DISCUSSION PAPER SERIES

DP16151
(v. 2)

The "kill zone": Copying, acquisition and start-ups' direction of innovation

Sandro Shelegia and Massimo Motta

INDUSTRIAL ORGANIZATION

CEPR

ISSN 0265-8003

The "kill zone": Copying, acquisition and start-ups' direction of innovation

Sandro Shelegia and Massimo Motta

Discussion Paper DP16151
First Published 13 May 2021
This Revision 18 May 2021

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

The "kill zone": Copying, acquisition and start-ups' direction of innovation

Abstract

An incumbent monopolist may prevent a firm which currently sells a complementary product from developing a substitute, by copying its product. Imitation reduces the potential rival's current profits, making it less likely for it to obtain funding in the financial market. The anticipation of the incumbent's aggressive behaviour may also create an "ex ante" effect, by inducing the rival not to challenge the incumbent with a substitute (that is, not to enter the "kill zone") and develop another complement instead. Further, in this case the incumbent will have an incentive not to copy, since a new complement will raise its rents. The possibility of being acquired by the incumbent tends to push the rival towards developing a substitute rather than a complement. By choosing the former, potential gains from the acquisition are created (in the form of suppression of competition): as long as the rival has some bargaining power in the determination of the takeover price, it will then benefit from entering the "kill zone".

JEL Classification: L12, L41

Keywords: Innovation, Copying, platforms

Sandro Shelegia - sandro.shelegia@upf.edu
Universitat Pompeu Fabra and Barcelona GSE and CEPR

Massimo Motta - massimo.motta@upf.edu
Universitat Pompeu Fabra and Barcelona GSE and CEPR

Acknowledgements
We are grateful to seminar audiences at the Digital Economics Conference, Toulouse School of Economics (January 2020), MaCCI Annual Conference (March 2020), to Heski Bar-Isaac, Miguel Espinosa, Jose Luis Moraga, Thomas Roende, Tom Ross for comments on earlier versions, as well as to our UPF Internal Micro Workshop colleagues, and UPF Research Seminar students. We have benefited from the BBVA Foundation for a grant within the programme "Ayudas Fundacion BBVA a Equipos de Investigacion Cientifica 2019" and from the Spanish Ministry of Economy and Competitiveness, through the Severo Ochoa Programme for Centres of Excellence in R\&D ((CEX2019-000915-S).. Shelegia acknowledges financial support from the Spanish Ministry of Economy and Competitiveness through the research grant RYC-2016-20307.

The "kill zone": Copying, acquisition and start-ups' direction of innovation*

Massimo Motta† Sandro Shelegia‡

May 18, 2021

Abstract

An incumbent monopolist may prevent a firm which currently sells a complementary product from developing a substitute, by copying its product. Imitation reduces the potential rival's current profits, making it less likely for it to obtain funding in the financial market.

The anticipation of the incumbent's aggressive behaviour may also create an "ex ante" effect, by inducing the rival not to challenge the incumbent with a substitute (that is, not to enter the "kill zone") and develop another complement instead. Further, in this case the incumbent will have an incentive *not* to copy, since a new complement will raise its rents.

The possibility of being acquired by the incumbent tends to push the rival towards developing a substitute rather than a complement. By choosing the former, potential gains from the acquisition are created (in the form of suppression of competition): as long as the rival has some bargaining power in the determination of the takeover price, it will then benefit from entering the "kill zone".

*We are grateful to seminar audiences at the Digital Economics Conference, Toulouse School of Economics (January 2020), MaCCI Annual Conference (March 2020), to Heski Bar-Isaac, Miguel Espinosa, Jose Luis Moraga, Thomas Roende, Tom Ross for comments on earlier versions, as well as to our UPF Internal Micro Workshop colleagues, and UPF Research Seminar students. We have benefited from the BBVA Foundation for a grant within the programme "Ayudas Fundacion BBVA a Equipos de Investigacion Cientifica 2019" and from the Spanish Ministry of Economy and Competitiveness, through the Severo Ochoa Programme for Centres of Excellence in R&D ((CEX2019-000915-S). . Shelegia acknowledges financial support from the Spanish Ministry of Economy and Competitiveness through the research grant RYC-2016-20307.

†ICREA-Universitat Pompeu Fabra and Barcelona Graduate School of Economics.

‡Universitat Pompeu Fabra.

1 Introduction

While the digital transformation has created gains for consumers and huge opportunities for innovation, there exist increasing worries that some digital companies have accumulated so much market power that they could, through various business strategies, eliminate competition and discourage new products and ideas from displacing their current offerings.

Commentators express two inter-related concerns. First, the big digital companies may engage in practices that impede rivals from contesting their dominance.

> "[P]latforms may create "kill-zones" around themselves. For example, Facebook and Twitter's aggressive API foreclosure, acquisition of competitors, and **copying of new services** have boosted their market power."[1]

> "Business analysts recognize the existence of a pre-emption threat on new ventures. They speak of a "kill zone", where start-ups cannot flourish, that is, a range of products or services where incumbent digital players are likely to dominate, either by acquiring their potential rivals or by reacting aggressively to entry by **launching competing products or services**."[2]

Second, such practices might discourage innovators and keep them away from their core markets:

> "The lessening or blocking of innovative entry is of particular concern given its value. A Venture Capitalist [VC in the text] will usually be **wary of outright investing in an innovative startup that will implicitly or explicitly compete head-on with a tech giant**. Given the tech incumbents' ability to block or foreclose a threatening entrant, the chance of successful entry is tiny."[3]

In this paper, we investigate these arguments, by (i) studying the incentives of a dominant firm to copy another firm's product in order to prevent it from competing head-on; and (ii) looking at the effects that such an exclusionary threat may have on the development trajectories of a start-up.

Facebook apparently did not fear firms trying to replicate Facebook's social network, but rather new firms with very different products which could grow into competitors.[4] Further, "Facebook's internal documents indicate that once it identified a competitive threat, it attempted to buy or crush them by **cloning their product features** or foreclosing them from Facebook's social graph. Facebook took these steps to harm competitors and insulate Facebook from competition, not just to grow or offer better products and services."[5]

Similarly, Twitter first cut off the video-sharing app Meerkat from its social graph, and then introduced in its own platform a new service (obtained by acquiring the company Periscope) which reproduced Meerkat's features, apparently in fear of the rapid spread of Meerkat among its users.[6]

[1] Scott Morton et al., 2019: 54); our emphasis.

[2] Bourreau and de Streel (2019); our emphasis. See also Crémer et al. (2019: 117) and Furman et al. (2019: 40).

[3] Scott Morton et al., 2019: 53, our emphasis. After reviewing some empirical evidence, the report states (p.56): "Much more research needs to be done to properly identify the existence and extent of "kill zones" for market entry and innovation. Nonetheless, the evidence thus far does suggest that current digital platforms face very little threat of entry and are negatively impacting investment in key digital areas."

[4] See Federal Trade Commission (2020: page 3).

[5] US Congress (2020: p. 164), our emphasis.

[6] See e.g. https://www.theverge.com/2015/3/13/8213255/twitter-cuts-meerkat-off-from-its-social-graph-just-as-sxsw-gets; https://www.theverge.com/2015/3/26/8293353/periscope-live-streaming-twitter-meerkat.

Likewise, in the mid-90s, Netscape Navigator was by far the dominant browser in the market and Microsoft decided to invest a lot of resources to develop its own browser, Internet Explorer (IE), fearing that Netscape could have eventually jeopardised Microsoft's monopoly power in the OS market. In Bill Gates' own words:

> Netscape's strategy is to make Windows and other OSs all but irrelevant by building the browser into a full-featured operating system. Over time Netscape will add memory management, file systems, security, scheduling graphics and everything else in Windows that applications require. The company hopes that its browser will become a de facto platform for software development, ultimately replacing Windows as the mainstream set of software standards.[7]

The introduction of a very close substitute to a complementary product (and the ensuing price drop: Netscape was soon obliged to give away its browser for free), with the objective of preventing the rival from using the complement as a stepping stone from which to enter the primary market is a good illustration of our theory.

In turn, incumbents' aggressive strategies may make it more difficult for startups to obtain financing for innovations which may lead them to compete with incumbents, and lead them to direct innovation efforts elsewhere. Kamepalli et al.(2020), for instance, document that Facebook and Google's acquisitions of start-ups producing substitutes to their products significantly reduces the likelihood of start-ups in the same space to obtain funding.

We shall also explore the interactions between copying and acquisitions, and show that these two strategies may well reinforce each other. In particular, copying or the threat of it can modify the outcome of an acquisition negotiation,[8] not unlike what happened during the negotiations between Facebook and Instagram, when Facebook's development of own versions of Instagram's successful app was restricting Instagram's options.[9] "In another example, Facebook executives approached Houseparty, a social networking app, about a potential acquisition. Houseparty's founders turned down Facebook's offer, and released the product they referred to as "the internet's living room." Shortly thereafter, Facebook announced that its Messenger app would become a "virtual living room." Houseparty's active user base fell by half between 2017 and 2018."[10]

In our base model, an incumbent is the monopolist of a primary product. A rival firm (a potential "entrant") is currently selling a product which is complementary to the incumbent's (one may also

[7]Testimony of Franklin M. Fisher, 90(i), United States v. Microsoft Corp., No. 98-1232 (D.D.C. filed Jan. 5, 1999) (quoting William Gates, The Internet PC, Apr. 10, 1996), available at http://www.usdoj.gov/atr/cases/f213400/213457.pdf.

[8]Burns (1986) finds empirical evidence that Standard Oil's aggressive pricing decreased the price of its acquisition of competitors, and Saloner (1987) models this mechanism, which is similar in spirit to what we find here.

[9]US Congress (2020: p. 165) gives the following quote referring to an exchange of messages between Facebook's and Instagram's CEOs: "Mr. Zuckerberg suggested that refusing to enter into a partnership with Facebook, including an acquisition, would have consequences for Instagram, referencing the product Facebook was developing at the time: 'At some point soon, you'll need to figure out how you actually want to work with us. This can be an acquisition, through a close relationship with Open Graph, through an arms length relationship using our traditional APIs, or perhaps not at all... Of course, at the same time we're developing our own photos strategy, so how we engage now will determine how much we're partners vs. competitors down the line — and I'd like to make sure we decide that thoughtfully as well.'

[10]US Congress (2020: p. 166).

think of it as an app/service hosted by the incumbent's platform). The entrant may decide to develop its product further to compete with the incumbent's primary product (*"substitute" trajectory*) or rather to stay away from the incumbent's core activity and produce another complement (*"complement" trajectory*). The chance to develop any further product will typically depend on current and future profits: the lower its assets and its pledgeable income, the less likely it will find investors willing to fund further development.[11]

(See e.g. Scott Morton et al. (2019, e.g. 68)[12] and Tirole (2019),[13] for the idea that the threat to incumbents may come from adjacent markets, and that it is not immediate but gradual.)

After the entrant's trajectory choice but before the entrant fully develops the new product, the incumbent may decide to develop and start selling an exact copy of the entrant's current complementary product.We assume that absent copying, the entrant's current and expected profits would allow it to obtain sufficient funding to develop a substitute of the incumbent's primary product, but with copying its assets may not be enough.

In principle, one would think that there is little incentive to introduce an exact copy of another product, and that it would be better to differentiate offerings. In our context, though, copying may arise even from a static perspective. Indeed, introducing a copycat version of a complement could be profitable for the producer of a primary product: by depressing the complement's price, the primary product's price could increase, allowing the incumbent to capture all the rents generated by the complement.[14] Suppose now that the cost of introducing a replica of the complement is high enough to discourage this "static" motive for copying. We show there may be a strategic incentive for doing so, which consists of harming a potential rival's prospect from developing a substitute. Note, however, that if the rival was to produce another complement, then the strategic incentive for copying would move in the opposite direction: the incumbent may want to abstain from copying even if it was profitable in the short run so as to encourage the entrant to develop another complement, because this would create extra rents for the primary product.[15]

Since the incumbent's copying incentives depend crucially on the type of the new product the entrant intends to develop, copying might also have an ex ante "selection" effect: anticipating the incumbent's strategic behaviour, the entrant may stay away from the "kill zone" — that is, from developing a product that could threaten the incumbent's primary product — and prefer instead to develop another complementary product, which the incumbent may respond to by refraining from

[11] We model financial contracting under moral hazard as in Holmström and Tirole (1997) and Tirole (2006: ch. 3).

[12] "[A] complement can develop the ability to form a relationship with the end user that is sufficiently free-standing and valuable to take the user off the platform and into a separate relationship with the complement. The platform has an incentive to foreclose the complement to prevent this loss of market power and profit."

[13] "New entrants into online markets often begin with a niche product; if it proves successful, they expand to offer a much wider range of products and services. Google began with only its search engine before it became the company we know today; Amazon started by selling books. So what matters is whether new entrants can access the market in the first place. If a newcomer has a single original product that is better than what the incumbent offers, the incumbent might want to block it from gaining even a partial foothold in the market. The incumbent will do so not to improve its short-term profits, but to prevent the newcomer from later competing in areas where the incumbent occupies a monopoly position, or to stop the newcomer from allying with the dominant firm's competitors."

[14] See also Farrell and Katz (2000).

[15] The mechanism is similar to Hellmann (2002) who shows that an incumbent has a higher incentive to acquire an entrant only when the entrant intends to produce a complement to the incumbent's asset.

copying even if the copycat strategy is relatively cheap and thus profitable in the short-run. We thus show that the anticipation of the incumbent's copying strategy may affect the direction of innovation of the entrant, shifting R&D resources from improvements to the incumbent's primary product (and subsequent competition) to the development of complementary products.

In an extension of the model, we allow the incumbent to take over the entrant, either before or after the copying strategy is decided, and we show that the "kill zone" effect still exists, in the sense that the entrant even in anticipation of accession may stay away from developing a substitute. However, relative to the base model (where acquisitions are not allowed) it arises for a smaller region of parameter values. The reason is that acquisitions push the entrant towards developing a substitute to the primary product in the hope of being taken over and extract some of the incumbent's rent from avoiding competition. Conversely, the incumbent may also decide to copy the entrant (in part) to depress the acquisition price.[16]

Relationship with the literature Our paper contributes to several literatures by studying the interaction of copying, acquisitions and innovation.

First, we contribute to the literature on copying and innovation. As this paper, Jiang et al. (2011) and Hagiu and Wright (2020) study copying of entrants by a monopoly platform.[17] In their setting the platform copies successful innovations by third party sellers who sell through the platform's marketplace. In both papers the platform copies so as to increase its own sales, something we would call a 'static' incentive to copying. In our model the incumbent's static rationale for copying is different, and it consists of decreasing the price of the complement in order to capture more rents from it. Furthermore, we identify dynamic incentives to copy and consider how the expectation of copying affects the entrant's *direction* of innovation, while these papers study the entrant's incentives to innovate and how copying affects them.

Second, several papers have studied how acquisitions, rather than copying or other incumbent's strategies, may affect innovation. Kamepalli et al. (2020) analyse a model where (due to network effects) the success of a new product which threatens the incumbent's one depends on a group of expert users ("techies") being early adopters, which requires some adoption costs; if they anticipate that the product will end up being acquired by the incumbent, the techies will not want to adopt it — which in turn implies the product will not be worth funding.[18]

Whilst in Kamepalli et al. (2020) acquisitions reduce the likelihood that a substitute to the incumbent's emerges, Dijk et al (2021) look at how they may affect the direction of innovation. They study a model where an entrant has a certain amount of resources available and decides how to allocate them between a "rival" project which would compete with an incumbent and a "non-rival"

[16] In a related paper Gans and Stern (2000) show that an incumbent may invest in developing a copy of the entrant's product for the purpose of improving its bargaining position during acquisition negotiations.

[17] The phenomenon is sometimes called "Sherlocking", a term that originates from the well known case of Apple copying the functionality of a search app Watson which was sold on its Mac platform. Apple updated its own app Sherlock with very similar functionality.

[18] Kamepalli et al. (2020) also find some empirical evidence in support of their result that acquisitions keep start-ups away from developing substitutes to the incumbent's core products.

one which would create an independent product. They study how the anticipation of an acquisition affects the investment allocation problem of the start-up, and find that, from both a consumer and total surplus perspective, acquisitions can improve or worsen the direction of innovation.

Third, some papers have studied acquisitions or financing of innovators. Hellmann (2002) studies new venture financing where the new venture may create a complement or a substitute of the incumbent's current asset. He shows that the incumbent finances the venture when it is a complement, whereas when it is a substitute the outside investors will finance it. Like in our paper the incentives of the incumbent to help the entrepreneur depend on the strategic interaction once the venture succeeds, with the difference that in our setting the incumbent can take steps (copying) to affect the profitability of the venture. In this regard our paper is similar to Gans and Stern (2000) who study acquisitions and licensing when an entrant and an incumbent attempt to develop an innovation which is a superior substitute to the incumbent's current product. In their model the incumbent may imitate the entrant's innovation in order to improve its bargaining position in licensing or acquisition negotiations. A similar effect is present in our extension with acquisitions, although in our model the entrant's direction of innovation may also change. In this respect, our paper is also related to papers which study firms' project selection, R&D direction, or innovation portfolios, such as Ali et al. (1993), Cabral (1994), Henkel et al. (2015), or Letina et al. (2020) although these works focus (inter alia) on how risky or radical the innovative projects are, rather than on whether the start-up chooses to develop a complement or a substitute to an existing incumbent's product.

Fourth, our paper is related more generally to the literature on the acquisition of potential competitors, spurred both by the empirical evidence gathered by Cunningham et al. (2021) on the pharmaceutical industry, and by the public debate prompted by the scores of acquisitions of start-ups carried out by the large digital platforms.[19] Our focus however lies elsewhere, and our model does not allow for the possibility that an incumbent may suppress a project after the acquisition — unlike e.g., Cunningham et al. (2021)'s model of killer acquisitions —, nor does it lend itself to study optimal merger policies in a model where acquisitions may have both anti-competitive effects (suppression of competition and/or of innovation) and pro-competitive effects (promotion of innovation by an incumbent which has resources that a start-up may lack) — which is the focus of Fumagalli et al. (2020).

Finally, our paper also contributes to the literature on exclusionary practices,[20] by showing that a dominant incumbent may have an economic incentive to copy a complementary product.[21] The rationale behind copying is very similar to the one identified by Carlton and Waldman (2002) and, more recently, by Fumagalli and Motta (2020): exclusion today is costly, but it allows the incumbent to preserve future rents. There are several crucial differences though. Firstly, those papers focus respectively on tying and on refusal to supply, which in our context would not achieve exclusion; instead, we show that copying may be used with the purpose of excluding a rival. Secondly, in our paper exclusion is achieved by making it more difficult for the entrant to obtain funds from outside

[19] See e.g. Cabral (2021), Katz (2021), Motta and Peitz (2021).

[20] See generally Fumagalli et al. (2018).

[21] We are not aware of any paper which shows that copying may be used with the purpose of excluding a rival.

investors, rather than by depriving the entrant of economies of scale.[22] Thirdly, we show that exclusionary practices may also distort the entrant's product choice. Indeed, the (correct) anticipation that the incumbent will engage in exclusionary strategies if it is threatened in its primary market will push the entrant to select a product trajectory which keeps it away from competing with the incumbent. This provides a rationalisation of the "kill zone" argument discussed above: potential rivals may stay away from the incumbent's core business area because they fear its reaction, and choose to develop other complements instead. Note, though, that this "redirection" of product trajectories is not necessarily welfare-detrimental, because — as we show in Section 2 (see Corollary 1) — in some circumstances another complement may add more to society than a substitute.

The paper continues thus. Section 2 describes and then solves the base model. Section 3 extends it to consider the possibility that the incumbent acquires the start-up. Section 4 presents a version of the model where final consumers do not pay for the products and the firms monetize through advertising. Section 5 concludes the paper.

2 The model

There are two players in our base model: the *I*ncumbent, which sells the primary product, denoted by I_p, and a start-up, that we call *E*ntrant, which sells a product E_c complementary to I_p. (One may think of I_p as a platform, and E_c as a service or product which can be accessed through the platform.)

We are interested in studying the choice of E between developing a substitute to I_p, denoted by E_p, or another complement to I_p, denoted by $\tilde{E}_c$;[23] and the choice of I between copying E's original complementary product E_c by creating a perfect substitute I_c, or not.[24] Since E may not have enough assets to cover the development cost of its second product, copying its current product will affect E's ability to obtain funding. We shall show that the incumbent has a strategic incentive to copy when the entrant plans to compete, and to abstain from copying when it plans to create another complement.

We assume that all consumers are identical. A representative consumer derives utility u from consuming the primary product I_p. When consumed with I_p, the current complement E_c gives the consumer an additional utility δ, otherwise the consumer derives no utility from E_c. If E_p is developed, it will be a superior substitute of I_p which gives the consumer utility $u + \Delta$.[25] If instead

[22] In this respect, our paper is close in spirit to Bolton and Scharfstein (1990), where predatory pricing by the incumbent reduces the rival's current profits, and hence its financial assets, making it more difficult for it to obtain the funding it needs to stay in the market. However, predatory pricing alone in our context would not achieve exclusion: unless it copies the entrant's complement, the incumbent would not harm the entrant by reducing the price of its primary product, but quite the opposite.

[23] An alternative interpretation of the model is that the entrant chooses between two different complements, a complement $C1$ that paves the way toward developing a substitute and a complement $C2$ that may lead to the development of another complement, with $C1$ and $C2$ earning the entrant the same profits.

[24] The fact that the incumbent's copycat version is a *perfect* substitute to the entrant's product just simplifies the analysis. The results would qualitatively be the same if the two were imperfect substitutes. But note that the less differentiated they are the lower the entrant's profits, and hence the higher the exclusionary power of the incumbent's imitation strategy.

[25] Qualitatively similar results would arise if we assumed that E_p is a horizontally differentiated substitute of I_p: the start-up's product might even not be better than the incumbent's, as long as it was differentiated enough to have a positive NPV and that the incumbent had lower profits if it was developed.

the new complement $\tilde{E}_c$ is developed, then it is an independent (of E_c) complement to I_p that gives the consumer utility $\tilde{\delta}$ when consumed alongside I_p. In each of the two market interactions they have, firms simultaneously set prices for all the products they are able to sell at the time. Consumers maximize utility net of prices.

More precisely, the consumption of a primary good (whether I_p or E_p) with a complementary one(s) (E_c, I_c, or $\tilde{E}_c$), would give rise to the following utilities:

$$\begin{aligned} U(I_p) &= u; & U(E_p) &= u + \Delta; \\ U(I_p, E_c) &= u + \delta; & U(E_p, E_c) &= u + \Delta + \delta; \\ U(I_p, \tilde{E}_c) &= u + \tilde{\delta}; & U(E_p, \tilde{E}_c) &= u + \Delta + \tilde{\delta}; \\ U(I_p, E_c, \tilde{E}_c) &= u + \delta + \tilde{\delta}; & U(E_p, E_c, \tilde{E}_c) &= u + \Delta + \delta + \tilde{\delta}. \end{aligned} \tag{1}$$

(Note that I_c being a perfect copy of E_c, if consumers consumed the former rather than the latter, their utility would be identical to that given by E_c in any configuration. Accordingly, utilities associated with I_c are not explicitly spelled out above.)

In what follows, we assume that:

$$(a)\ \tilde{\delta} = \delta; \qquad (b)\ \frac{\delta}{2} < \Delta < \frac{3\delta}{2}. \tag{A1}$$

(A1)(a) says that each complementary product brings the same extra utility δ to consumers, to simplify calculations. (A1)(b) allows us to focus on the most interesting cases: the first inequality tells us that other things being equal E would prefer to develop a new substitute than a new complement; the second one puts an upper bound to the revenue coming from the substitute, and allows for the possibility that E may choose to develop a complement if I does not copy rather than developing a substitute if I copies.[26] Finally, as will be clear below, (A1)(b) is sufficiently permissive so that either the new substitute or the new complement is more efficient. Namely, if $\Delta > \delta$ welfare is higher when E_p is developed; if $\Delta < \delta$, welfare is higher when $\tilde{E}_c$ is developed.

We also assume that that there is a unit mass of consumers in each of the two periods where firms will sell. Once the mechanisms at work will be clear, it will be easy to understand how the results would change if the number of consumers in the second period increased (decreased) relative to the first period.

The timing of the game Next, we describe the timing of the game.

- At time $t = 0$, E chooses which product to develop, denoted by $\sigma_E \in \{C, S\}$, where C stands for developing the *C*omplementary product $\tilde{E}_c$ and S for developing the *S*ubstitute product I_p.
- At $t = 1(i)$, I decides on a strategy $\sigma_I \in \{\emptyset, ©\}$, that is, it can either take no action ($\emptyset$); *or* spend an amount F to create a product which is an identical copy of the entrant's complementary

[26] In terms of the thresholds introduced below, this amounts to allowing for $\underline{A}_c < \bar{A}_s$. If this assumption did not hold, the entrant would never have an incentive to develop another complement instead of a substitute: either E would develop the substitute, or would not develop anything.

product — and which hence is perceived as perfect substitute by consumers (©). We assume that the "copycat product" will be immediately available.[27]

- At $t = 1(ii)$, there is the first period market interaction. At this stage only I_p, E_c, and possibly I_c can be sold in the market.

- At time $t = 2(i)$, the entrant decides whether to develop or not the second product (primary product E_p or complementary product $\tilde{E}_c$), at an investment cost K; if so it engages in financial contracting with outside investors, because its assets $A_E < K$.

- At time $t = 2(ii)$, if the entrant has obtained finance and made effort, success (with probability p) or failure (with probability $1 - p$) of the project is determined. For simplicity, we shall assume $p = 1$.[28] Therefore, at an equilibrium where E obtains funding, E_p or $\tilde{E}_c$ will become available.

- At time $t = 2(iii)$, there is the second period market interaction: active firms sell in the market, payoffs are realized and contracts are honored.

The assumption that at time $t = 1$ the incumbent observes the product strategy of the entrant plays a crucial role in our game. It can be justified in at least two ways. Firstly, the incumbent may be able to detect the intentions of the entrant by looking at the type of complement the entrant puts on the market. Through its choice of underlying technology and features and the type of consumers it may appeal to, the entrant may reveal its intentions for the development of subsequent products. Alternatively, while the initial choice of the entrant may be hidden from the incumbent, if the entrant's ultimate goal is to develop a competing platform, before it will have to secure financing, and the incumbent may find out the entrant's proposed trajectory through the links (e.g., with venture capitalists) that the entrant tries to establish. A technologically and financially sophisticated incumbent may then be able to copy the entrant's original complement fairly fast before the entrant is able to secure financing and starts launching the competing substitute.[29]

We shall solve the game by backward induction. For simplicity, we assume no discounting.

In Section 3 we shall also study an extension of the game where between $t = 0$ and $t = 1(i)$ the incumbent can acquire the entrant.

2.1 Product market payoffs.

We now find the payoffs that firms and consumers obtain under the different configurations, that is, depending on the actions $\sigma_E = \{S, C\}$ and $\sigma_I = \{\emptyset, ©\}$ taken by E and I. Note that we assume away all marginal costs of production.

[27] Assuming that the copy was available with one period delay would give qualitatively similar results.

[28] Assuming $p < 1$ would not affect the qualitative results, but it would make expressions (marginally) less straightforward. Note also that we assume that the probability of success is the same whether E intends to develop a substitute to I_p or another complement. One could think of reasons why these probabilities may differ, but using the same p provides a useful benchmark.

[29] See Section 2.6), for the case where the incumbent is not able to observe the entrant's choice of trajectory before committing to copying (or where the entrant and the incumbent choose their strategies simultaneously.

It is useful to denote by, say, $(I_p + I_c; E_c)$ the configuration where I sells both I_p and I_c (that is, it has copied E's good) and E just sells the complementary product E_c. Notations for other configurations will be similar.

Lemma 1. *Per-consumer gross profits, consumer surplus and welfare corresponding to the different market configurations are as follows:*

Market Configuration	π_I	π_E	CS	W
$(I_p; E_c)$	$u + \delta/2$	$\delta/2$	0	$u + \delta$
$(I_p + I_c; E_c)$	$u + \delta$	0	0	$u + \delta$
$(I_p; E_p + E_c)$	0	$\Delta + \delta$	u	$u + \delta + \Delta$
$(I_p + I_c; E_p + E_c)$	0	Δ	$u + \delta$	$u + \delta + \Delta$
$(I_p; E_c + \tilde{E}_c)$	$u + \delta$	δ	0	$u + 2\delta$
$(I_p + I_c; E_c + \tilde{E}_c)$	$u + 3\delta/2$	$\delta/2$	0	$u + 2\delta$

Proof. See Appendix. □

Let us briefly explain the *gross* payoffs obtained. Consider first the case $(I_p; E_c)$ where I has taken no action and E has not developed a second product. There exists a continuum of equilibria of the price game. Consider for instance a candidate equilibrium where I sets a price $u + \delta$ for its primary product and E sets zero for its complementary product. Clearly, there is no profitable deviation from it: I extracts all surplus that consumers derive from the two products and so has no incentive to deviate; and E has no incentive to deviate either, because if it tried to raise the price of E_c, consumers would not buy E (in fact, they would not buy at all) and hence E would still obtain zero profits. Next, consider the candidate equilibrium where I sets a price u for its primary product and E sets δ for its complementary product. Here as well all consumer surplus is extracted by sellers, and again, there is no profitable deviation from the candidate equilibrium: if either firm tried to raise its price, consumers would not buy. In the former equilibrium, all of the rents δ that consumers add to their basket by using also E_c are extracted by I; in the latter equilibrium, it is E which appropriates them. It turns out that any combination in between these two extremes are also equilibria. By denoting with $\beta \in [0, 1]$ the share of the rents which I manages to extract, we can therefore describe all of the possible equilibrium payoffs. We are assuming that $\beta = 1/2$, namely that the two firms equally share the rent from the complementary product.[30]

Note, however, that if E has its own version of the substitute product, so we are in the configuration $(I_p; E_p + E_c)$, then competition between the primary products drives I_p's price to zero and E_p's to Δ (at this price pair consumers will be indifferent between buying E_p and I_p), the entrant will sell its version of the primary product at equilibrium and will be able to appropriate all of its efficiency rents. Note that even if the entrant did not have a superior primary good (that is, $\Delta = 0$), developing

[30]See inter alia Carlton and Waldman (2002), who also assume $\beta = 1/2$. As in their model, this restriction does not affect the qualitative results, as long as $\beta \neq 1$. Under such an assumption, the game would become uninteresting: I already squeezes all of the rents from E_C, and hence creating a copycat product would be pointless.

E_p would raise its profits because it would avoid being squeezed of part of the efficiency rent on its complementary product.

In case of copying, I will have a clone of E_c on the market, which will bring the equilibrium price of the complementary products down to 0, and by setting the price of I_p to equal $u+\delta$, the incumbent will be able to appropriate all of the consumer surplus. When both I and E have a primary as well as a complementary product, competition will drive complement prices down to zero, while E can exploit its advantage in the primary product by setting the price Δ. I earns zero profits, E earns Δ, and consumers obtain the rest.

Further, when E has an additional complementary product, $\tilde{E}_c$, the same considerations as for the determination of the payoffs in case it has only E_c would apply.

Finally, note that all these are gross profits, which do not include the cost K of development for E, and the cost F of producing a copycat product for I.

Now that the payoffs are clear, it is worth stressing that we would obtain the same qualitative results if we assumed that the incumbent's version is not an identical copy, as long as product substitution is close enough to decrease significantly the entrant's market profits; and/or if we assumed that the entrant's primary product is not a superior version of the incumbent's, but it is horizontally differentiated, provided that its introduction raises the entrant's profits and decreases the incumbent's.

2.2 Funding and development of the project.

As mentioned above, the entrant might not hold sufficient assets A_E to cover the cost of the investment even after first period earnings. If this was the case, then in order to develop the new product (E_p or $\tilde{E}_c$), it would have to search for funding on perfectly competitive capital markets.

We assume that A_E is publicly observed by the market participants, all agents are risk neutral, the borrowing firm E has limited liability and the risk-free rate is zero.

To model financial contracting, we follow the standard model by Holmström and Tirole (1997), and assume that the probability that the entrant will successfully develop a new product (whether E_p or $\tilde{E}_c$) depends on the non-contractible effort it exerts. If it does, the probability of success is p that we set to $p = 1$; if E does not make effort, the project fails for sure, but it obtains a private benefit $B > 0$. In case of no effort the entrant will continue to sell its original product, E_c.

To make things interesting, we assume

$$K < \frac{\delta}{2}. \tag{A2}$$

Since $\Delta > \delta/2$, this ensures that developing either E_p ($\sigma_E = S$) or $\tilde{E}_c$ ($\sigma_E = C$) is profitable whether I copies ($\sigma_I = ©$) or not ($\sigma_I = \emptyset$). Consider first $\sigma_E = S$ and $\sigma_I = \emptyset$. The project has a positive net present value (NPV): $\Delta + \delta - K > \delta/2$, or $K < \Delta + \delta/2$, always satisfied by (A2). Similarly, if $\sigma_I = ©$ the project has a positive NPV since $\Delta - K > 0$.

Next turn to $\sigma_E = C$. Like in the previous case, the NPV of the project is positive by (A2): $\delta - K > \delta/2$. This is true regardless of whether incumbent engages in copying or not.

2.2.1 Financial contracting, when the incumbent does not act strategically

Let us consider first the financial contracting stage when the incumbent does not engage in copying, that is, it chooses $\sigma_I = \emptyset$ at the first stage of the game.

When funding is negotiated, the entrant and outside investors correctly anticipate that, if funded and if effort is made, the project will be successful and E will earn profits $\Delta + \delta$ or δ, depending on its product choice.

Outside investors are interested in financing the project only if E exerts effort. Consider the financial contract which gives the entrant the amount R^s in case of *s*uccess and R^f in case of *f*ailure of the project. Outside investors anticipate that, in case of funding, the entrant will exert effort if (and only if) the (IC) constraint $R^s \geq B + R^f$ is satisfied. In order to make it easier to elicit effort, the optimal contract establishes $R^f = 0$: the entrant obtains a revenue only when the project is successful. E's incentive compatibility constraint becomes:

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

At the moment of asking for funding, E will have assets $A' = A + \delta/2$, that is, the sum of its initial assets A and of any retained first-period market profits. Outside investors will then be willing to lend $K - A'$ if they expect to receive back as least as much. For a substitute this reads as

$$\Delta + \delta - R^s \geq K - A', \tag{IP$_S$}$$

Substituting in the investors' participation constraint (IP$_S$) the minimum amount of resources that must be attributed to the start-up to elicit effort (i.e. $R^s = B$ from condition (IC')), and rearranging, one obtains that the investors' participation constraint can be satisfied if (and only if):

$$A \geq \underline{A}_S \equiv B - (\Delta + 3\delta/2 - K), \tag{2}$$

Where $\underline{A}_S$ is the minimal level of initial assets that ensures that the project gets funded.

When this inequality holds, the entrant obtains external funding. Otherwise, it is credit rationed and cannot develop its version of the primary product even though the NPV of the project is positive. Perfect competition between investors implies that the participation constraint is satisfied with equality: $R^s = \Delta + \delta - (K - A - \delta/2)$.

Similarly, if E had decided to develop another complement, the project is funded iff:

$$A \geq \underline{A}_C \equiv B - (3\delta/2 - K) > \underline{A}_S. \tag{3}$$

We can now state the continuation equilibrium of the subgames where I takes no action.

Lemma 2. *If I decides not to copy the entrant's original complementary product E_c at $t = 1$, depending on $\sigma_E \in \{C, S\}$ and at equilibrium:*

(i) If $A < \underline{A}_{\sigma_E}$, the entrant is credit-rationed and will not invest.

(ii) If $A \geq \underline{A}_{\sigma_E}$, the entrant receives funding and undertakes the investment to develop E_p or $\tilde{E}_c$ (respectively if $\sigma_E = S$ or $\sigma_E = C$).

2.2.2 Financial contracting, when the incumbent copies

If at $t = 1$ the incumbent decides to incur the fixed cost F of copying, it will have product I_c, a perfect substitute to E_c.[31] As a result of the competition from the perfect substitute I_c, E will make zero profits on its product E_c, and the financing condition will amount to:

$$A \geq B - (\Delta - K) \equiv \overline{A}_S, \tag{4}$$

if the entrant intends to develop a substitute. This requirement is more stringent than that without the incumbent copying the entrant's first complement (see (2)).

Similarly, if the entrant develops a second complement, the financing condition is:

$$A \geq B - (\delta/2 - K) \equiv \overline{A}_C, \tag{5}$$

which is also more stringent than when incumbent takes no action, as given in (3).

It is now straightforward to derive the equilibrium of this stage, as follows.

Lemma 3. *If I decides to copy the entrant's complementary product E_c at $t = 1$, depending on $\sigma_E \in \{C, S\}$ and at equilibrium:*

(i) If $A < \overline{A}_{\sigma_E}$, the entrant is credit-rationed and will not invest.

(ii) If $A \geq \overline{A}_{\sigma_E}$, the entrant receives funding and undertakes the investment to develop E_p or $\tilde{E}_c$ (respectively if $\sigma_E = S$ or $\sigma_E = S$).

Note that the restrictions on parameters allow us to rank these thresholds as: $\underline{A}_S < \underline{A}_C < \overline{A}_S < \overline{A}_C$.

To focus on the most interesting cases, we assume that absent copying by the incumbent, the entrant would be able to develop either the substitute or the complement:

$$A_E \geq \underline{A}_C. \tag{A3}$$

2.3 Copying decision by the incumbent

Absent any cost of copying, the duplication of the complementary product of the entrant will be a profitable business strategy for the incumbent in a static perspective: if it monopolizes the primary market, by creating a perfect substitute of E_c, the incumbent depresses its market price and can raise the price of the primary product so as to appropriate all the surplus that consumers obtain from the complementary product. The incumbent obtains 'static' benefit from copying equal to $\delta/2$ whenever E does not have a substitute primary product, holding E's product portfolio constant. For instance,

[31] If the copy was imperfect, or if it were available with delay, the exclusionary power of the strategy would be lower.

from the payoffs table in Lemma 1, we can see that under the $(I_p; E_c)$ configuration, I's profits are $u + \delta/2$ whereas under $(I_p + I_c; E_c)$ the corresponding profits are $u + \delta$. This static benefit has to be compared to the copying cost F.[32]

In addition to the above static consideration, there is a dynamic perspective for I - copying might prevent the rival from finding financial support to develop a new product. This, in turn, has very different effects on I's incentive depending on the product choice by E. If E intended to develop a *substitute*, it would threaten I's entire profits. If $A_E < \overline{A}_S$, by imitating the incumbent can prevent E from obtaining financing, thus I may have *additional* incentive to invest in order to prevent E from obtaining financing.

If E has decided to develop a *complement*, I's strategic incentive to copy goes in the opposite direction. Indeed, E's success in developing the new complement benefits I by giving it rents from the new product, thus for $A_E < \overline{A}_C$, I may sacrifice static benefits from copying in order to facilitate the development of $\tilde{E}_c$. Therefore, for $\sigma_E = C$, from the dynamic point of view I has *less* incentive to imitate: it does not want to reduce the chance that E may develop another complement.

Once understood the incentives to engage in copying absent costs, it is intuitive that the optimal decision of the incumbent will depend on the fixed cost of copying. In particular, given the choice $\sigma_E = \{S, C\}$ of the entrant, there will be two relevant thresholds. Suppose the entrant will invest for sure (denote it by Y), whether I copies or not. Then I will choose to copy iff $\pi_I(\sigma_I = \copyright \mid Y) - F \geq \pi_I(\sigma_I = \emptyset \mid Y)$, or $F \leq \pi_I(\sigma_I = \copyright \mid Y) - \pi_I(\sigma_I = \emptyset \mid Y) \equiv F^{YY}_{\sigma_E}$. But we know that the copying decision may also prevent the entrant from developing its product (denote by N the case where the entrant cannot develop). If this is the case, then I will choose to copy iff $\pi_I(\sigma_I = \copyright \mid N) - F \geq \pi_I(\sigma_I = \emptyset \mid Y)$, or $F \leq \pi_I(\sigma_I = \copyright \mid N) - \pi_I(\sigma_I = \emptyset \mid Y) \equiv F^{YN}_{\sigma_E}$.

Accordingly, by replacing the payoffs in Lemma 1 [33] one can define the following thresholds:

$$F^{YY}_S \equiv \frac{\delta}{2}; \;\; F^{YN}_S \equiv u + \frac{3\delta}{2}; \;\; F^{YY}_C \equiv \delta; \;\; F^{YN}_C \equiv \frac{\delta}{2}. \tag{6}$$

as the associated cost levels at which I is indifferent between copying and not when $\sigma_E = S$ (first two thresholds) and when $\sigma_E = C$ (last two), when copying does not affect E's chance of developing (1st and 3rd threshold) and when it does (2nd and 4th).

From the discussion above, it should not come as a surprise that $F^{YY}_S < F^{YN}_S$, since I will have a *higher* incentive to copy when E chooses to develop a substitute; and that $F^{YY}_C > F^{YN}_C$, since it has *lower* incentive to copy when E chooses to develop a complement.

Finally, note that we can rank the thresholds as follows: $F^{YY}_S = F^{YN}_C < F^{YY}_C < F^{YN}_S$.

[32] The cost F may also be seen as a sort of reduced form for anything which might make copying more or less difficult. For instance, if the entrant's product was protected by some form of intellectual property right, then this would reflect into a higher F.

[33] In terms of Lemma 1, $\sigma_I = \copyright$ and $\sigma_I = \emptyset$ correspond to the configurations where I sells respectively $I_p + I_c$ and I_p alone. As for E, the case Y corresponds to the entrant selling either $E_c + E_p$ or $E_c + \tilde{E}_c$ depending on if it has chosen to develop a substitute or a second complement respectively; whereas N corresponds to E selling only E_c. Hence, for example, the notation $\pi_I(\sigma_I = \copyright \mid N)$ corresponds to $\pi_I(I_p + I_c; E_c)$ in Lemma 1.

Proposition 1 (Incumbent's best responses to the entrant's product choice)**.** *Depending on the product choice by E, the incumbent*

(i) For $\sigma_E = S$, I copies unconditionally if $F \leq F_S^{YY}$, and copies for $F \in [F_S^{YY}, F_S^{YN}]$ only if $A \in [\underline{A}_S, \overline{A}_S]$.

(ii) For $\sigma_E = C$, I copies unconditionally if $F \leq F_C^{YN}$, and copies for $F \in [F_C^{YN}, F_C^{YY}]$ only if $A \notin [\underline{A}_C, \overline{A}_C]$.

(iii) I does not copy in all other cases.

Proof. Suppose $\sigma_E = S$ (the entrant has chosen to develop a substitute). If $F < F_S^{YY}$, copying is so cheap that I will always copy: $S \rightarrow$ ©. At the other extreme, if $F > F_S^{YN}$, copying is so costly that I will never engage in copying: $S \rightarrow \emptyset$. For intermediate values, I will have an incentive to copy only if it can discourage E from developing its substitute, which can happen only if $A < \bar{A}_S$.

Suppose next $\sigma_E = C$ (the entrant has chosen to develop a second complement). In this case, I will want to abstain from copying if this led E not to develop another complement. Hence, copying is optimal only when both it is not too costly ($F < F_C^{YY}$) and it does *not* prevent E from developing the complement, which occurs when $A > \bar{A}_C$. □

Figure 2 illustrates Proposition 1 in the (A, F) space. The Figure also makes use of Lemmas 2 and 3, and indicates for any pair of choices σ_E and σ_I whether in the continuation equilibrium the entrant will be able to develop (Y) or not (N).

Static vs. strategic effects of copying Figure 1 also helps illustrate the static vs strategic effects of copying discussed above. Consider first a hypothetical case where the entrant intends to develop a substitute ($\sigma_E = S$) and cannot be prevented from developing the substitute. In this case, the only reason for copying is "static", and it would consist of allowing the incumbent to appropriate the extra rents $\delta/2$ in the first period (in the second period it will always make zero profits). Hence, in a static perspective copying will take place whenever $F \leq F_S^{YY} = \delta/2$.

However, Proposition 1 and Figure 1 tell us that the incumbent is also copying in the region where $A_E < \bar{A}_S$ and $F \in (F_S^{YY}, F_S^{YN}]$, where the copying allows to prevent the entrant from developing the substitute. Hence, *when $\sigma_E = S$, strategic reasons make copying more likely*.

Consider next the hypothetical case where the entrant intends to develop a complement ($\sigma_E = C$) and will develop the second complement no matter the strategy followed by I. In this case, the "static" rationale behind copying will consist of allowing the incumbent to appropriate the extra rents $\delta/2$ in *each* period (the appearance of a new complement in the second period does not modify the profits it can make on the original complement). Hence, in a static perspective copying will take place whenever $F \leq F_C^{YY} = \delta$.

Proposition 1 and Figure 1 show that the incumbent will *not* want to copy in the region where $A_E < \bar{A}_C$ and $F \in (F_C^{YN}, F_C^{YY}]$, because for this constellation of parameters the copying would

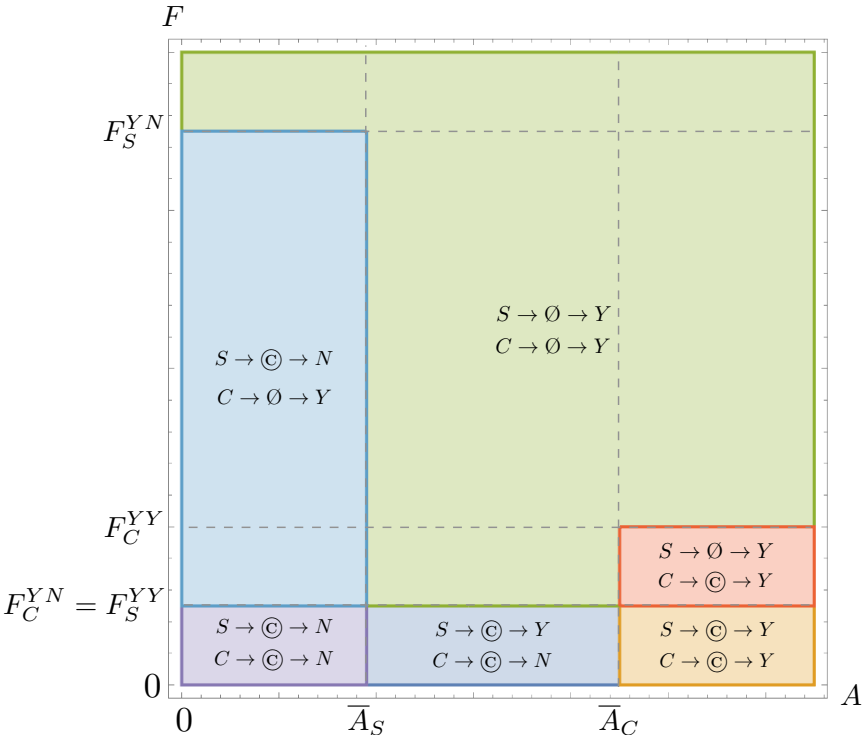

Figure 1. *I*'s best responses to *E*'s product choice: different cases in Proposition 1. In each pair, the first symbol corresponds to $\sigma_E = \{S, C\}$, the second to $\sigma_I = \{\textcircled{c}, \emptyset\}$, and the third to whether *E* will be able to develop its second product (Y) or not (N). In this and all other figures, unless noted, we use $u = 1$, $\delta = B = 0.5$, $\Delta = 0.51$ and $K = 0.2$.

.

prevent the entrant from developing the complement, depriving the incumbent of the extra profits $\delta/2$ it makes from the second complement. Hence, *when $\sigma_E = C$, strategic reasons make copying less likely*.

2.4 Product development choice by the entrant at $t = 0$

We are now in position to characterize the entrant's choice at $t = 0$, who has to choose $\sigma_E \in \{S, C\}$.

Proposition 2. *At $t = 0$, when it can choose which second product to develop $\sigma_E = \{S, C\}$:*

(i) If $A < \overline{A}_S$ and $F \in [F_C^{YN}, F_S^{YN}]$, then $\sigma_E = C$: the entrant chooses a complement and will be able to develop it;

(ii) If $A < \overline{A}_S$ and $F < F_C^{YN}$, the entrant is indifferent between choosing a substitute or a complement, because it will be unable to develop either;

(iii) In all other cases, $\sigma_E = S$: the entrant chooses a substitute and will develop it.

Proof. (i) When $A \in [\underline{A}_C, \overline{A}_S)$ the entrant will be able to fund the project of a substitute only if the incumbent does not copy. But if $F \in [F_C^{YN}, F_S^{YN}]$, the entrant expects copying by the incumbent, which would result in its inability to develop the substitute, and a total profit of 0. In contrast, if

E chose to develop a second complement, the incumbent would not copy because either the cost of copying is too high ($F > F_C^{YY}$), or because the incumbent strategically encourages investment by the entrant ($F \in (F_C^{YN}, F_C^{YY})$). This will result in E earning a higher profit of $3\delta/2$. Hence, $\sigma_E = C$ is optimal.

(ii) Since $F < F_C^{YN}$, the cost of copying is so low that I copies regardless of E's earlier choice. When $A < \underline{A}_S$ it also follows that $A < \underline{A}_C$, and hence the copying will deprive E of the possibility to develop either product. Whether $\sigma_E = C$ or $\sigma_E = S$, E's profits will be nil. Accordingly, E will be indifferent and at the continuation equilibrium it will just sell its original product.

(iii) For $A \geq \overline{A}_S$, the entrant will be able to develop the substitute product regardless of the incumbent's choice of copying its original product or not. Therefore, given that E makes higher profits when developing the substitute, it will always want to do so. If $A \in (\underline{A}_C, \overline{A}_S)$, the entrant can develop only if I does not copy. But if $F > F_S^{YN}$ (which is the only case we have not analyzed yet) copying is so expensive that I will always choose not to do it. Therefore, given its preference for developing the substitute, $\sigma_E = S$.

□

Figure 2 combines Propositions 1 and 2 in order to illustrate the SPNE path of the whole game.

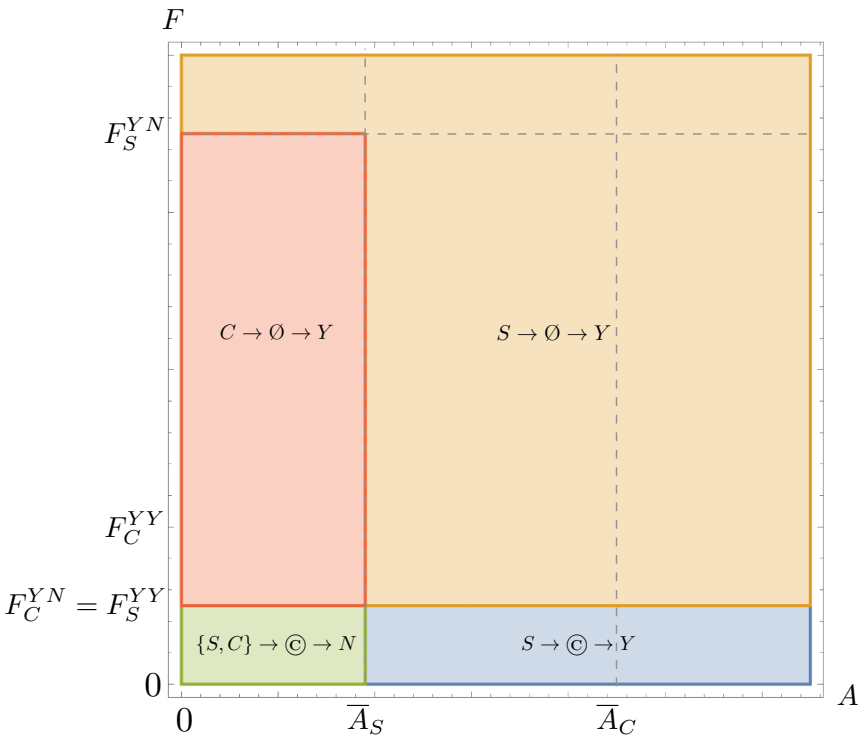

Figure 2. Equilibrium paths (see Proposition 2). The red region corresponds to (i), the green region to (ii) and the remaining regions to (iii). The first symbol corresponds to σ_E, the second to σ_I, and the third to whether E will be able to develop its second product (Y) or not (N).

Part (i) of Proposition 2 (illustrated by respectively the red region in Figure 2) arguably provides a rationalization of the "kill zone" argument: because of the risk of an exclusionary strategy by the incumbent, a potential entrant may prefer to avoid a market trajectory which would lead it to

compete with the core product of a dominant incumbent, and would choose to develop another complementary product instead.

2.5 Welfare analysis

In this Section we analyze the welfare effects of copying. Since demands are inelastic, copying cannot lead to allocative inefficiency. Nevertheless, copying may affect welfare via three different mechanisms. First, it leads to a duplication of costs, because total surplus does not increase when a copy of the original complement is produced, but a wasteful fixed cost emerges.[34] Second, it may result in the entrant not developing a new project, which would be welfare detrimental because by assumption (A2) whenever the entrant introduces either E_p or $\tilde{E}_c$ society gains. Third, copying may lead E to develop a complement rather than a substitute, which may be good or bad from the welfare point of view. Indeed, we know from Lemma 1 that welfare is higher with an additional complement than with a substitute of the primary product whenever $\Delta < \delta$, and vice versa.

The following Corollary states the effects of copying relative to a hypothetical benchmark in which copying is not allowed, for instance because there exist broad and strongly enforced IPR laws or because public policy prevents a dominant platform from copying complementary products hosted on its platform.

Corollary 1. *Relative to a benchmark in which copying is not feasible, copying has the following welfare effects:*

(i) If $A < \overline{A}_S$ and $F \in [F_C^{YN}, F_S^{YN}]$, copying pushes the entrant to develop a complement.

- *If $\Delta \geq \delta$ copying is (weakly) welfare detrimental;*
- *If $\Delta < \delta$ copying is welfare beneficial.*

(ii) If $A < \overline{A}_S$ and $F < F_C^{YN}$, the entrant is unable to develop a second product, and copying occurs at equilibrium. Hence, copying is welfare detrimental.

(iii)^a If $A \geq \overline{A}_S$ and $F \leq F_C^{YN} = F_S^{YY}$, the entrant will develop a substitute but the incumbent copies, resulting in welfare to decrease.

(iii)^b In all other cases, the entrant chooses a substitute and the incumbent does not copy, hence welfare is unaffected.

Proof. If copying is not feasible, the entrant will always develop the substitute at equilibrium ($S \rightarrow \emptyset \rightarrow Y$), resulting in $W = u + \delta + \Delta$. When copying is feasible, we have the following welfare levels. In region (i), at equilibrium $C \rightarrow \emptyset \rightarrow Y$, resulting in $W = u + 2\delta$, which is bigger than at the benchmark iff $\delta > \Delta$. In region (ii), there is copying but no development, resulting in

[34] In a model with elastic demands, copying may lower any allocative inefficiency arising from E having market power over the only complement, E_C, provided that the lower price is not entirely absorbed by an increase in price of the primary product.

$W = u + \delta - F$, lower than at the benchmark. In region (iii).a, there is a substitute, but also copying, hence $W = u + \delta + \Delta - F$, again lower than at the benchmark. In region (iii).b, at equilibrium we have the same outcome as in the benchmark. □

One may also be interested in looking at the effects of copying over consumer surplus. Note that a necessary condition for consumers to obtain positive surplus is that a substitute to the primary good is developed; otherwise, they have zero surplus. Given there is a substitute, they will receive additional surplus whenever copying arises, because they can also appropriate δ due to competition between the complementary products. This leads us to the following:

Corollary 2. *Relative to a benchmark in which copying is not feasible, copying has the following effects on consumers:*

(i) (Kill Zone) If $A < \overline{A}_S$ and $F \in [F_C^{YN}, F_S^{YN}]$, copying pushes the entrant to develop a complement: CS falls.

(ii) If $A < \overline{A}_S$ and $F < F_C^{YN}$, the entrant is unable to develop a second product, and copying occurs, but all surplus is appropriated by the incumbent via a higher price of I_p: CS falls.

(iii)^a If $A \geq \overline{A}_S$ and $F \leq F_C^{YN} = F_S^{YY}$, the entrant will develop a substitute but the incumbent copies: CS increases;

(iii)^b In all other cases, the entrant chooses a substitute and the incumbent does not copy, hence CS is unaffected.

Proof. Lemma 1 establishes CS under the different cases. At the benchmark, $S \rightarrow \emptyset \rightarrow Y$, hence a substitute is developed, and $CS = u$. In regions (i) and (ii) no substitute is develop, resulting in $CS = 0$. In region (iii).a, there is competition both between primary products and complements, resulting in $CS = u + \delta$, higher than at the benchmark. □

In sum, copying may play a positive or a negative role depending on (i) which welfare standard one adopts, (ii) whether a priori developing a substitute to the primary product is socially desirable or not: if the new substitute does not bring much additional surplus, it will represent a (partial) duplication for society, which may be better off if the entrant developed a new complement instead.

2.6 Unobservability of the entrant's strategy

So far, we have assumed that the entrant's development choice, $\sigma_E = \{S, C\}$ has been observed by the incumbent by the time it considers its own strategy, $\sigma_I = \{©, \emptyset\}$, that is when it decides whether to commit resources to copy the original complement. Here we show that if the incumbent was not able to observe σ_E at the moment of choosing σ_I, then the "kill zone" effect whereby the entrant stays away from the substitute in order to avoid being copied would not take place. Intuitively, in the game as we studied it so far, the only reason why the entrant is choosing a trajectory leading to

another complement is because it anticipates that if it chose one leading to a substitute, the incumbent would copy. But if the incumbent cannot observe the entrant's choice, then the entrant cannot hope to strategically affect the decision of the incumbent.

Formally, the game played by the two firms changes from a sequential game to a simultaneous move game (or a sequential game where moves cannot be observed, which amounts to the same). Under our assumptions, choosing a substitute is always a (weakly) dominant strategy for the entrant: if the incumbent does not copy, it always obtains funding and it would then choose a substitute trajectory; if the incumbent copies, three cases may arise: (i) it can develop both products, in which case it prefers the substitute; (ii) it can develop the substitute, but not the complement, which again makes it prefer the substitute; or (iii) it can develop neither, in which case it is indifferent between the two trajectories. Therefore, an equilibrium where the incumbent chooses not to copy and the entrant chooses to develop a complement — the equilibrium where the expectation of entering the "kill zone" pushes the entrant away from the substitute — can never arise.

The following states this result, which is illustrated by Figure 3.

Proposition 3. *When the entrant and the incumbent choose simultaneously σ_E and σ_I:*

(i) If $A < \overline{A}_S$ and $F \in [F_C^{YN}, F_S^{YN}]$, the equilibrium is $(\sigma_E = S, \sigma_I = ©)$, and the entrant will not be able to develop;

(ii) If $A < \overline{A}_S$ and $F < F_C^{YN}$, both $(\sigma_E = C, \sigma_I = ©)$ and $(\sigma_E = S, \sigma_I = ©)$ are equilibria, and the entrant will not be able to develop;

(iii) If $A \geq \overline{A}_S$ and $F < F_C^{YN}$, the equilibrium is $(\sigma_E = S, \sigma_I = ©)$, and the entrant will develop the substitute;

(iv) In all other regions, the equilibrium is $(\sigma_E = S, \sigma_I = \emptyset)$, and the entrant will develop the substitute.

Proof. To find the equilibrium solutions we need to find the intersection of the best replies. The incumbent's best replies to σ_E are given by Proposition 1 and illustrated by Figure 1. The entrant's best replies are as follows.

If $A < \bar{A}_S$, if I copies the entrant will never be able to develop, so it is indifferent between $\sigma_E = S$ and $\sigma_E = C$. If I does not copy, E will choose S. For $F < F_S^{YN}$, I's best reply to S is $\sigma_I = ©$, hence $(S, ©)$ will be an equilibrium. For $F < F_S^{YY}$, $\sigma_I = ©$ is I's best reply, hence $(C, ©)$ is also equilibrium. For $F \geq F_S YN$ I's best reply to S is not to copy, hence the equilibrium is $(S, \emptyset)$.

If $A \geq A_S$, playing $\sigma_E = S$ is the dominant strategy for E. Hence, the equilibrium is determined by I's best reply to $\sigma_E = S$. □

The main takeaway from this proposition is that the possibility that the incumbent engages in copying will not affect the direction of innovation any longer. When the incumbent could observe the entrant's decision, its own strategy would depend on the entrant's choice. In turn, the entrant may decide to stay away from the "kill zone" in order to elicit a softer response from the incumbent.

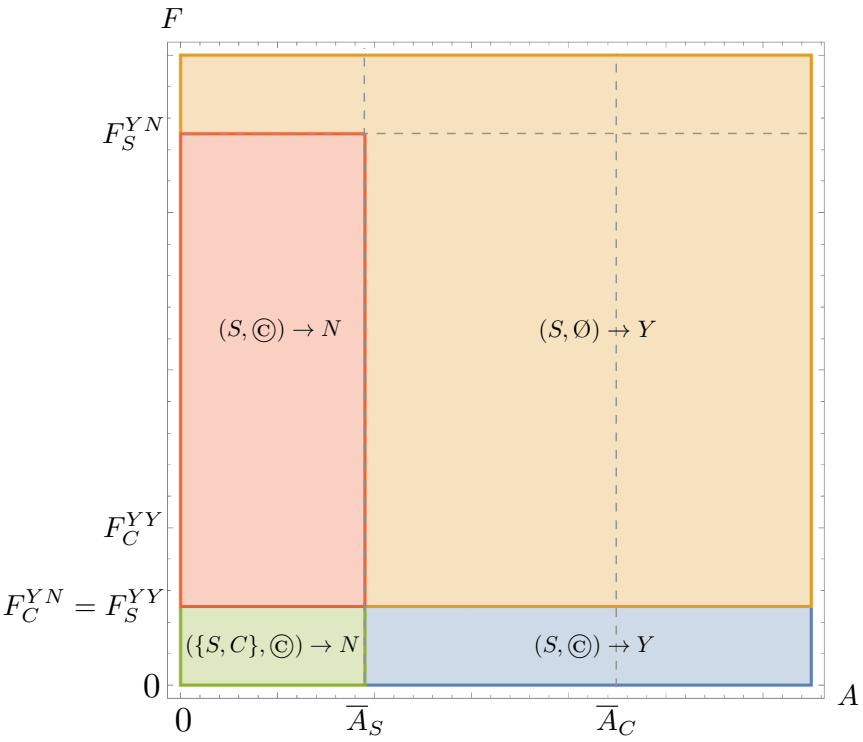

Figure 3. Equilibrium paths, when E and I choose strategies simultaneously (see Proposition 3).

As a result, there was region where the equilibrium path consisted of $C \to \emptyset \to Y$ because the entrant anticipated that choosing $\sigma_E = S$ would be followed by I's copying. This occurred in the region where $A < \bar{A}_S$ and the fixed cost of copying was intermediate. Once strategies are chosen simultaneously, if the incumbent copies the entrant is unable to develop anything and hence choosing a substitute trajectory is (by indifference) a best response to copying. And the incumbent will respond by copying whenever the entrant will choose a substitute. Hence, the only equilibrium in this region consists of $(S, ©)$.

In conclusion, the existence of a situation whereby the entrant avoids entering a substitute trajectory (i.e. the "kill zone") in order not to trigger the incumbent's aggressive response crucially depends on the observability of the entrant's strategy. Arguably, though, there may be situations where — through product design or marketing choices, for instance — the entrant could commit to some actions which signals that it does not intend to enter the incumbent's home turf. If it could find the way to convince the incumbent that it will not become a rival, and it would have all the incentive to commit to do so, then the game would be like the sequential moves game analysed above. Otherwise, the entrant will never choose a complement just to avoid copying, and it will jump into the "kill zone".

3 "Kill zone" and acquisitions

To explore how acquisitions may modify the entrant's and the incumbent's strategic choices, we extend the base model to allow for an acquisition to take place *after* the incumbent commits to

copying the entrant's original complementary product. (We shall discuss in Section 3.3 below the case where the acquisition may take place before the copying decision by the incumbent.)

3.1 The game with acquisitions

The game is the same as in the previous section, but we introduce an additional stage of the game between $t = 1$ and $t = 2$ where acquisitions can take place. In line with the hypothesis of balanced bargaining power made so far (I and E share equally the efficiency rents), we assume that the incumbent and the entrant share equally the gains (if any) from the acquisition.

We also assume that (a) the incumbent has assets $A_I > K$, so that it is always able to finance the project; (b) if it acquires the entrant it will have the same probability of success, $p = 1$; (c) after an acquisition the incumbent will not be able to change the nature of the project. In other words, if $\sigma_E = S$ (resp. $\sigma_E = C$), the incumbent can only develop the substitute E_p (resp. The new complement $\tilde{E}_c$). For simplicity, we will further impose that $u > \Delta$, so that the entrant's innovation is not too drastic compared to the original value of the incumbent's primary good.[35]

3.1.1 Development

To look for the equilibrium of this extended game, we move by backward induction. We have already studied the development decisions absent acquisitions. The following Lemma shows that in case the incumbent has acquired the entrant, development will always take place.

Lemma 4 (Development choices after acquisition)**.** *The incumbent always develops after acquiring the entrant.*

Proof. First, recall that we have assumed $K < \delta/2$. If $\sigma_E = C$ and I has taken over E. By developing the new complement the incumbent will obtain extra profits $\delta - K > 0$. If $\sigma_E = S$, by developing the substitute, the incumbent will obtain extra profits $\Delta - K$. □

The result that after a takeover I will always have an incentive to develop is by no means a general one. Under more general assumptions, the Arrow replacement effect would imply that the incumbent has less incentive to develop than an outsider, leading to so-called *killer acquisitions* (see e.g. Cunningham et al., 2021).[36]

3.1.2 Incumbent's choice and acquisition

Next, we move backwards to analyse the acquisition game and the incumbent's choice.

[35] We will explain its import later in this section where this assumption comes into play.

[36] We should note that the present model by construction can only generate welfare gains: first, if E did not have enough assets, the acquisition would allow for developing a product that otherwise would have not been developed; second, the existence of an inelastic demand implies there are no allocative inefficiencies resulting from the suppression of competition. Accordingly, this model is not suitable for a policy discussion on the effects of takeovers, but it still can help us understand how acquisitions may affect the incumbent's decision of copying. See Fumagalli et al. (2020) for a model which analyses the possible trade-offs that acquisitions may generate, and the optimal merger policy to deal with such acquisitions.

Proposition 4 (Incumbent's best responses and acquisition decision)**.** *Following the entrant's product choice, the incumbent's decision on copying and the acquisition outcome will be as follows.*

Denote $F_S^{ACQ} \equiv \frac{u+3\delta+\Delta-K}{2}$ *and* $F_C^{ACQ} \equiv \delta - \frac{K}{2}$:

(I) For $\sigma_E = S$*, I copies unconditionally if* $F \leq F_C^{YY} = \delta$*; it copies for* $F \in [F_C^{ACQ}, F_S^{ACQ}]$ *only if* $A \in [\underline{A}_C, \overline{A}_S]$*; it does not copy in all other cases. Acquisitions always take place in the continuation equilibria.*

(II) For $\sigma_E = C$*, I copies unconditionally if* $F \leq F_C^{ACQ}$*; it copies for* $F \in [F_C^{ACQ}, F_C^{YY}]$ *only if* $A \geq \overline{A}_C$*; it does not copy in all other cases. Acquisitions only take place for* $F < F_C^{ACQ}$ *and* $A \in [\underline{A}_C, \bar{A}_C)$.

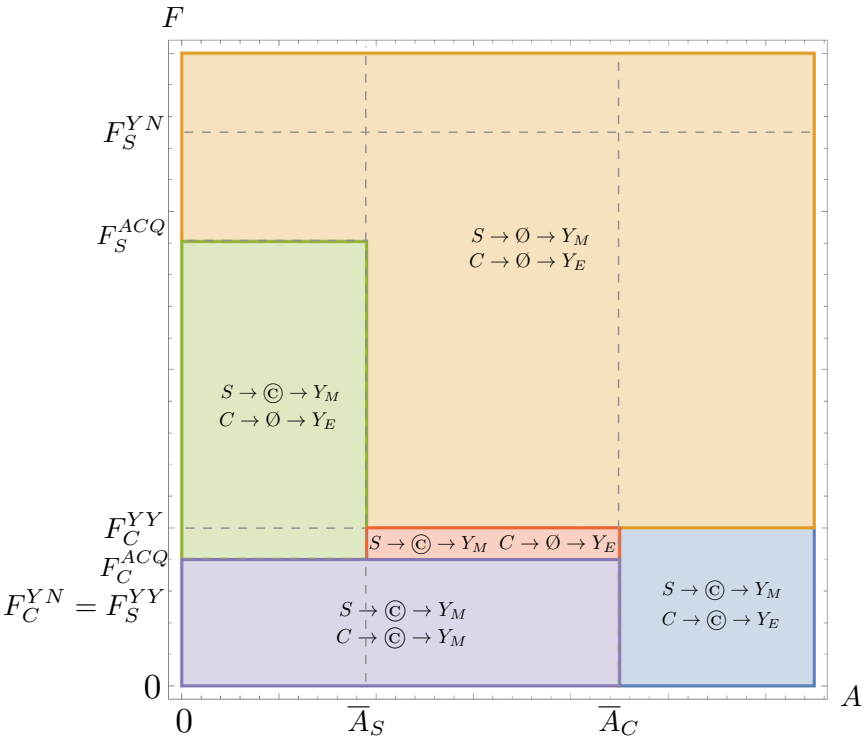

Figure 4. Best response and equilibrium solutions when acquisitions take place after the copying decision of the incumbent.

Figure 4 shows the incumbent's best responses and the development outcomes in the continuation path. The triples indicate the entrant's choice of product ($\sigma_E = \{S, C\}$), the incumbent's best reply to that ($\sigma_I = \{©, \emptyset\}$) and whether there is development by the entrant (Y), by the merged entity (Y_M) or no development in the continuation equilibrium.

Comparison with the incumbent's choices absent acquisitions Let us discuss how the possibility of acquiring the entrant modifies the incumbent's choice of copying. As we shall see, copying tends to be chosen for a wider range of parameter values. Intuitively, relative to the trade-off which arises absent acquisitions, now when the incumbent chooses between $\sigma_I = ©$ and $\sigma_I = \emptyset$ it will take into account that it will obtain half the gains from the acquisition. When the incumbent's copies

and the entrant has sufficient assets to develop the substitute, absent a takeover there will be more competition and hence lower industry profits: this will result in higher gains from the acquisition, of which the incumbent will appropriate a share.

Consider for instance the case where $\sigma_E = S$ and $A_E \geq \bar{A}_S$. If $\sigma_I = \emptyset$, the entrant would be able to develop (it has enough financial assets), and hence the acquisition allows to avoid competition, creating a gain from trade equal to u. Therefore, the incumbent will add $u/2$ over its disagreement payoff (that is, the profit absent the acquisition). If instead the incumbent chooses to copy the entrant's complement, then absent the acquisition competition will be very fierce because it will involve both the primary product and the complement. Hence, the gains from trade from the acquisition will be $u + \delta$. Hence, the incumbent will be able to add $u/2 + \delta/2$ to its disagreement payoff (i.e., the profit absent the acquisition). Given the cost of copying F, *the copying strategy is therefore more profitable under the acquisition*. By making the industry profits lower, the more aggressive copying strategy creates higher gains from the acquisition.

In some cases, the acquisition may also create opportunities for developing the project which would not arise in the base model, and this will affect the incumbent's optimal choice of copying. Consider for instance the case where $\sigma_E = S$ and $A < \bar{A}_S$. Here if the incumbent copies absent the acquisition the entrant will not be able to develop and the incumbent will appropriate all of the profits from the complementary product. The acquisition will therefore increase its disagreement payoffs by $(\Delta - K)/2$ (since after acquiring the entrant, the superior substitute will be developed). If instead it does not copy, the entrant will be able to develop (since $A > \underline{A}_S$), and hence the gain from the acquisition will be given by the avoidance of competition: the incumbent will add $u/2$ to its disagreement payoff. Since by assumption $\Delta - K < u$, for low initial assets of the entrant acquisitions make copying less likely in response to substitute choice. The opposite is true for $\sigma_E = C$ because here there is no gains from trade without copying, but there are with copying. As a result, for $A < \overline{A}_S$ if we further have $F \in [F_S^{YY}, F_C^{ACQ}]$ the incumbent's best response to C changes from no action to copying, while if $F \in [F_S^{ACQ}, F_S^{YN}]$ the incumbent's best response to S changes from copying to no action.

If $A \geq \bar{A}_C$, then acquisitions do not alter the choice of the incumbent. Whether it copies or not, the entrant will always develop, and the acquisition will not create any gains, and will hence not be done at equilibrium.

3.1.3 The entrant's choice

Let us analyse the entrant's choice between another complement and a substitute.

Proposition 5 (The entrant's equilibrium choice, when acquisitions are allowed)**.** *At $t = 0$, when it can choose which second product to develop $\sigma_E = \{S, C\}$:*

(i) (Kill Zone) If $A < \overline{A}_S$ and $F \in [F_C^{ACQ}, F_S^{ACQ}]$, then $\sigma_E = C$: the entrant chooses a complement and will be able to develop it;

(ii) If $A < \overline{A}_S$ and $F < F_C^{ACQ}$, the entrant will choose a substitute if $\Delta \geq \delta$ and a complement if $\Delta < \delta$;

(iii) In all other cases, $\sigma_E = S$: the entrant chooses a substitute and will develop it.

3.2 Discussion and comparison with the base model

Figure 5 draws the equilibrium solutions of the extended game with acquisitions, and compares them with the base model without acquisition (under the hypothesis that $\Delta > \delta$, but it is straightforward to see what changes if the reverse holds).

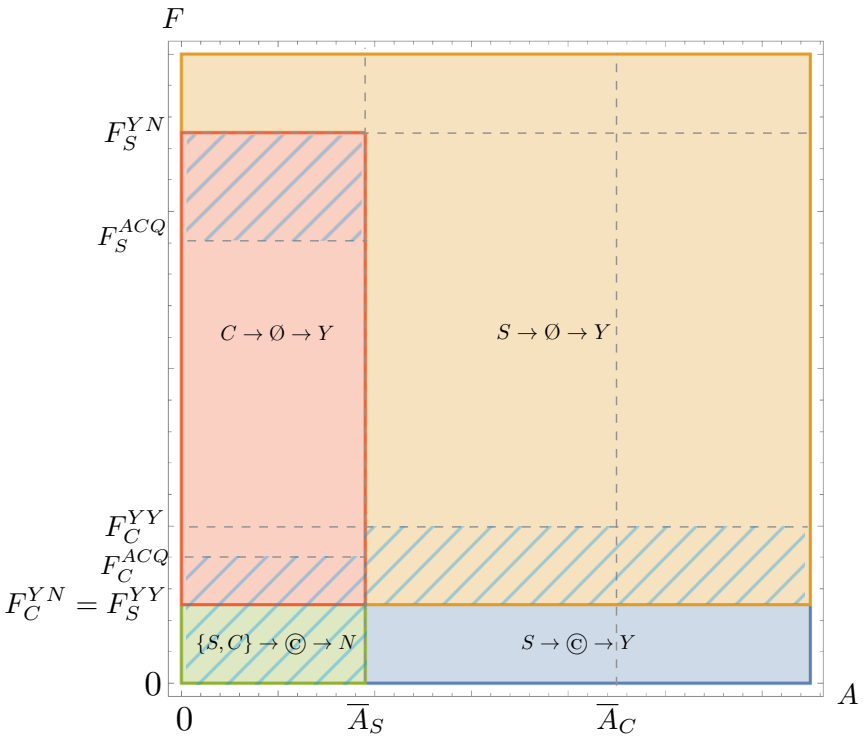

Figure 5. Equilibrium solutions absent acquisitions and when acquisitions take place after the copying decision of the incumbent.

A first consideration is that the "kill zone" still appears as a possible equilibrium outcome, although for a more reduced region of the parameter space. Indeed, for $A < \bar{A}_S$ and intermediate fixed costs of copying (i.e, copying is not a dominant strategy for I), then the entrant chooses to develop a second complement because if it chose to develop a substitute to the incumbent's primary product it would be copied. Although it will be acquired — and will appropriate some of the gains from the acquisition — after the incumbent copies it, the entrant's overall profits are higher if it develops a complement).

However, the prospect of getting some of the acquisition gains does tend to increase the profits from developing a substitute to the primary product, and this explains why part of the "kill zone" region where a complement was chosen absent the acquisition becomes characterised by the choice of

a substitute instead (more precisely, this happens for $A < \overline{A}_S$, in the intervals where $F \in [F_S^{ACQ}, F_S^{YN})$ and $F \in [F_S^{YY}, F_C^{ACQ})$).[37]

Overall, therefore, it appears that not only the existence of acquisitions tends to lead to copying by the incumbent for a broader set of parameter values (see discussion above), but also that it tends to increase the space where the entrant chooses to develop a substitute.[38]

3.3 Alternative formulations of the acquisition game

Acquisitions before the incumbent commits to copy We have so far discussed the role of acquisitions in our model within a game where they can take place after the incumbent decides whether to introduce a copycat version of the entrant's complement or not. An alternative formulation could be to allow for acquisitions to take place *before* the copying decision by the incumbent. We study this case in the Online Appendix 6, where we show that the results would be qualitatively similar to those found above. In particular, it would still hold that the acquisitions would result in the entrant to choose to develop a substitute rather than a complement for a broader set of parameter values.

Note that in this alternative formulation of the game copying would never occur along the equilibrium path: indeed, there would be an additional source of gains from acquisition (on top of avoiding competition and of permitting development in intervals where the independent entrant would not be able to obtain funding, should the incumbent copy) consisting precisely of avoiding the fixed cost of copying, F.

It is in order to show that both copying and acquisitions may occur at equilibrium that we have chosen to devote more attention to the version of the extended game where acquisitions can take place only after the incumbent decides on its copying strategy. On the other hand, it may be natural to think that acquisitions take place before the incumbent commits to the cost of copying, because this avoids an inefficiency and increases industry profits.

Explain that in our setting acquisitions never push the entrant towards complements... Finally, we note that if copying was not allowed in our model, the threat of acquisitions alone would not push the entrant towards developing a complement rather than a substitute. Absent copying, and if the acquisition did not take place, the entrant would be able to develop both a substitute and a second complement, and under our assumptions on parameters it would choose the former. If the acquisition was allowed, it would occur at equilibrium when the entrant chooses the substitute, because the suppression of competition would create gains from trade, but it would not occur when the entrant chooses the second complement, because there are no gains from trade (industry profits are the same with and without the acquisition). Although it would not modify the entrant's product

[37] Consider for instance the latter region. Both with and without acquisitions, if the entrant chooses $\sigma_E = S$, the incumbent will copy. Absent acquisitions, E chooses to develop a second complement, to avoid the incumbent's copying. But when acquisitions are allowed, choosing a substitute creates a surplus from the acquisition (because the takeover would avoid the loss of $u + \delta$ in industry profits), of which the entrant can appropriate a share.

[38] Note that here we rely on our earlier assumption $u > max\{\delta, \Delta\}$, otherwise there is a parameter region where absent acquisitions the equilibrium is $(S, \emptyset, Y_E)$ and with the acquisition it will be $(S, ©, Y_M)$.

equilibrium choices, therefore, the acquisition increases the profits from choosing $\sigma_E = S$, very much in line with what emerges from the extended games analysed in this section.

Some commentators have conjectured that the threat of being acquired by an incumbent may push a new firm not to develop products which may compete with a dominant incumbent, so as to avoid the "kill zone" represented by the core activity of the incumbent. Our paper points to the opposite direction, that is, that a firm may have an incentive towards developing substitutes, because it expects to appropriate some of the rents which are created by the acquisition, which avoids the dissipation of profits resulting from competition.[39]

4 A two-sided market version of the model

Some of the markets which motivate this work are characterised by two-sidedness, with consumers who do not pay for use, while firms' monetisation comes entirely from advertising. In this section, we provide a very stylised model of such a market, and show that the main qualitative results are not affected.

To keep things as simple as possible, continue to assume that the utility that consumers derive from using the products is the same as in previous sections. However, we assume that firms cannot charge consumers and obtain all their revenue from advertisers who pay a price proportional to consumer utility: for each unit of utility, a firm derives a revenue equal to μ, which we normalise to 1 without loss of generality. Further, assume that the primary product obtains an extra advertising revenue when a complement is available together with its primary product — for instance because to have access to the complement, consumers have to be on the platform (or because the platform obtains extra data from the consumers' activity on the complement, which allows the incumbent to increase monetisation): we denote with $\gamma \in (0, 1)$ this additional revenue.

For instance, if the market configuration is $(I_p; E_c)$, the incumbent obtains a revenue $u + \delta\gamma$ and the entrant obtains a revenue δ. When the incumbent sells a perfect substitute of the entrant's complement, we assume that firms split equally demand for the complement. As a result, if the market configuration was, say, $(I_p + I_c; E_c)$ then the incumbent obtains a revenue $u + \delta/2 + \delta\gamma$ and the entrant revenue $\delta/2$. It is then straightforward to summarise the payoffs as follows.

Market Configuration	π_I	π_E
$(I_p; E_c)$	$u + \delta\gamma$	δ
$(I_p + I_c; E_c)$	$u + \delta(1/2 + \gamma)$	$\delta/2$
$(I_p; E_p + E_c)$	0	$u + \Delta + \delta(1 + \gamma)$
$(I_p + I_c; E_p + E_c)$	$\delta/2$	$u + \Delta + \delta(1/2 + \gamma)$
$(I_p; E_c + \tilde{E}_c)$	$u + 2\delta\gamma$	2δ
$(I_p + I_c; E_c + \tilde{E}_c)$	$u + \delta(1/2 + 2\gamma)$	$3\delta/2$

[39] Of course, one may think of particular mechanisms through which the threat of acquisitions may result in the entrant to refrain from challenging the incumbent's home turf. See for instance Kamepalli et al. 2020.

We now make an assumption analogous to A1(b) and A2, namely that absent copying (i) the project has positive NPV regardless of the path taken; and (ii) the substitute path is preferable:

$$\gamma\delta + \Delta > \delta > k. \tag{A4}$$

By making use of the firms' payoffs we can then identify the relevant thresholds needed to find the equilibrium solutions. Let us start with the threshold levels of the assets that ensure the entrant's project will be funded. Following the same steps as in Section 2, the investors' participation constraint is satisfied if (and only if):

$$\pi_E(\sigma_I, \sigma_E, D) - B \geq K - A', \tag{7}$$

where $\pi_E(\sigma_I, \sigma_E, D)$ is the profit obtained in the second period, which depends on the strategies chosen by I and E and on whether E is able to develop or not: $D = \{Y, N\}$), and A' is the first period profit, $\pi_E(\sigma_I, \{Y, N\}, N)$ (which just depends on I's strategy, since in the first period E has only the first complement and cannot have developed another product yet). By making use of the payoffs above, we can obtain the relevant asset thresholds, as follows:

$$A_E \geq B + K - (u + \Delta + \delta(2 + \gamma) \equiv \underline{A}_S; \;\; A_E \geq B + K - (3\delta) \equiv \underline{A}_C; \tag{8}$$

$$A_E \geq B + K - (u + \Delta + \delta(1 + \gamma) \equiv \overline{A}_S; \;\; A_E \geq B + K - (2\delta) \equiv \overline{A}_C, \tag{9}$$

where we have kept the same notation as in the previous sections. Let us assume:

$$u + \Delta > \delta(1 - \delta) \tag{A5}$$

Note that a sufficient (but far from necessary) condition for this assumption to hold is that the complement does not give consumers more utility than the primary product. Armed with this assumption, we obtain that the thresholds can be ranked as follows: $\underline{A}_S < \underline{A}_C < \overline{A}_S < \overline{A}_C$, like in the base model. We also continue to assume ($A3$) holds: $A_E > \underline{A}_C$, that is, the entrant will be able to develop if the incumbent does not copy.

We can now turn to the fixed cost thresholds of the incumbent. Recall that, given the choice $\sigma_E = \{S, C\}$ of the entrant, there will be two relevant thresholds. First, if the entrant invests for sure ($D = Y$), independently of σ_I, then I will choose to copy iff $\pi_I(©, \sigma_E, Y) - F \geq \pi_I(\emptyset, \sigma_E, Y)$, or $F \leq \pi_I(©, \sigma_E, Y) - \pi_I(\emptyset, \sigma_E, Y) \equiv F^{YY}_{\sigma_E}$.

Second, if the copying decision prevents the entrant from developing ($D = N$), then I will choose to copy iff $\pi_I(©, \sigma_E, N) - F \geq \pi_I(\emptyset, \sigma_E, Y)$, or $F \leq \pi_I(©, \sigma_E, N) - \pi_I(\emptyset, \sigma_E, Y) \equiv F^{YN}_{\sigma_E}$.

By replacing the payoffs above, we obtain the relevant fixed cost thresholds:

$$F^{YY}_S = \delta; \;\; F^{YN}_S = u + \delta(1 + \gamma); \;\; F^{YY}_C = \delta; \;\; F^{YN}_C = \delta(1 - \gamma). \tag{10}$$

We are now armed with all the ingredients to find the equilibrium solutions of the game, which are summarised in the following proposition.

Proposition 6. *At $t = 0$, when it can choose which second product to develop $\sigma_E = \{S, C\}$:*

(i) If $A < \overline{A}_S$ and $F \in [F_C^{YN}, F_S^{YN}]$; or if $\bar{A}_S \leq A_E < \bar{A}_C$ and $F_C^{YN} \leq F < F_C^{YY}$ and $u + \Delta < \delta(3 - \gamma)$: the entrant chooses to develop a complement;

(ii) If $A < \overline{A}_S$ and $F < F_C^{YN}$, the entrant is indifferent between complement and substitute, since it will be unable to develop either);

(iii) In all other cases, $\sigma_E = S$: the entrant chooses a substitute and will develop it.

Proof. The proof is by backward induction. To find the best replies of the incumbent to the entrant's choice, it is enough to apply the thresholds obtained above, in each region of the entrant's assets. For instance, if $A_E < \bar{A}_S$, then we know that if $\sigma_E = S$ the incumbent will prefer to copy if $F \leq F_S^{YN}$, and will not copy otherwise. If $\sigma_E = C$, then I will copy for $F \leq F_C^{YN}$. Likewise for the remaining intervals. I's best replies are summarised by Figure 6.

Next, we find the optimal strategies of the entrant, for each of the relevant region of the plan. Consider for instance the region where $A < \overline{A}_S$ and $F \in [F_C^{YN}, F_S^{YN}]$. The entrant knows that if it chooses S, the incumbent will copy and hence will not be able to develop; whereas if it chooses C, the incumbent will not copy and it will be able to develop. Hence, it will need to compare the associated profits. Since $\pi_E(S, ©, N) < \pi_E(C, \emptyset, Y)$ amounts to $\delta < 4\delta$, it will choose to develop the complement.

Consider next the region where $\bar{A}_S \leq A_E < \bar{A}_C$ and $F_C^{YN} \leq F < F_C^{YY}$. Here if the entrant chooses S, the incumbent will copy but it will still be able to develop; if it chooses C, the incumbent will not copy and it will be able to develop. The inequality $\pi_E(S, ©, N) < \pi_E(C, \emptyset, Y)$ amounts to $u + \Delta + \delta(1 + \gamma) < 4\delta$, or $u + \Delta < \delta(3 - \gamma)$, which is the condition stated in the proposition for E to choose a complement.

In the same manner, one can find all the other optimal choices.

□

Figure 6 illustrates the incumbent's best replies and the entrant's equilibrium choices derived in Proposition 6.

The comparison between Propositions 2 and 6 or the associated Figures 2 and 6 reveals that the results are qualitatively very similar. In particular, there exist parameter values such that the entrant decides to develop a complement because it anticipates that if it chose a substitute then the incumbent would copy, and it will be unable to have sufficient funding. This is the possible rationalization of the "kill zone" argument: a start-up stays away from an innovation trajectory leading to a substitute because it fears the aggressive reaction of the dominant incumbent.

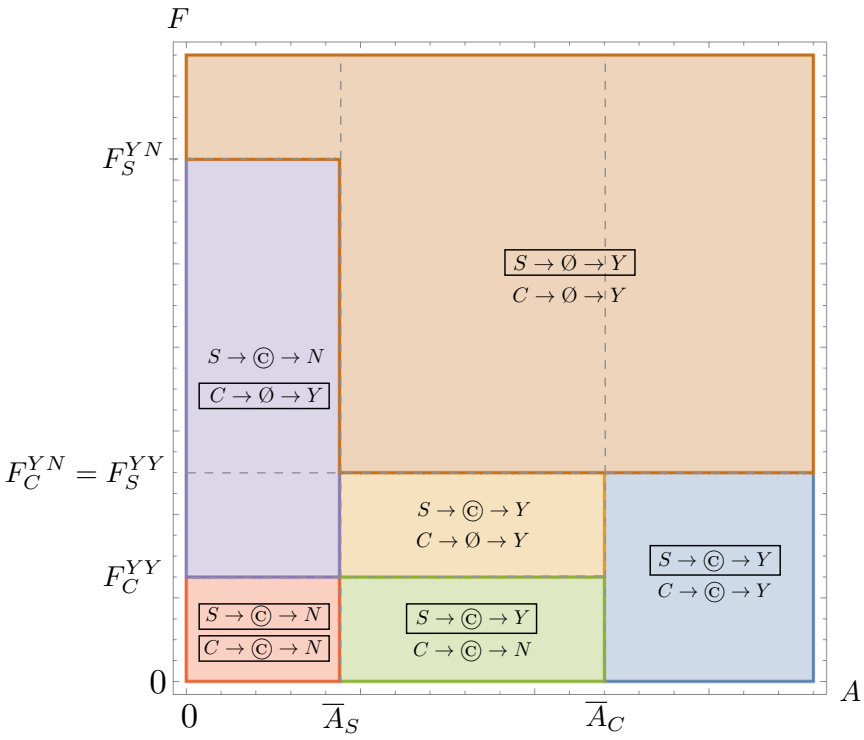

Figure 6. Best replies and (in the boxes) equilibrium solutions in the two-sided version of the model. In the central region with no box, the equilibrium path is $C \to \emptyset \to Y$ if $u + \Delta > \delta(3 - \gamma)$ and $S \to © \to Y$ otherwise. In this figure we use $\delta = u = \gamma = 0.5$, $\Delta = 0.51$, $K = 0.2$, and $B = 2$.

5 Concluding remarks

In this paper we have rationalized the well-known "kill zone" argument by providing a simple model that explains how and when an incumbent firm may induce an entrant to choose a "non-aggressive" innovation path. More precisely, the model revealed that platform-owning incumbents react in diametrically opposing fashion to an entrant's plans to develop a substitute to their platform (by fighting) and a complement (by accommodating). In turn, this is why a kill zone may emerge: an entrant may refrain from developing a product which competes with the incumbent fearing its reaction (which in our model takes the shape of the incumbent introducing a copycat version of the entrant's original complement product). Interestingly, the possibility of an acquisition by the incumbent does not make the kill zone effect worse, but it may even induce the entrant to develop a product which may rival with the incumbent, in the hope of being acquired and share rents from suppression of competition.

6 References

Ali, A., Kalwani, M.U., Kovenock, D. (1993). "Selecting product development projects:pioneering versus incremental innovation strategies". Management Science 39, 255-274.

Bourreau, Marc and Alexandre de Streel (2019). "Digital Conglomerates and EU Competition Policy", Working Paper available at https://ssrn.com/abstract=3350512.

Burns, Malcolm R. (1986). "Predatory Pricing and the Acquisition Cost of Competitors." Journal of Political Economy, 94(2): 266-296.

Cabral, Luis (1994), "Bias in market R&D portfolios", International Journal of Industrial Organization, 12(4): 533-547.

Cabral, Luis (2021). "Merger policy in digital industries", Information Economics and Policy, 54.

Carlton, Dennis and Michael Waldman (2002), "The Strategic Use of Tying to Preserve and Create Market Power in Evolving Industries", The RAND Journal of Economics, 33(2): 194-220.

Carlton, Dennis and Michael Waldman (2012), "Upgrades, Switching Costs and the Leverage Theory of Tying", The Economic Journal, 122(561): 675-706.

Choi, Jay-Pil and Doh-Shin Jeon (2018) "A Leverage Theory of Tying in Two-sided Markets". Mimeo.

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

Cunningham Colleen, Florian Ederer, and Song Ma (2021), "Killer Acquisitions", Journal of Political Economy, 123(9): 649-702.

Dijk, Esmee, Jose L. Moraga Gonzalez, and Evgenia Motchenkova (2021), "How Do Start-up Acquisitions Affect the Direction of Innovation?", manuscript.

Farrell Joseph and Michael L. Katz (2000), "Innovation, Rent Extraction, and Integration in Systems Markets", Journal of Industrial Economics, 48(4): 413-432.

Farrell Joseph and Michael L. Katz (2006), "The Economics of Welfare Standards in Antitrust", Competition Policy International, 2(2): 2-28.

Federal Trade Commission (2020). "FTC v. Facebook, Inc. Complaint for Injunctive and other Equitable Relief", https://www.ftc.gov/enforcement/cases-proceedings/191-0134/facebook-inc-ftc-v

Fumagalli, Chiara and Massimo Motta (2020). "Dynamic vertical foreclosure", Journal of Law and Economics, 63: 763-812.

Fumagalli, Chiara, Massimo Motta, and Claudio Calcagno (2018). Exclusionary Practices. The Economics of Monopolisation and Abuse of Dominance, Cambridge University Press.

Fumagalli, Chiara, Massimo Motta, and Emanuele Tarantino (2020), "Shelving or Developing? The Acquisition of Potential Competitors Under Financial Constraints", CEPR Discussion Paper No. DP15113.

Furman Jason, Diane Coyle, Amelia Fletcher, Philip Marsden and Derek McAuley (2019). "Unlocking digital competition. Report of the Digital Competition Expert Panel", March 2019. Available at www.gov.uk/government/publications

Gans, Joshua S. and Scott Stern (2000). "Incumbency and R&D Incentives: Licensing the Gale of Creative Destruction", Journal of Economics & Management Strategy, 9(4): 485-511.

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

Hagiu, Andrei, Tat-How Teh, and Julian Wright (2020). "Should Amazon Be Allowed to Sell on Its Own Marketplace?." Available at SSRN 3606055.

Henkel, Joachim, Thomas Rønde, and Marcus Wagner (2015). "And the winner is — Acquired. Entrepreneurship as a contest yielding radical innovations", Research Policy, 44: 295-310

Jiang, Baojun, Kinshuk Jerath, and Kannan Srinivasan. "Firm Strategies in the 'Mid Tail' of Platform-based Retailing", Marketing Science, 30(5) (2011): 757-775.

Hellmann, Thomas (2002). "A Theory of Strategic Venture Investing", Journal of Financial Economics. 64(2): 285-314.

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

Kamepalli, Sai Krishna, Raghuram Rajan, and Luigi Zingales (2020), "Kill zone". NBER Working Paper No. 27146.

Katz, Michael L. (2021), "Big-Tech Mergers: Innovation, Competition for the Market, and the Acquisition of Emerging Competitors", Information Economics and Policy, 54.

Letina, Igor, Armin Schmutzler and Regina Seibel (2020). "Killer Acquisitions and Beyond: Policy Effects on Innovation Strategies." Manuscript.

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

Saloner, Garth (1987). "Predation, Mergers, and Incomplete Information". The RAND Journal of Economics, 18(2): 165-186.

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

Shapiro Carl, "Antitrust in a time of populism" (2018). International Journal of Industrial Organization, 61, 714-748.

Singh Nirvikar and Xavier Vives (1984),"Price and Quantity Competition in a Differentiated Duopoly", The RAND Journal of Economics, 15(4): 546-554.

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

Tirole, Jean (2019). "Regulating the disrupters". Project Syndicate. Also available at: https://www.livemint.co
the-disrupters-Jean-Tirole.html

US Congress Majority Staff Report (2020). "Investigation on Competition in Digital Markets", October 4, 2020.

Appendix A1

Proof of Lemma 1

Here we derive the payoffs corresponding to the possible market configurations.

- $(I_p; E_c)$. Consider first a price equilibrium where I is able to extract all of the consumer surplus, for instance: $p_{I_p} = u + \delta; p_{E_c} = 0$. At this candidate equilibrium, E makes no profits, but given I's price, it cannot profitably deviate. For instance, if it increased its price, consumers would simply refrain from buying; and by decreasing prices, it would make losses. I has no incentive to deviate either, since it already extracts all surplus from consumers.

  Next, consider the other extreme equilibrium where $p_{I_p} = u; p_{E_c} = \delta$. Here, there is no deviation by I which would make it better off: by decreasing its price it would get lower profits, and by raising it consumers would not purchase any longer. Likewise, E would not have an incentive to change p_{E_c}. Between these two equilibria, there is a continuum of price equilibria: $p_{I_p} = u + \beta\delta; p_{E_c} = (1 - \beta)\delta$, where $\beta \in [0, 1]$ can be interpreted as the bargaining power of I, or the probability that it can set prices first.

  Note also that no other price equilibrium exists. For instance, an equilibrium where $p_{E_c} > \delta$ and $p_{I_p} < u$ would not exist, because I could set $p_{I_p} = u - \varepsilon$ and consumers would prefer to buy I_p alone.

  One might interpret the result as a Nash bargaining solution with weight β: the outside value for I being u, E's outside value being 0, and the surplus from the agreement being δ.

- $(I_p + I_c; E_c)$. Here the existence of a perfect substitute to E_c drives the price of this complementary product down to zero: $p_{E_c} = p_{I_c} = 0$, making it possible for I, which is monopolising the primary product, to extract all surplus from consumers, e.g. by setting $p_{I_p} = u + \delta$. I would not have any incentive to deviate since it is already getting all surplus. And if E tried to increase prices above zero, nobody would buy E_c. (Whether at equilibrium consumers buy E_c or I_c is immaterial.)

- $(I_p; E_p + E_c)$. Here both I and E have the primary product, E's being superior, and E has a complementary product. At the candidate price equilibrium, $p_{I_p} = 0; p_{E_p} = \Delta; p_{E_c} = \delta$, consumers buy E_p and E_c, and obtain an overall surplus equal to u. They would achieve the same utility if they deviated and bought (I_p, E_c), and the indifference explains why there are no incentives to deviate for either E or I. For instance, if E raised p_{E_p}, consumers would switch to I_p, and so forth.

  No other equilibrium exists because Bertrand-like competition for the primary product has to drive p_{I_p} to zero, and then E has to charge $p_{E_p} = \Delta$ for the primary product and extract all surplus for the complement with $p_{E_c} = \delta$.

- $(I_p + I_c; E_p + E_c)$. Competition drives prices of the complementary and primary product down to respectively $p_{E_c} = p_{I_c} = 0$ and $p_{E_p} = \Delta, p_{I_p} = 0$. Consumers would buy E_p and are indifferent between E_c and I_c, getting $CS = u + \delta$. For similar reasoning as in the previous cases, there are no profitable deviations, nor alternative equilibria.

- $(I_p; E_c + \tilde{E}_c)$: Much like the case with $(I_p; E_c + \tilde{E}_c)$, in this case I extracts all surplus from

the primary good and β share of the surplus from the two complementary products. Prices are $p_{I_p} = u + \beta(\delta + \tilde{\delta}); p_{E_c} = (1-\beta)\delta; p_{\tilde{E}_c} = (1-\beta)\tilde{\delta}$.

- $(I_p + I_c; E_c + \tilde{E}_c)$: Price for the first complement is driven down to zero $p_{I_c} = 0; p_{E_c} = 0$. The incumbent extracts all the surplus from the primary good and the first complement, as well as share β of surplus from the second complement by charging $p_{I_p} = u + \delta + \beta\tilde{\delta}$; E charges $p_{\tilde{E}_c} = (1-\beta)\tilde{\delta}$.

Proof of Proposition 4

The extended game is one where after E has chosen $\sigma_E = \{S, c\}$, I chooses $\sigma_I = \{\emptyset, ©\}$, followed by the negotiation over the acquisition and the usual remaining stages of the game. Moving backwards let us analyse the equilibrium at the acquisition stage. We consider first the case (I) where $\sigma_E = S$ and then that where (II) $\sigma_E = C$.

(I) The entrant has chosen to develop a substitute. If $\sigma_E = S$, the incumbent could decide not to copy (I.a) or to copy (I.b).

(I.a): $\sigma_E = S; \sigma_I = \emptyset$. If there is no acquisition, payoffs will be:

$$\pi_E^{no}(S, \emptyset, Y_E) = \Delta + \frac{3\delta}{2} - K; \;\; \pi_I^{no}(S, \emptyset, Y_E) = u + \frac{\delta}{2}$$

where $(S, \emptyset, Y_E)$ refers to the payoff corresponding to the entrant's choosing the substitute ($\sigma_E = S$), the incumbent not copying ($\sigma_I = \emptyset$), and the fact that the entrant will be able to develop (Y_E).

If an acquisition takes place, the merged entity will earn $\pi_M(S, \emptyset, Y_M) = 2u + \Delta + 2\delta - K$, hence the gains from the acquisition (to be split equally between I and E) amount to u. (Note that Y_M refers to the merged entity, rather than the entrant, developing the project.) As a result, the acquisition will take place and payoffs will be:

$$\pi_E^{ACQ}(S, \emptyset, Y_M) = \Delta + \frac{3\delta}{2} + \frac{u}{2} - K; \;\; \pi_I^{ACQ}(S, \emptyset, Y_M) = \frac{3u + \delta}{2}.$$

(I.b): $\sigma_E = S; \sigma_I = ©$. If there is no acquisition, payoffs will depend on the assets of the entrant:

- If $A < \bar{A}_S$: $\pi_E^{no}(S, ©, N) = 0; \;\; \pi_I^{no}(S, ©, N) = 2(u + \delta) - F;$

  where $(S, ©, N)$ refers to $\sigma_E = S$, $\sigma_I = ©$, and the entrant *not* being able to develop (N). If the acquisition takes place, the merged entity will earn $\pi_M(S, ©, Y_M) = 2u + \Delta + 2\delta - K - F$, hence the gains from the acquisition (to be split equally between I and E) amount to $\Delta - K$. As a result, if $A < \bar{A}_S$ the acquisition will occur and payoffs will be:

$$\pi_E^{ACQ}(S, ©, Y_M) = \frac{\Delta - K}{2}; \;\; \pi_I^{ACQ}(S, ©, Y_M) = 2(u + \delta) + \frac{\Delta - K}{2} - F.$$

- If $A \geq \bar{A}_S$: $\pi_E^{no}(S, ©, Y_E) = \Delta - K$; $\pi_I^{no}(S, ©, Y_E) = u + \delta - F$;

  If an acquisition takes place, the merged entity will earn $\pi_M(S, \emptyset, Y_M) = 2u + \Delta + 2\delta - K - F$, hence the gains from the acquisition (to be split equally between I and E) amount to $u + \delta$. As a result, if $A \geq \bar{A}_S$ the acquisition will take place and payoffs will be:

$$\pi_E^{ACQ}(S, ©, Y_M) = \Delta - K + \frac{u + \delta}{2}; \quad \pi_I^{ACQ}(S, ©, Y_M) = \frac{3(u + \delta)}{2} - F.$$

(I): the incumbent's choice of copying, when $\sigma_E = S$. We now look for the incumbent's choice between copying and not copying, having seen that in either case the acquisition will take place.

- $If\ A < \bar{A}_S$: $\pi_I^{ACQ}(S, ©, Y_M) \geq \pi_I^{ACQ}(S, \emptyset, Y_M) \quad \Leftrightarrow F \leq \frac{u+3\delta+\Delta-K}{2}$.
- $If\ A \geq \bar{A}_S$: $\pi_I^{ACQ}(S, ©, Y_M) \geq \pi_I^{ACQ}(S, \emptyset, Y_M) \quad \Leftrightarrow F \leq \delta$.

II. The entrant has decided to develop a complement. The incumbent could decide not to copy (II.a) or copy (II.b).

(II.a): $\sigma_E = C; \sigma_I = \emptyset$. If there is no acquisition, payoffs will be:

$$\pi_E^{no}(C, \emptyset, Y_E) = \frac{3\delta}{2} - K; \quad \pi_I^{no}(C, \emptyset, Y_E) = 2u + \frac{3\delta}{2}.$$

If an acquisition takes place, the merged entity will earn $\pi_M(S, \emptyset, Y_M) = 2u + 3\delta - K$, hence there are *no gains from the acquisition*. As a result, the acquisition will not take place.

(II.b): $\sigma_E = C; \sigma_I = ©$. If there is no acquisition, payoffs will depend on the assets of the entrant:

- $If\ A < \bar{A}_C$: $\pi_E^{no}(C, ©, N) = 0$; $\pi_I^{no}(C, ©, N) = 2(u + \delta) - F$.

  If the acquisition takes place, the merged entity will earn $\pi_M(C, ©, Y_M) = 2u + 3\delta - K - F$, hence the gains from the acquisition (to be split equally between I and E) amount to $\delta - K$. The acquisition will occur and payoffs will be:

$$\pi_E^{ACQ}(C, ©, Y_M) = \frac{\delta - K}{2}; \quad \pi_I^{ACQ}(C, ©, Y_M) = 2(u + \delta) + \frac{\delta - K}{2} - F.$$

- $If\ A \geq \bar{A}_C$: $\pi_E^{no}(C, ©, Y_E) = \frac{\delta}{2} - K$; $\pi_I^{no}(C, ©, Y_E) = 2(u + \delta) + \frac{\delta}{2} - F$.

  If an acquisition takes place, the merged entity will earn $\pi_M(S, \emptyset, Y_M) = 2u + 3\delta - K - F$, hence there are *no gains from the acquisition*. The acquisition will not take place.

(II): the incumbent's choice of copying, when $\sigma_E = C$. We now look for the incumbent's choice between copying and not copying.

- $If\ A < \bar{A}_C:\ \pi_I^{ACQ}(C, ©, Y_M) \geq \pi_I^{no}(C, \emptyset, Y_E) \ \Leftrightarrow F \leq \delta - \frac{K}{2} \equiv F_C^{ACQ}$.

  In the interval $A < \bar{A}_C$, absent acquisitions, copying emerged for $\sigma_E = C$ if $F < \delta/2$. Since $\delta - K/2 > \delta/2$, copying is more likely when acquisitions take place.

- $If\ A \geq \bar{A}_C:\ \pi_I^{no}(C, ©, Y_E) \geq \pi_I^{no}(C, \emptyset, Y_E) \ \Leftrightarrow F \leq \delta$.

  In the interval $A \geq \bar{A}_C$, absent acquisitions, copying emerged for $\sigma_E = C$ if $F < \delta$. Hence the copying decision is not affected when acquisitions take place.

Proof of Proposition 5

The proof is simple but unfortunately boring, since it involves comparing the entrant's payoffs in each of the different regions where different continuation equilibria arise.

- If $F < \delta - K/2$ and $A < \bar{A}_S$, the choice is between an equilibrium path $(S, ©, \textit{acquisition})$ and $(C, ©, \textit{acquisition})$. The former is chosen if:

$$\pi_E^{ACQ}(S, ©, Y_M) = \frac{\Delta - K}{2} \geq \pi_E^{ACQ}(C, ©, Y_M) = \frac{\delta - K}{2}, \quad \Leftrightarrow \quad \Delta \geq \delta.$$

- If $F < \delta - K/2$ and $\bar{A}_S \leq A < A_C$, the choice is between an equilibrium path $(S, ©, \textit{acquisition})$ and $(C, ©, \textit{acquisition})$. The former is chosen if:

$$\pi_E^{ACQ}(S, ©, Y_M) = \Delta - K + \frac{u + \delta}{2} \geq \pi_E^{ACQ}(C, ©, Y_M) = \frac{\delta - K}{2}, \quad \Leftrightarrow \quad \textit{always}.$$

- If $F < \delta - K/2$ and $A > A_C$, the choice is between an equilibrium path $(S, ©, \textit{acquisition})$ and $(C, ©, \textit{acquisition})$. The former is chosen if:

$$\pi_E^{ACQ}(S, ©, Y_M) = \Delta - K + \frac{u + \delta}{2} \geq \pi_E^{ACQ}(C, ©, Y_M) = \frac{\delta - K}{2}, \quad \Leftrightarrow \quad \textit{always}.$$

- If $F < \delta$ and $A \geq A_C$, the choice is between an equilibrium path $(S, ©, \textit{acquisition})$ and $(C, ©, \textit{no acquisition})$. The former is chosen if:

$$\pi_E^{ACQ}(S, ©, Y_M) = \Delta - K + \frac{u + \delta}{2} \geq \pi_E^{no}(C, ©, Y_E) = \frac{\delta}{2} - K, \quad \Leftrightarrow \quad \textit{always}.$$

- If $F_C^{ACQ} \leq F < F_S^{ACQ}$ and $A < A_S$, the choice is between an equilibrium path $(S, ©, \textit{acquisition})$ and $(C, \emptyset, \textit{no acquisition})$. The former is chosen if:

$$\pi_E^{ACQ}(S, ©, Y_M) = \frac{\Delta - K}{2} \geq \pi_E^{no}(C, \emptyset, Y_E) = \frac{3\delta}{2} - K, \quad \Leftrightarrow \quad \textit{never};$$

  indeed, the above inequality amounts to $\Delta \geq 3\delta - 2K$, which can be rewritten as $\Delta - \frac{3\delta}{2} \geq \frac{3\delta}{2} - 2K$, that never holds given our restrictions o parameters (the LHS being negative and the RHS being positive).

- If $F_C^{ACQ} \leq F < \delta$ and $\bar{A}_S \leq A < \bar{A}_C$, the choice is between an equilibrium path $(S, ©, acquisition)$ and $(C, \emptyset, no\ acquisition)$. The former is chosen if:

$$\pi_E^{ACQ}(S, ©, Y_M) = \Delta - K + \frac{u+\delta}{2} \geq \pi_E^{no}(C, \emptyset, Y_E) = \frac{3\delta}{2} - K, \quad \Leftrightarrow \quad \frac{u}{2} + \Delta \geq \delta \Leftrightarrow \quad always.$$

- If $F \geq \delta$ and $A \geq \bar{A}_S$, the choice is between an equilibrium path $(S, \emptyset, acquisition)$ and $(C, \emptyset, no\ acquisition)$. The former is chosen if:

$$\pi_E^{ACQ}(S, ©, Y_M) = \Delta - K + \frac{u+3\delta}{2} \geq \pi_E^{no}(C, \emptyset, Y_E) = \frac{3\delta}{2} - K, \quad \Leftrightarrow \quad always.$$

- If $F < \delta$ and $A \geq \bar{A}_C$, the choice is between an equilibrium path $(S, ©, acquisition)$ and $(C, \emptyset, no\ acquisition)$. The former is chosen if:

$$\pi_E^{ACQ}(S, ©, Y_M) = \Delta - K + \frac{u+\delta}{2} \geq \pi_E^{no}(C, ©, Y_E) = \frac{\delta}{2} - K, \quad \Leftrightarrow \quad always.$$

Appendix A2 — Not for publication

Adjust the text so as to focus on the differences relative to the case of acquisitions after copying.

Acquisitions take place before copying decision

In this section, we allow for acquisitions to take place before, rather than after, the incumbent's decision on copying. The rest of the game is as in the base model. Therefore, if the acquisition does not take place, the continuation equilibria will be those described in Proposition 1, which illustrates I's best responses.

We also continue to assume that, if an acquisition takes place, the entrant and the incumbent equally share the gains from trade. Given that acquisitions take place after product choice but before the incumbent incurs the cost of copying, taking over the entrant makes it unnecessary to copy and hence it allows to save the associate cost of it, F.

We next outline the equilibrium of the extended game with acquisitions.

Proposition 7. *When acquisitions are possible, the entrant at $t = 0$ will choose:*

(i) (Kill Zone) If $A < \overline{A}_S$ and $F \in [F_C^{YN}, F_S^{YN}]$:

- *If $u > 3\delta - 2\Delta - 2K$, then for $F \geq 3\delta - \Delta - K \equiv F_2$, the entrant will choose $\sigma_E = S$, rather than $\sigma_E = C$ as without acquisitions.*
- *If $u > 3\delta - 2\Delta - 2K$, but $F < F_2$, or $u \leq 3\delta - 2\Delta - 2K$, it will still choose $\sigma_E = C$.*

(ii) If $A < \overline{A}_S$ and $F < F_C^{YN}$: the acquisition leads to the development of the socially efficient product (rather than no development as without acquisitions):

- *If $\Delta \geq \delta$, $\sigma_E = S$;*
- *If $\Delta < \delta$, $\sigma_E = C$.*

(iii) In all other cases, $\sigma_E = S$, like in the case of no acquisitions.

Proof. (i) For $F \in [F_S^{YY}, F_S^{YN}]$ and $A < \overline{A}_S$, the continuation equilibria absent the acquisition are $C \to \emptyset \to Y$ and $S \to \copyright \to N$. If $\sigma_E = C$, an acquisition does not raise industry profits, and hence there are no gains from the takeover: the entrant still earns $3\delta/2 - K$. If $\sigma_E = S$, absent the acquisition there is copying and no development, and E makes zero profits. The acquisition will save the fixed costs F of copying and will result in I developing the superior substitute. The entrant will obtain half the gains from the acquisition, $(F + \Delta - K)/2$. Hence, it will choose $\sigma_E = S$ iff $F \geq 3\delta - \Delta - K \equiv F_2$. Since $F_2 < F_S^{YN}$ for $u > 3\delta - 2\Delta - 2K$, if this last inequality holds, then $\sigma_E = S$. The acquisition increases the chance the entrant develops a substitute.

(ii) For $F < F_S^{YY}$ and $A < \overline{A}_S$ we have $S \to \copyright \to N$ and $C \to \copyright \to N$. For $\sigma_E = S$ the entrant will earn $(F + \Delta - K)/2$ and for $\sigma_E = C$ it will earn $(F + \delta - K)/2$. E will choose C when $\delta > \Delta$, which is the socially optimal choice. In this region acquisition leads to investment in the socially optimal product, whereas in its absence there would be no investment.

(iii).a If $A \in [\overline{A}_S, \overline{A}_C)$ and $F \leq F_C^{YN} = F_S^{YY}$, we have $S \to \copyright \to Y$ and $C \to \copyright \to N$. For $\sigma_E = S$ the entrant will earn $\Delta - K + (F + u + \delta)/2$, where $\Delta - K$ is its outside payoff, and the term in brackets is its share of the gain from trade (I saves fixed costs of copying and avoids losing from competition). For $\sigma_E = C$ the entrant earns $(F + \delta - K)/2$, its share of the gain from saving copying costs and developing the new complement (absent acquisition, it makes zero profits). Hence, $\sigma_E = S$.

(iii).b If $A \geq \overline{A}_C$ and $F \leq F_C^{YN} = F_S^{YY}$, we have $S \to \copyright \to Y$ and $C \to \copyright \to Y$. For $\sigma_E = S$ as in the previous point .a the entrant will earn $\Delta - K + (F + u + \delta)/2$. For $\sigma_E = C$ the entrant earns $\delta/2 - K + F/2$, the last term being its share of the gain from saving copying costs. Hence, $\sigma_E = S$.

(iii).c If $A \geq \overline{A}_C$ and $F \in [F_C^{YN} = F_C^{YY}$, we have $S \to \emptyset \to Y$ and $C \to \copyright \to Y$. For $\sigma_E = S$ there will be no acquisition (the incumbent does not copy and the substitute is developed) and the entrant earns $\delta/2 + \Delta + \delta - K$. For $\sigma_E = C$ the entrant earns $\delta/2 - K + F/2$ (like at point .b). The former is higher in the interval considered, hence $\sigma_E = S$.

(iii).d In all other areas, we have $S \to \emptyset \to Y$ and $C \to \emptyset \to Y$. In neither case there are gains from trade so the acquisition will not occur. E will choose the same as without acquisition: $\sigma_E = S$.

□

This Proposition shows that extending the game to consider acquisitions does not change the product selection of the entrant, with two notable exceptions which involve the kill zones areas identified above.

If $F \in [F_S^{YY}, F_S^{YN}]$ and $A < \overline{A}_S$, corresponding to case (i), absent the acquisition the entrant knows that by choosing a substitute would lead to copying and its inability to develop. So it chooses $\sigma_E = C$ instead, which results in no copying by the incumbent and the development of the complement. If an acquisition is possible and E chooses the $\sigma_E = C$, there is no gain from the acquisition (it does not bring any savings on F, since copying does not occur along the equilibrium path, nor would it lead to development since that already occurs). Therefore, E would have the same profit as at the equilibrium if it chose $\sigma_E = C$. Instead, if $\sigma_E = S$, the acquisition would occur because it would allow saving the fixed costs of copying (F) and would result in additional industry profits ($\Delta - K$) from the development of the substitute. Therefore, relative to the benchmark, E raises its profits by its share of the gains from trade, $(F + \Delta - K)/2$, and the proposition tells us that under certain conditions this will give it an incentive to choose $\sigma_E = S$ when absent the acquisitions it would have chosen to develop a new complement instead. Therefore, in this region the opposite of a "kill zone" argument takes place: the entrant on purpose chooses a substitute, in order to trigger an acquisition offer by the incumbent.

If $F < F_S^{YY}$ and $A < \overline{A}_S$ (case (ii)), absent acquisitions the entrant was indifferent between complement and substitute because copying would always occur and would never allow it to develop the new product. When an acquisition can take place, it will save the fixed cost of copying (the incumbent can appropriate all the surplus without having to introduce a copycat product of the original complement) and it will lead to development of whichever new product the entrant has chosen to go for. By choosing $\sigma_E = S$ the entrant will earn $(F + \Delta - K)/2$ and by choosing $\sigma_E = C$ it will earn $(F + \delta - K)/2$. E will choose C (resp. S) when $\delta > \Delta$ (resp. $\delta < \Delta$). Hence in this region the acquisition leads to investment in the socially optimal product, whereas in its absence there would be no investment.