{x\in[0,1]:L_2(\lambda_1,\lambda_2,x)\geq 0\}$. Moreover, (9) holds for all $x\in[0,1]$ when (λ_1,λ_2) is sufficiently close (or equal) to $(0,0)$. For each $(\lambda_1,\lambda_2)\in[0,1]^2$, define $\overline{x}_K(\lambda_1,\lambda_2)$ as in (8), replacing $L_1(\cdot)$ with $L_2(\cdot)$. We now show that $\overline{x}_K(\lambda_1,\lambda_2)$ possesses the properties required in Remark 4, dividing the proof into two steps.

- First, suppose $\lambda_1\leq\frac{K-p(\pi_M-\pi_m)}{p\pi_m}$, which implies $L_2(\lambda_1,\lambda_2,1)\geq 0$. Then, since

  $$
  \begin{aligned}
  L_2(\lambda_1,\lambda_2,0)&=p^2(\pi_D^I-\pi_D)+(1-p)(K-p(\pi_M-\pi_m))-p(1-p)\lambda_1\pi_m-p^2\lambda_2\pi_m \\
  &\geq p^2\pi_D^I-\pi_D-p\lambda_1\pi_m\geq 0
  \end{aligned}
  $$

  and $L_2(\lambda_1,\lambda_2,x)$ is linear in x, $L_2(\lambda_1,\lambda_2,x)\geq 0$ for all $x\in[0,1]$. Thus, $\overline{x}_K(\lambda_1,\lambda_2)=1$ is the relevant threshold. Furthermore, it is immediate for any pair $(\lambda_1',\lambda_2')\in[0,1]^2$ such that $\lambda_1'\leq\lambda_1$ and $\lambda_2'\leq\lambda_2$, $\overline{x}_K(\lambda_1,\lambda_2)\geq\overline{x}_K(\lambda_1',\lambda_2')$.

- Next, suppose $\lambda_1>\frac{K-p(\pi_M-\pi_m)}{p\pi_m}$, so $K<p(\pi_M-(1-\lambda_1)\pi_m)$. Then, $L_1(\lambda_1,\lambda_2,1)<0<L_1(\lambda_1,\lambda_2,0)$. Further observing

  $$
  \begin{aligned}
  \frac{\partial L_2}{\partial\lambda_1}&=-p(1-p(1-x))\pi_m<0,\quad \frac{\partial L_2}{\partial\lambda_2}=-p^2(1-x)\pi_m<0 \\
  \frac{\partial L_2}{\partial x}&=-p[p(\pi_D^I-\pi_D)-K+p(\pi_M-\pi_m)]-p^2(\lambda_1-\lambda_2)\pi_m \\
  &\leq -p[p(\pi_D^I-\pi_D)-(p(\pi_M-(1-\lambda_1)\pi_m))+p(\pi_M-\pi_m)] \\
  &< -p^2((\pi_D^I-\pi_D)-\lambda_1\pi_m)\leq 0
  \end{aligned}
  $$

  where the last inequality follows from Assumption 1, $\overline{x}_K(\lambda_1,\lambda_2)$ is the unique value of $x\in[0,1]$ such that $L_1(\lambda_1,\lambda_2,x)\geq 0$ if and only if $x\leq\overline{x}(\lambda_1,\lambda_2)$. Furthermore, that the signs on $\frac{\partial L_2}{\partial\lambda_1},\frac{\partial L_2}{\partial\lambda_2},\frac{\partial L_2}{\partial x}$ do not change from a decrease in λ_1 or λ_2 imply that for any pair $(\lambda_1',\lambda_2')\in[0,1]^2$ such that $\lambda_1'\leq\lambda_1$ and $\lambda_2'\leq\lambda_2$, $\overline{x}_K(\lambda_1,\lambda_2)\geq\overline{x}_K(\lambda_1',\lambda_2')$.

Case 3: $K_D^{E1}(x) < K \leq K_D^I(\lambda_1)$. I's profit following the acquisition is π_m. Hence, I's gain from the acquisition, i.e., subtracting (6) from π_m, is given by

$$p^2(1-x)(1-\lambda_2)\pi_m + ((1-p)p(1-x) + (1-p(1-x))p)(1-\lambda_1)\pi_m$$

Thus, I acquires $E2$ if and only if

$$\begin{aligned} L_3(\lambda_1, \lambda_2, x) \equiv K &+ p^2(1-x)((1-\lambda_2)\pi_m - \pi_D) \\ &+ p(1-p(1-x))((1-\lambda_1)\pi_m - \pi_M) + p(1-p)(1-x)(1-\lambda_1)\pi_m \geq 0 \end{aligned} \tag{10}$$

and so $\mathcal{L}_K(x) = \{x \in [0,1] : L_3(\lambda_1, \lambda_2, x) \geq 0\}$. Furthermore, for all $(\lambda_1, \lambda_2) \in [0,1]^2$,

$$\frac{\partial L_3}{\partial \lambda_1} = -((1-p)p(1-x) + (1-p(1-x))p)\pi_m < 0, \quad \frac{\partial L_3}{\partial \lambda_2} = -p^2(1-x)\pi_m < 0$$
$$\frac{\partial L_3}{\partial x} = -p^2[\pi_M - \pi_D + (\lambda_1 - \lambda_2)\pi_m] - p(1-p)(1-\lambda_1)\pi_m < 0$$

Hence, defining $\overline{x}_K(\lambda_1, \lambda_2)$ as in (8), replacing $L_1(\cdot)$ with $L_3(\cdot)$, a similar argument to Case 1 shows that $\overline{x}_K(\lambda_1, \lambda_2)$ has all of the properties required in Remark 4.

Case 4: $K > K_D^I(\lambda_1)$. I's profit following the acquisition is

$$p(1-x)\lambda_1\pi_m + (1-p(1-x))\pi_m$$

Hence, I's gain from the acquisition, i.e., subtracting (6) from the above, is given by

$$p^2(1-x)(1-\lambda_2)\pi_m + p(1-\lambda_1)\pi_m$$

Thus, I acquires $E2$ if and only if

$$L_4(\lambda_1, \lambda_2, x) \equiv K + p^2(1-x)((1-\lambda_2)\pi_m - \pi_D) + p((1-\lambda_1)\pi_m - (1-p(1-x))\pi_M) \geq 0 \tag{11}$$

and so $\mathcal{L}_K(x) = \{x \in [0,1] : L_4(\lambda_1, \lambda_2, x) \geq 0\}$. Furthermore, for all $(\lambda_1, \lambda_2) \in [0,1]^2$,

$$\frac{\partial L_4}{\partial \lambda_1} = -p\pi_m < 0, \quad \frac{\partial L_4}{\partial \lambda_2} = -p^2(1-x)\pi_m < 0$$
$$\frac{\partial L_4}{\partial x} = -p(p(1-\lambda_2)\pi_m - \pi_D) + \pi_M) < 0$$

Hence, defining $\overline{x}_K(\lambda_1, \lambda_2)$ as in (8), replacing $L_1(\cdot)$ with $L_4(\cdot)$, a similar argument to Case 1 shows that $\overline{x}_K(\lambda_1, \lambda_2)$ has all of the properties required in Remark 4. □

Stage 1: project choice stage. As with the analysis in the main text, we split the discussion of project choice into four parts.

Case 1: $K \leq K_M^I$. Suppose $E1$ chooses the type-0 project. Then, since $L_1(\lambda_1, \lambda_2, 0) \geq 0$ (see Footnote 2), Remark 4 implies that acquisitions always occur. Following the analysis in Stage 3, this implies that $E1$'s payoff is $K_D^{E1}(0) - K$. Meanwhile, if $E1$ chooses the type-X project, then $E1$ obtains a payoff of $K_D^{E1}(x) - K$ when $x \leq \overline{x}_K(\lambda_1, \lambda_2)$, and $p(x\pi_X(x) + (1-x)\Pi) - K$ when $x > \overline{x}_K(\lambda_1, \lambda_2)$, where $\overline{x}_K(\lambda_1, \lambda_2)$ is the threshold value discussed in Remark 4. Therefore, $E1$ chooses the type-0 project if and only if the former profit is greater than the latter. This can be simplified to

$$\int_0^1 x(K_D^{E1}(0) - p\pi_X(x))dF(x) + \int_{\overline{x}_K(\lambda_1,\lambda_2)}^1 (1-x)(K_D^{E1}(0) - p\Pi))dF(x) \geq 0 \qquad (12)$$

Furthermore, since $\overline{x}_K(\lambda_1, \lambda_2)$ is decreasing in (λ_1, λ_2) by Remark 4, and $K_D^{E1}(0) < p\Pi$, (12) becomes harder to satisfy if (λ_1, λ_2) increases. That is, less drastic innovation makes choosing project X more attractive to $E1$. Furthermore, for sufficiently small $\lambda_1, \lambda_2)$, $\overline{x}_K(\lambda_1, \lambda_2) = 0$. Hence, (12) coincides with the condition in Proposition 1 which determines whether $E1$ chooses a type-0 project or type-X project, I always acquires $E2$, and the game plays out identically to that described in the main text.

Case 2: $K_M^I < K \leq \min\{K_D^{E1}(0), K_D^I(\lambda_1)\}$. By the discussion in Stage 2, $L_2(\lambda_1, \lambda_2, 0) \geq 0$ such that $E1$'s payoff from choosing the type-0 project is $K_D^{E1}(0) - K$. Meanwhile, if $E1$ chooses the type-X project, then $E1$ obtains a payoff of $K_D^{E1}(x) - K$ when $x \leq \overline{x}_K(\lambda_1, \lambda_2)$, and $p(x\pi_X(x) + (1-x)\Pi) - K$ when $x > \overline{x}_K(\lambda_1, \lambda_2)$, where

$\overline{x}_K(\lambda_1, \lambda_2)$ is the threshold value discussed in Remark 4. Hence, the condition which determines whether $E1$ chooses the type-0 project (alongside how it changes from a change in λ_1, λ_2) is identical to Case 1.

Case 3: $\boldsymbol{K_D^{E1}(0) < K \leq K_D^I(\lambda_1)}$ Here, we consider two possibilities.

- First, suppose $(\lambda_1, \lambda_2) \notin \mathcal{L}_K(0)$, i.e., acquisitions do not occur for $x = 0$. By Remark 4, this implies $\overline{x}_K(\lambda_1, \lambda_2) = 0$, so acquisitions do not occur for all $x > 0$. Hence, acquisition never occurs regardless of the project type $E1$ chooses, and $E1$'s project choice is identical to when acquisitions are banned.

- Next, suppose $(\lambda_1, \lambda_2) \in \mathcal{L}_K(0)$. Then, if $E1$ chooses the type-0 project, I acquires $E2$, and develops in response to $E1$'s entry (since $K \leq K_D^I(\lambda_1)$. Furthermore, since $K_D^{E1}(0) < K$, $E1$ will not develop if it anticipates I developing in response to its entry into market 0. Hence, $E1$'s profit from choosing the type-0 project is 0, and so $E1$ always weakly prefers choosing the type-X project over the type-0 project, as in Proposition 1 of the main text.

Case 4: $\boldsymbol{K > K_D^I(\lambda_1)}$ Recall by Remark 4 that there exists a cutoff value, $\overline{x}_4(\lambda_1, \lambda_2)$ which determines whether $(\lambda_1, \lambda_2) \in \mathcal{L}_K(x)$, i.e., acquisitions occur

- **Case 4a:** First, suppose $(\lambda_1, \lambda_2) \notin \mathcal{L}_K(0)$. By a similar logic to Case 3, acquisition never occurs regardless of the project type $E1$ chooses, and the game plays out identically to when acquisitions are banned.

- **Case 4b:** Next, suppose $(\lambda_1, \lambda_2) \in \mathcal{L}_K(0)$. Observe that by choosing the type-0 project, $E1$ guarantees that acquisition occurs. Furthermore, since $K > K_D^I(\lambda_1)$, I will not develop in response to successful entry by $E1$ into market 0. Therefore, $E1$'s profit from choosing the type-0 project is $p\pi_M - K$, which is the largest possible profit $E1$ can obtain in any circumstance. Therefore, $E1$ always chooses the type-0 project, as in Proposition 1 of the main text.

We summarize these findings as follows.

Remark 5. *Suppose that innovation is non-drastic, and Assumption (1) holds. Then,*

- *If* $K \leq \min\{K_D^{E1}(0), K_D^I(\lambda_1)\}$, $E1$ *chooses the type-0 project if and only if (12) holds, which becomes easier to satisfy from an increase in* (λ_1, λ_2), *i.e., less drastic innovation.* I *acquires* $E2$ *if and only if the realized value of* x *is sufficiently low. Furthermore, for* (λ_1, λ_2) *close to* $(0, 0)$, *i.e., sufficiently drastic innovation, the equilibrium behaviour by firms is exactly identical to that in Proposition 1.*

- *If* $K > \min\{K_D^{E1}(0), K_D^I(\lambda_1)\}$, *then*

  - *If* $(\lambda_1, \lambda_2) \notin \mathcal{L}_K(0)$, *i.e., innovation is insufficiently drastic, then no acquisitions occur in equilibrium.* $E1$*'s project choice and subsequent behaviour by both* $E1$ *and* $E2$, *are identical to that when acquisitions are banned.*

  - *If* $(\lambda_1, \lambda_2) \in \mathcal{L}_K(0)$, *i.e., innovation is sufficiently drastic, then the equilibrium behaviour by firms is exactly identical to that in Proposition 1. In particular,* $E1$ *chooses the type-*X *project whenever* $K_D^{E1}(0) < K \leq K_D^I(\lambda_1)$, *and chooses the type-*0 *project whenever* $K > K_D^I(\lambda_1)$, *and* I *always acquires* $E2$.

OD2: Discussion

Remark 5, which characterises the equilibrium of the game when innovation is non-drastic, provides several insights. First, an increase in (λ_1, λ_2) weakly lowers the probability in which I acquires $E2$. Intuitively, this arises as both the benefit of eliminating competition from $E2$ *and* utilizing acquired technology to either defend against or deter $E1$'s entry falls. In particular, for sufficiently drastic innovation, i.e., small λ_1, λ_2, the equilibrium outcome is identical to those in Proposition 1 of the main text. Put differently, our main text conclusions are robust to sufficiently drastic innovation.

Second, when innovation is insufficiently drastic and K is moderately high, I finds it profitable to acquire $E2$ if and only if the probability that $E1$ successfully obtains a superior substitute is large enough, i.e., when x is small. Put differently, choosing the type-X project allows $E1$ to remove I's incentive to acquire $E2$ with positive probability. As $E1$ prefers competing against $E2$ over I, this provides an additional incentive for $E1$ to choose the type-X project over the type-0 project. Consequently, an increase in λ_1, λ_2, i.e., a less drastic innovation, may lead to $E1$ switching from choosing the type-0 project to a type-X project. This reduces the probability of entry of the non-targeted firm $E1$ into market 0. Meanwhile, since acquisitions may now fail with positive probability such that the no-acquisition subgame arises with positive probability, non-drastic innovation increases the probability of $E2$'s development, at the expense of I's development.