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"Market Structure and Investments : A Progress Report"

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Market Structure and Investments: A Progress Report*

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This paper reviews recent studies on the impact of changes in market structure on investments. First, we examine the relationship between competition intensity and investments from both theoretical and empirical perspectives. Second, we discuss the impact of mergers among competing incumbents on firms' incentives to introduce new products and to undertake cost-reducing and quality-enhancing investments. Last, we explore how the acquisition of an innovative entrant by an incumbent can affect the investment incentives of both firms.

Keywords: Competition, Investments, Innovation, Mergers, Entry.
JEL codes: D43, L13, L40.

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Contents

1 Introduction

The long-standing debate on the relationship between competition and investments has recently been revived due to the growing interest of competition authorities in the so-called "non-price effects" of mergers. For example, the European Commission has taken actions in several merger cases based on an adverse impact on investments in innovation. Notable examples include the mergers between Medtronic and Covidien (2014), Novartis and GSK (2015), and Pfizer and Hospira (2015) in the pharmaceutical and medical device sector, as well as those between Dow and Dupont (2017), Bayer and Monsanto (2018), and Bayer and BASF (2018) in the agricultural products industry. All of these mergers have been cleared under the condition that remedies that address concerns about innovation incentives are implemented. Similar concerns have been raised over the last few years in the context of digital markets, where incumbents have engaged in a large number of acquisitions of innovative startups. The impact of mergers on innovation has also been a central issue in the ongoing debate on European competitiveness. For example, in a recent report for the European Commissio, Draghi (2024) recommends revising the Commission's merger guidelines to clarify how the impact of mergers on innovation incentives is assessed and to allow for an "innovation defense". According to the report, such a defense could be justified in certain sectors by the need to pool resources in order to compete at the global level.

The literature on the effects of competition on investments draws on two seminal contributions that offer seemingly opposite views. The first perspective, put forward by Schumpeter (1942), posited that market power (and firm size) spur innovation. The logic behind this assertion is that firms with market power have a stronger incentive to innovate because of their greater ability to appropriate innovation rents (owing to low competitive pressure). The second viewpoint, articulated by Arrow (1962), argues that a monopolist has weaker incentives to innovate compared to a firm in a perfectly competitive environment, due to the so-called *replacement effect* (Tirole, 1988). This effect refers to the idea that a monopolist makes profits even if it does not innovate, whereas a firm in a perfectly competitive market makes profits only if it innovates (thus becoming more efficient than its rival). Consequently, a firm under operating perfect competition has more to gain from innovating than a monopolist. As a preamble, it is important to note that the Arrowian and Schumpeterian views do not inherently contradict each other (Shapiro, 2012). The former essentially states that greater competition *before* innovation raises firms' incentives to innovate, whereas the Schumpeterian view suggests that greater competition *after* innovation reduces innovation incentives.

The early literature on competition and investments has primarily relied on two measures of competition intensity: the number of competitors and the degree of substitutabil-

ity between products. However, neither of these measures captures a key feature of mergers: the ability of merging firms to coordinate their decisions. This led to the emergence of a new literature that examines the specific effects of mergers on investments. This literature consists of two strands corresponding to two distinct policy debates: one focusing on the impact of mergers between incumbents on post-merger investment incentives and the other exploring the effects of an incumbent's acquisition of an innovative entrant on pre- and post-merger investment incentives.

The present literature review begins with an examination of the connection between the intensity of competition and investments (Section 2). We pay special attention to how the Schumpeterian and Arrowian effects have been incorporated into theoretical models and to the potential inverted-U relationship between competition and investments that can arise from the combination of these two effects (Aghion et al., 2005). We highlight the mixed effects of competition on investments from both theoretical and empirical points of view.

In Section 3, we examine the effects of horizontal mergers among incumbents on the level and direction of R&D investments. We first provide an overview of the main theoretical contributions, distinguishing between three distinct types of investments: investments in new products, cost-reducing investments, and quality-enhancing investments. The literature shows that different types of investments are affected differently by horizontal mergers. To see why, consider two rival firms that compete in prices and investments. If they invest in cost reduction, a firm's investment affects its rival's profit solely through the price changes it induces. Unlike a cost-reducing investment, a quality-enhancing investment by a firm directly affects its rival, meaning that even if prices remain unchanged, it negatively affects the rival's demand. Consequently, the externalities generated by these two types of investments differ, and, therefore, the effects of their internalization due to a merger are also different. We complement our theoretical discussion with a review of (some of) the empirical evidence on the effects of horizontal mergers on investments, starting with aggregate studies and then delving into sector-specific studies.

In Section 4, we discuss the impact of acquisitions of innovative entrants by incumbents on the investment incentives of both the acquired and the acquiring parties. The existing literature has shown that incumbents can have incentives to stifle competition by acquiring emerging competitors and halting their innovative projects. This practice, empirically documented in the pharmaceutical industry, has been termed a *killer acquisition* (Cunningham et al., 2021) and is usually considered anticompetitive because its sole objective is to reduce future competition. However, the prospect of acquisition may offer an innovative entrant incentives to invest in entering the market in a situation where, without the acquisition, entry would not be profitable. More generally, the literature shows that permitting the acquisition of innovative entrants yields conflicting effects on

competition and innovation and establishes conditions under which the net effect is either positive or negative.

2 The relationship between competition intensity and investments

In this section, we discuss how the intensity of competition can alter the incentives of a firm to invest. We first focus on theoretical contributions and then turn to empirical studies.

2.1 Theory

Several scholars have investigated the Arrowian and Schumpeterian effects from a theoretical perspective. In a seminal contribution, Aghion et al. (2005) build a model that incorporates both types of effects and show that the relationship between competition and innovation is non-monotonic. More specifically, the authors find that when competition in the market gets fiercer, there are two opposite forces that lead to an *inverted-U relationship* between competition and innovation. First, more competition reduces the marginal gains from innovation, and, as a result, there is a lower incentive to innovate. Second, there is a force—the *escape-competition effect*—that gives a firm incentives to invest to escape competition and enjoy profits as a leader.[1]

Many papers have explored the relationship between competition and investments in other contexts. It is important to note that, in theoretical models, the intensity of competition is typically measured in two ways. First, the intensity of competition can be measured by the number of firms in the industry. For a given type of product, increasing the number of firms makes the market more competitive. Second, for a given number of firms in the market, the intensity of competition can be measured by the degree of product substitutability. The closer two (or many) products are perceived by consumers, the more intense the competition is in the market.

The two measures for competitive pressure are not neutral to the firm's strategies and may have different implications regarding firms' incentives to innovate. Vives (2008) identifies various channels through which competition affects incentives to innovate using a broad class of models and the two discussed measures of competition.[2] He considers both price competition with product differentiation (Bertrand competition) and quantity competition with homogeneous products (Cournot competition). In either case, a firm

[1] For a critical discussion of the Aghion et al.'s results and interpretation, see Shapiro (2012) and Gilbert (2022).

[2] A similar analysis is also provided by Schmutzler (2013).

features the following stages: product introduction, in which it decides whether to enter the market and produce a new variety; process innovation, wherein the firm decides how much to spend in R&D to reduce its marginal cost of production; and then competition. A central aspect of the analysis is the trade-off between fixed and variable costs, as process innovation is usually modeled in terms of variable cost reduction resulting from a fixed R&D investment. The incentive to engage in process innovation depends on the final output as the larger the output, the larger the returns from the investment. The output sold by each firm depends on the competitive pressure and the shape of consumer demand.

Vives (2008) shows that there are two main effects of competition on investments that should be considered for a given total market size. The first one is typically a negative effect because more competition reduces each firm's residual demand. The second one is a positive elasticity effect because more competition also leads to an increase in the elasticity of demand. These effects impact firms' investment incentives in two opposite ways. Vives (2008) finds that when the intensity of competition is measured by the number of firms, the negative effect tends to prevail over the positive one for several classes of models. However, when considering product substitutability as a measure of competitive pressure, the results are more ambiguous; that is, competition can lead to either more or less investments in process innovation depending on the considered class of models. When it comes to product innovation, the decision of the firm depends exclusively on the ability to appropriate/capture rents relative to the fixed investment cost. If competition reduces the appropriability of the firm ex post, this means that ex ante there is a lower incentive to introduce a new product. This argument is in line with the Schumpeterian view that competition reduces incentives to invest to due ex post weak appropriability.

A similar type of analysis is performed by Belleflamme and Vergari (2011) who study the relationship between competition and innovation in a different setting where firms can acquire an innovation by a third party (e.g., a lab). In their model, firms are horizontally differentiated and the incentive to innovate is given by the difference between the profit obtained when acquiring an innovation and the profit obtained in the absence of such an innovation.[3]

The authors find that intermediate forms of competition may maximize firms' incentives to invest, identifying a possible inverted U-shaped relationship between competition and investment, depending on the characteristics of the industry of interest. Specifically, they conclude that if products are differentiated, then the incentive to innovate is always inverted U-shaped in the competitive pressure if the latter is measured by the level of

[3]An important assumption in the paper is that if one firm does not acquire the innovation, no other firm does, which implies that the analysis does not consider the possibility that a firm might have the incentive to innovate as a defensive strategy. However, as shown by Gilbert and Newbery (1982), an incumbent might have the incentive to invest in the acquisition of an innovation to prevent an entrant from acquiring it, thus preserving its market position.

product substitutability. However, if competitive pressure is measured by the number of firms operating in a given market, the type of competition between firms plays a more critical role. The incentive to innovate is either decreasing in the number of firms or inverted U-shaped under Cournot competition, whereas the situation changes drastically, with either positive or negative effects of the number of firms on the incentive to innovate, under Bertrand competition.

Chen and Schwartz (2013) take a different perspective and study the incentives of firms to invest in non-drastic product innovation, whereby the latter is a different version—not necessarily a "better" version— of an existing product. They show that a monopolist can have greater incentives to innovate than a competitive firm. By adding a second product, the monopolist would face two main effects. On the one hand, it would suffer from an Arrow-like replacement effect as some of the new sales cannibalize the old product (the authors call this a *diversion effect*). However, on the other hand, due to product differentiation, the monopolist could profitably segment the market by coordinating prices of two products for which it is a monopolist. This is a novel *coordination effect* that turns out to play a fundamental role. In a duopolistic market, instead, the incumbent would suffer from a *business-stealing effect* associated with competition. The authors identify sufficient conditions for the coordination effect to be positive and dominate the diversion effect. Specifically, if the new product is strictly higher quality than the old product, the incentive to innovate is greater under a monopolistic market structure than under a duopolistic market structure. In contrast, a duopolistic market structure would feature a greater incentive to introduce a new product (than a monopolistic market structure) when the latter is of lower quality than the old one. These results complement the findings of Greenstein and Ramey (1998), who show that in a model with only vertical differentiation, competition and monopoly in the old product market provide identical incentives to innovate.[4]

Jeanjean (2021) studies how technological progress, which increases the size of innovation, impacts the relationship between competition and innovation. This is an interesting aspect to consider because technological progress affects both the *escape-competition effect* and the *Schumpeterian effect* that we discussed previously. Using an oligopoly model with differentiated products and using both the number of competitors and the degree of substitutability as measures of the intensity of competition, Jeanjean (2021) shows that technical progress strenghtens the *Schumpeterian effect* relative to the *escape-competition effect*. This implies that an increase in the size of innovation (due to technical progress) leads to a decrease in the level of competition that maximizes investment. The author also finds that consumer surplus and total welfare are maximized for lower levels of com-

[4]Results by Greenstein and Ramey (1998) apply if there is non-drastic innovation and provided that the monopolist is protected from new product entry,

petition if the size of innovation is larger.

The dynamic aspects of competition and innovation are considered by Marshall and Parra (2019) in a study on sequential innovation. They consider a market in which there are firms of two types: large firms that operate and compete both in developing innovations and in product markets, and research firms that only develop innovations but do not commercialize them. The model is dynamic in the sense that a large firm that develops itself a successful innovation becomes the new market leader, and a successful lab can monetize its innovation by selling it to a large firm that will become the market leader as a result of the transaction. The innovation can be either cost-reducing or quality-enhancing; what is relevant for the analysis is that it enlarges the gap between the profit of the leader and the profit of the followers.

The authors analyze how competition in the product and research market affects R&D and the pace of innovation. In the product market, competition has a two-fold effect on innovation. First, for a *given* incentive to innovate, more competition means that more firms invest, which mechanically leads to more innovation. Second, more competition affects the profits of the firms, which in turn has an effect on the incentive to innovate as the gap between the leader and the followers can either increase or decrease. If the profit gap between the leader and the followers increases, then each firm increases its investment level, and as a result, total investments increase. However, if the profit gap between the leader and the follower decreases, then each firm's incentive to invest decreases, and the effect on the overall pace of innovation in the industry is ambiguous.

In the R&D market, a reduction in the number of labs induces firms to increase their R&D effort even though it reduces the pace of innovation in the industry. The mechanism behind this is the following: because the pace of innovation decreases, the current leader in the economy can maintain its technological advantage and rent for a longer time span, which in turn leads to a higher incentive to invest by the other firms. Finally, the interplay between the R&D and product markets gives rise to complex interactions. Marshall and Parra (2019) show that competition tends to benefit innovation if the profit gap between the leader and the follower increases with the number of firms. However, if the profit gap between the leader and the followers decreases with the number of firms, the overall effect is ambiguous.

2.2 Empirical evidence

The empirical literature reviewed in the following provides mixed evidence on an inverted U-shaped relationship between competition and innovation and suggests that country and/or sector-specific aspects might play an important role in the existence or absence of

such a relationship.[5]

The first empirical support for the existence of an inverted-U relationship between competition and innovation comes from Aghion et al. (2005) who test their model predictions using data from approximately 300 UK manufacturers, listed on the London Stock Exchange, and that received patent grants from the US Patent and Trademark Office over the period between 1973 and 1994. Innovation is measured by citation-weighted patents, whereas a measure of competition is given by 1 minus the Lerner index (a measure of market power and, therefore, of the intensity of the competition). They find empirical support for the inverted-U-shaped relationship.

A confirmation of this relationship is provided in a recent experiment conducted by Aghion et al. (2018). Their experimental approach has the advantage of mitigating endogeneity concerns stemming from the fact that market structure not only affects but also is affected by innovation.

The experiment matches subjects for a number of periods and in each period, one of the two subjects can decide how much to invest in R&D, which has an effect on the probability of innovation and increases the technological level. Subjects can either be in the leader-laggard environment or in the neck-and-neck environment. In the former case, at the end of each period, only the leader receives positive profits, whereas in the latter case, they get profits that depend on the fierceness of the competition. If there is no competition, monopoly profits are split, whereas if there is full competition under neck-and-neck competition, profits are zero. In the intermediate scenario of competition, the monopoly rents are split. The authors obtain the following results. First, an increase in competition leads to a significant increase in R&D investments by neck-and-neck firms and reduces investments by laggard firms. Moreover, this Schumpeter effect is stronger the shorter the time horizon. Second, increased competition leads to a composition effect in the sense that it leads more industries to be characterized by leader-laggard dynamics.

However, other papers have not found support for the inverted-U relationship identified by Aghion et al. (2005). We discuss in the following two of these papers. Interestingly, one of them finds a monotonically negative relationship between competition and innovation, while the other one finds a monotonically positive relationship.

Hashmi (2013) tests the inverted-U relationship between competition and innovation by relying on a large dataset from manufacturing firms in the US. The author finds a statistically significant and negative relationship between competition and innovation, although the magnitude of the coefficient is small. The difference with the original study

[5]Other studies have focused on the relationship between competition and innovation in the context of international trade by looking at the opening of the European and US markets to Chinese competitive pressure. In this case again, there is no conclusive evidence: some find a negative relationship (Autor et al., 2020), some a positive relationship (Bloom et al., 2016), whereas others find a mixed relationship (Gutiérrez and Philippon, 2017).

by Aghion et al. (2005) might come from the fact that the latter focuses on the UK, which may feature more neck-and-neck competition than in the US.

Correa and Ornaghi (2014) study the relationship between competition and innovation by introducing new indicators for innovation effort (e.g., R&D intensity and productivity growth) and adopting an instrumental variable approach (using lagged values of competition) to tackle endogeneity concerns. They use US manufacturers' data and find a positive relationship between competition and innovation.

The empirical literature also shows that firm size and sector-specific characteristics may play a key role in determining the effect of competition on innovation.

Focusing on the automotive industry, Hashmi and Biesebroeck (2016) show that small and large firms present on average fewer patent applications than intermediate firms, identifying an inverted U-shaped relationship between firm size (measured by number of sales) and patent applications. They estimate parameters to run a counterfactual analysis on how, in a market characterized by four active firms, entry by an additional competitor impacts innovation. However, they show that, with the caveat that each firm gets an equal share of the overall demand, entry into the market would lower innovation. The logic behind their results is that fiercer competition would reduce appropriability (i.e., marginal gains from innovation), which would in turn lower firms' incentives to innovate. They also find that the magnitude of the reduction in the level of innovation increases with the quality of the competitors' products, which means that the business stealing effect resulting from more competition gets larger and so marginal gains from innovation decrease even more. They quantify the reduction in innovation level by 16%, although it can go down by as much as 19%. However, they also find that overall innovation increases at the industry level.

Askenazy et al. (2013) try to assess the relationship between competition and innovation through the lens of the firm's size. They replicate the analysis by Aghion et al. (2005) using French data and argue that the inverted-U relationship exists when considering large French firms. They show that when considering the entire sample of firms, there is no support for the inverted-U shape relationship between competition and innovation because the relationship between competition and innovation tends to be flattened the larger the number of small firms.

Houngbonon and Jeanjean (2016) and Jeanjean and Houngbonon (2017) focus instead on the wireless and mobile industry, respectively. In the former study, Houngbonon and Jeanjean (2016) use data from 110 wireless operators over the period 2005-2012 and identify conditions for which competition leads to more investments depending on market power. They approximate the Lerner index by using the share of profits over total revenues and find that competition leads to more innovation if this share is above 37-40%. On the contrary, if competition leads to a lower profit-revenue ratio, it tends to

have a negative effect on investments. Therefore, the authors' results support an inverted U-shaped relationship between the measure of competition intensity and the amount of investment.

Jeanjean and Houngbonon (2017) rely on data from the mobile industry (50 mobile operators) in Western Europe over the period 2006-2015. The authors restrict attention to the incentive to invest by mobile network operators with physical infrastructure. They find that operators' investments decrease with the number of operators in the market, with the level of investments per operator that can decrease by 14-23% depending on whether there are 4 or 5 operators in the market.[6] A feature of the model by Jeanjean and Houngbonon (2017) is the role played by asymmetric market shares on the operators' incentive to invest. They show that the reduction in the incentive to invest is stronger in more symmetric markets. Total investments at the industry level can, however, increase with the number of operators in the short run but decrease in the long run. The authors conclude that raising the number of operators in the market might hinder technological progress, highlighting the presence of a trade-off between static and dynamic efficiency.

Elliott et al. (2024) develop a model of the mobile telecommunications industry to investigate the impact of changes in market structure on prices, investments, quality (proxied by download speeds) and welfare. Firms (mobile network operators) choose the prices of their mobile service plans and their level of investment in infrastructure, which consumers rely on for data consumption. The authors develop a structural model of demand for mobile plans and data consumption based on the French market in 2015 and estimate it using proprietary data from a leading operator. A key feature of their analysis is the presence of a congestion externality, as a consumer's download speed depends on the decision of other consumers' consumption decisions. Computing counterfactual equilibria under different market structures, they find that consolidation leads to higher quality (faster downloads) at the cost of higher prices. Focusing on symmetric firms, they also find that consumer welfare is maximized at eight firms while total welfare is maximized at four firms.

Guiffard et al. (2023) study how market structure affects 5G deployment through spectrum allocation.[7] To this end, they implement a structural model of demand in the mobile sector and run counterfactual simulations to measure the effect of spectrum allocations for different numbers of operators in Germany. In particular, starting from the equal allocation of 5G spectrum to three operators (O2 Germany, Telekom Germany, and Vodafone Germany) based on a 2019 auction, they find that for 50MHz and 100MHz, consumer surplus is always higher when spectrum is allocated to three rather than four

[6]These results are consistent with their theoretical model. The authors consider a simple model with multiple firms selling homogeneous products and deciding how much to invest and their prices. They find that increasing the number of firms in the market lowers the incentives to invest in quality.

[7]The total amount of spectrum is limited and is allocated via an auction to a few winning companies.

operators—the fourth one being an entrant operator. The underlying rationale for this result is attributed to changes in the quality of the network, which improves when there are fewer competing networks because spectrum quantity is less diluted. Notably, the enhanced network quality delivered by having only three operators more than compensates for the potential increase in average prices resulting from reduced competition. As a result, consumer surplus increases.

Ciriani and Jeanjean (2020) present an across-sector study on the relationship between technological progress and the inverted-U relationship between competition and innovation. For each sector of the French economy, between 1978 and 2015, they take the average mark-up rate of the sector as a proxy for the level of competition and the growth of hourly productivity as a proxy for technological progress and investment. When grouping the sectors based on their average technical progress rate over the period, they observe that for each sector group, there is an inverted U-shaped curve between the growth of hourly productivity and the mark-up. They find that the maximum of this curve is heterogeneous across sectors and is shifted towards higher mark-up levels, thereby indicating weaker competition, for those sector groups with higher rates of technical progress. Against this backdrop, the authors suggest that sectors experiencing significant technical progress (e.g., the digital sector) should be granted the flexibility to align their level of competition with their rate of technological advancement, as this would fully harness the productivity gains resulting from technology adoption.

Beneito et al. (2017) examine the relationship between competition and innovation taking into account a new channel that affects the incentives to invest of the laggard firm: bankruptcy cost. They first show that this new channel can either confirm or overturn results in Aghion et al. (2005) because the Schumpeterian effect dominates the positive Arrow force in sectors with leader-and-laggard firms but this dominance can be offset if laggard firms innovate to avoid exit and survive in the market. In the presence of this new force, the relationship between competition and innovation may be either inverted-U shaped or become a positive relationship. The authors test this prediction in the context of Spain, a country that exhibits a high rate of exit by firms when market conditions worsen. They find a positive relationship between competition and innovation in a sample of Spanish manufacturers over the period between 1990 and 2006.

Beneito et al. (2015) provide further evidence of the relationship between competition and innovation by distinguishing between process and product innovation. As discussed in Section 2.1, a firm's incentives can significantly depend on the nature of innovation (Vives, 2008). Using Spanish manufacturers' data, they show empirically that more intense competition, measured by product substitutability, is positively associated with process innovation but negatively associated with product innovation.

3 Horizontal mergers between incumbents

This section focuses on the effects of horizontal mergers between incumbents on both merging and non-merging parties' incentives to invest.[8]

In what follows, we first present several theoretical contributions on the effects of mergers between incumbents on investments. We then provide an overview of the empirical literature on the impact of horizontal mergers on different measures of investments and innovation. We distinguish between aggregate studies, which investigate the discussed effect across different sectors and industries, and sector-specific studies which focus on particular sectors.

3.1 Theory

In this section, we distinguish between different types of investments. First, we discuss the effects of horizontal mergers on firms' incentives to invest in new products. Second, we discuss how horizontal mergers affect firms' incentives to lower their marginal cost of production. Third, we provide an overview of the effects that horizontal mergers have on firms' incentives to enhance the quality of existing products. Fourth, we discuss papers that study the impact of mergers on investments using general approaches allowing for both cost-reducing and quality-enhancing investments. Fifth, we review recent papers analyzing the effects of mergers on innovation in a dynamic setting. Finally, we discuss papers exploring the effects of horizontal mergers on the diversity and the direction of innovation.

3.1.1 Investments in new products

Federico et al. (2017) study the effects of a merger on product innovation. They consider a market in which several identical research labs compete to discover a new product (e.g., a treatment for a disease). Because the outcome of research is uncertain, the number of successful labs is random, and competition among several products reduces profits. The authors assume that when there are three or more successful products, all profits are eroded. An investor can only expect positive profits if it is the sole successful inventor or if there is only one other successful inventor.

If a merger between two research labs takes place, the authors assume that the two research units remain separate and are coordinated by the merged entity. Under the assumption that the merged entity would continue to invest equally in the two units,

[8] A recent literature analyzes common and cross-ownership and their relationship with innovation efforts (López and Vives, 2019; Nevrekar, 2022; Li et al., 2023; Antón et al., 2024; Shelegia and Spiegel, 2024). Common and cross-ownership can be thought of as "partial mergers". A review of these studies is beyond the scope of this paper.

they conclude that the merged entity will invest less in R&D than the two independent labs. The mechanism is quite simple: Differently from competing labs, the merged entity internalizes that if the two labs succeed simultaneously in their innovation, sales would be cannibalized. As a result, the merged entity has lower incentives to invest than two competing labs. The authors also argue that for concentrated industries, the non-merging firms' reactions would not be able to compensate for the reduction in innovation by the merged entity.

This study has been challenged by Denicolò and Polo (2018), who have shown that the central result of Federico et al. (2017) that the innovation efforts of merging firms always decrease after a merger crucially depends on the assumption that the merged entity finds it optimal to maintain two research labs after the merger. However, the merged entity might want to shut down one of the two research units and focus on only one. The logic behind it is quite simple. Under competition, firms might jointly succeed in innovation, resulting in innovation duplication and cannibalization of sales. Because the merged entity would internalize this externality, it may find it optimal to reduce its R&D effort in one research path and increase it in another. The authors show that whether the merged entity has such an incentive depends on the returns of R&D. Specifically, if the R&D technology involves little decreasing returns at the research unit level, the merged entity will focus all its efforts on one research unit. The authors also find that, in this case, the merger (weakly) increases the probability that an innovation is achieved.

Another extension of the analysis of Federico et al. (2017) is provided by Jullien and Lefouili (2020) who study the effects of a horizontal merger on incentives to introduce new products as a result of R&D investments in a setting with potentially differentiated products. They consider an industry with two firms and a merger to a monopoly. Each firm owns a research lab and the probability that its research lab is successful in achieving an innovation depends on the amount invested in R&D. The authors show that if the assumption that R&D investments lead to the development of a homogeneous product is relaxed, the merged entity can have a greater incentive to invest and innovate than independent firms. The mechanism is similar to that of Chen and Schwartz (2013) in the sense that the merged entity can benefit from the price coordination of two new products. They also identify conditions (in a Hotelling setting) under which a merger not only increases innovation efforts but also has a positive effect on consumer surplus.

3.1.2 Cost-reducing investments

Motta and Tarantino (2021) examine the impact of a horizontal merger on cost-reducing investments. They consider a market where firms produce differentiated products and compete in prices and investments. In the main model, they consider a market in which

firms make their decisions on prices and investments simultaneously.[9] To simplify matters, they first focus on the case in which two independent firms decide to merge and give rise to a multiproduct monopolist.[10] Motta and Tarantino (2021) abstract from the presence of merger-specific efficiency gains and involuntary spillovers, finding that the merger will internalize pricing externalities and lead to higher prices relative to the case with independent firms. The resulting increase in prices would reduce quantities, which would lower the returns from cost-reducing investments, leading to a reduction in investment effort. Therefore, in that setting, the merger has a negative impact on the incentive to invest and on consumer surplus.

When considering the strategic response of non-merging parties, a new effect arises. Motta and Tarantino present a scenario where at least three firms compete and show that the merger reduces competition between merging and non-merging parties, which results in a positive incentive for non-merging parties to increase their prices. As the prices of non-merging parties increase to a lesser extent than the merging party, this generates higher demand, which increases the return from cost-reducing investments. This leads to opposite effects on merging and non-merging parties' incentives to invest, with the former being negative and the latter being positive. The overall effect of the merger on the industry-wide level of investments is therefore ambiguous in general. However, the authors find that this effect is negative under some commonly used model specifications.

Note that these results are derived under the assumption that efficiency gains and technological spillovers are absent. As the authors suggest in their conclusions, it is possible that the merger leads to higher investments in the event of technological spillovers or merger-specific efficiency gains.[11]

Another assumption that seems to play an important role in the model of Motta and Tarantino (2021) is the symmetry among firms in terms of production costs. Baranes and Vuong (2021) extend the model to the case in which not all firms are symmetric in their costs. Specifically, they consider a market with two symmetric firms willing to merge and an outsider firm with a lower cost. They show that if the outsider firm has a sufficiently low cost relative to the merging firms, its level of investment can more than offset the reduction in investment of the merged entity. This could spur total investments post-merger and, in some cases, result in an increased consumer surplus.

The impact of mergers on cost-reducing investments is also assessed by Mukherjee (2022), who extends the model by Federico et al. (2017) to a setting in which the payoffs when innovation fails are not equal to zero (which implies that the Arrow replacement

[9] They also consider an extension in which decisions on prices and investments are made sequentially.

[10] In their model, analyzing the effect of a merger to monopoly is equivalent to studying the effect of a horizontal merger on process innovation without accounting for the strategic reaction of the non-merging firms.

[11] Related to this, Denicolò and Polo (2021) show that the effect of innovation sharing between merging firms on their incentives to innovate may make horizontal mergers pro-competitive.

effect is present). He builds a simple model that leaves aside any involuntary spillovers or R&D synergies and where two competing firms sell horizontally differentiated products. The two sellers can invest in R&D which, with some probability, results in a lower marginal cost of production. As in Federico et al. (2017), the author assumes that the probability of failure in innovation is log-convex in the R&D investments, which implies that the merged entity would does not shut down one of the two labs after the merger. Comparing the level of investments without and with a merger, Mukherjee concludes that R&D investments can be either higher or lower with a merger. To further explore this finding, the author provides an example with a specific functional form. If R&D investments substantially lower marginal cost and competition is intense, there is a significant *business-stealing effect* for the firm that succeeds in innovation when the firms are independent relative to when they are merged. In this case, the merger reduces R&D investments in process innovation. If either competition intensity is low or the marginal cost before R&D is not too high, a weak business-stealing effect prevents the successful independent firm from having a large benefit from unilateral innovation. In this case, a merger can spur investments. The study also highlights that a merger can result in an increase in expected consumer surplus and total welfare even in the absence of spillovers and synergies.

3.1.3 Quality-enhancing investments

Some investments are aimed at enhancing the quality of the product sold to consumers. There is an important difference between these investments and cost-reducing investments, as illustrated by Vives (2008) and Chen and Schwartz (2013). Specifically, investments in cost reduction affect rivals only indirectly because of the effect that investments have on final prices. In contrast, quality-enhancing investments also have a direct effect on rivals because a higher-quality product diverts sales from rivals. The presence of direct and indirect effects generates more complex interactions between prices and investment decisions that should be accounted for.

In what follows, we review studies that deal with quality-enhancing investments and how market consolidation affects them. In the mobile market, for example, investments in quality can take the form of larger network coverage.

Bourreau and Jullien (2018) study the effect of a merger to monopoly on demand-enhancing investments. The study is well suited to understand mergers in the TLC market where firms compete in price and coverage (of broadband, for example). Serving territories is costly and, absent a merger, there are circumstances in which one company out of two is the monopolist for that area and circumstances in which there exists competition between the two companies. Moreover, it is also possible that some areas are not covered at all.

The authors show that in the absence of a merger between the two companies prices are inefficiently high if products are sufficiently differentiated. The firm covering both

the competitive segment and the monopolistic segment sets an intermediate price that balances the incentive to raise the price on the monopolistic segment of the market and the incentive to lower the price to attract consumers in the duopolistic segment. As prices are strategic complements, also the rival responds by setting a price that is higher than the price that would be set under competition only. Therefore, the impossibility for the firm serving two markets to differentiate prices entails a price externality in the duopoly setting. If the two companies merge, the merged entity coordinates the deployment of the two products. The authors find that a merger raises prices and total coverage but the coverage of the multi-zone market decreases. The effect on consumers depends on the relative magnitude of the extended coverage and higher prices. In particular, there exist cases in which the merger becomes desirable for consumers.

Federico et al. (2018) study the relationship between mergers and the incentive to invest in product innovation, the latter being defined as innovation aimed at increasing the quality of existing products. They consider an oligopolistic market with symmetric firms and study the effects of a merger between two firms and start their analysis by abstracting from any merger-specific efficiency and involuntary spillovers. This makes the merger anti-competitive in the absence of investments because of the usual *pricing externality*, which the authors label *price coordination*. In other words, the merged entity internalizes the negative pricing externality that merging parties exert on each other when they are independent. Importantly, this price coordination has an impact on the incentive to invest and has ambiguous effects that depend on modeling specifications. A second channel through which a merger impacts the level of investments is via the internalization of the *innovation externality*: the merging party that innovates exerts a negative externality on the profits of its merging partner. This effect is unambiguously negative.

Due to tractability issues, the authors present separate analyses of the price coordination channel and the innovation externality channel and provide a numerical simulation to study the relationship between them. They numerically find that the effect stemming from the internalization of the innovation externality dominates, which ultimately leads to a reduction in the post-merger innovation incentives of the merged entity. The authors then look at the industry level of investment and find that, while the merged entity reduces its incentive to invest in R&D, non-merging parties respond by raising their R&D effort. To identify which effect prevails, the authors rely on a numerical simulation and find that the net effect of the merger is negative. However, when they allow for efficiency gains, they show that if these are sufficiently large, a merger can raise incentives to invest.

3.1.4 General approaches

We now discuss two papers that examine the effects of mergers on innovation within general frameworks that allow for both cost-reducing and quality-enhancing investments.

Bourreau et al. (2024) investigate the effects of a horizontal merger in a setting where (incremental) innovation can be cost-reducing and/or quality-enhancing and demand functions take a general form. In their baseline model, they study the impact of a merger between two symmetric duopolists on their incentives to innovate, assuming away any spillovers or efficiency gains in either R&D or production. They show that the overall impact of the merger on innovation is the sum of a *market power effect* and an *externality effect*. The former subsumes two effects driven by the impact of the merger on output. First, when innovation increases margins, a reduction in output has an adverse effect on merging firms' incentives to innovate. This *margin expansion effect* is negative. Second, a change in output may affect the return to investment per unit of output either positively or negatively. The externality effect can also be decomposed into two effects. First, the merged entity accounts for the negative impact of each merging firm's innovation on the other merging firm's demand, which reduces its incentives to innovate (the authors call this the *innovation diversion effect*). Second, the merger has an impact on the merging firms' margins and thereby affects their incentives to innovate when innovation increases their sales. This *demand expansion effect* is positive. An important insight of the paper is that, whenever the externality effect is different from zero, it is negative if and only if the price diversion ratio,[12] which measures the reallocation of output between the merging parties as a consequence of a unilateral increase in the price of one of the two parties, is less than the innovation diversion ratio, its counterpart for innovation.[13]

The authors show that when innovation reduces marginal costs but does not affect demand, the externality effect is zero and the market power effect is negative. Therefore, a merger reduces innovation in this case. By contrast, when innovation affects demand, the externality effect generally differs from zero, and the impact of the merger on innovation can be either positive or negative. This in turn implies that the effect of the merger on consumer surplus is ambiguous in general. However, simulations relying on two classes of demand functions under which a merger can spur innovation suggest that it is is unlikely that a merger benefits consumers in the absence of both efficiency gains (in R&D and production) and spillovers.

The authors pay special attention to the case in which mergers are *P-neutral*, meaning that they would not lead to changes in prices if the innovation level of the merging parties

[12]The price diversion ratio is commonly used by competition authorities, in particular in the Upward Pricing Pressure (UPP) analysis initially proposed by (Farrell and Shapiro, 2010).

[13]The innovation diversion measures the reallocation of output between the merging parties as a consequence of a unilateral increase in the quality of one of the two parties. For a discussion, see Salinger (2019).

was fixed.[14] This allows investigating a *standalone* innovation theory of harm, that is, a theory of harm in which adverse effects on innovation are not (entirely) driven by adverse effects on prices.[15] It is shown that in the case of P-neutral mergers, the overall impact of the merger on innovation depends solely on the comparison of the price diversion ratio and the innovation diversion ratio. If the former (resp., latter) is greater, a merger raises (resp., reduces) the merging firms' incentives to innovate.

Moraga-González and Motchenkova (2024) consider a (more) general reduced-form model that allows for both deterministic and stochastic innovation. Because the reduced-form approach allows for both cost-reducing and demand-enhancing R&D, their unified approach accommodates many of the existing models in the literature (e.g., Federico et al. 2017; Denicolò and Polo 2018; Jullien and Lefouili 2020; Motta and Tarantino 2021; Mukherjee 2022). The authors identify three channels through with a merger affects merging firms' incentives to invest in R&D: payoff-enhancing price coordination, internalization of a direct negative innovation externality resulting from a higher probability of success, and internalization of an indirect negative externality resulting from business stealing in the product market.

The authors first show that, in the absence of price effects (for example due to price regulation), a merger always leads a to a decrease in R&D investment as the only two channels at work are the second and the third.[16] Second, they examine the class of models in which the R&D process is deterministic. In this case, the only active channels are the first and the third (because the probability of success is set to one), resulting in two opposite effects and, therefore, an a priori ambiguous overall effect. The authors provide a condition under which the latter is positive or negative. Third, they study models with stochastic innovation enabling entry (where profits are equal to zero when innovation fails), and provide a necessary and sufficient condition for a merger to have an adverse impact on R&D investment. Finally, they investigate a richer stochastic R&D model in which a firm makes a non-zero profit even it fails to innovate (which means that the Arrow replacement effect is present). In this case, the effects are substantially more complex and the findings make it clear that the nature of the cost function may play a key role in the assessment of the impact of a merger on R&D investment.

3.1.5 Dynamic aspects

In this section, we review three papers that investigate the effects of horizontal mergers on innovation in a dynamic setting. These studies identify novel channels through which mergers affect innovation, thereby improving our understanding of the (long-term) welfare

[14]Note that efficiency gains in production are necessary for this to happen.
[15]See Denicolò and Polo (2019) for a critical assessment of the innovation theory of harm.
[16]Note that the authors abstract away from spillovers and efficiency gains in their model.

effects of mergers.

Hollenbeck (2020) analyzes industry dynamics in the presence of mergers and quality investments and identifies conditions for which mergers that in the short-run lead to lower consumer surplus (because of higher prices) might generate a positive long-run effect on innovation. The author finds that this is possible if entry costs are low and technological progress is possible. He follows a conservative approach and focuses only on mergers that are inherently anti-competitive. In other words, he restricts attention to mergers that do not bring about merger-specific efficiencies. In a dynamic setting, the author shows that when there are mergers, more firms enter the markets and these entrants invest in new products. If new products are brought to the market, then competition takes place, which in turn fosters more investments. This may bring about positive long-term effects for consumers if they benefit from merger-driven investments. Finally, Hollenbeck (2020) also finds that if acquisitions lead to the incorporation of innovation in existing products, then the positive effect of mergers increases as synergies now arise.

Das et al. (2024) consider a dynamic setting in which two competitors have the opportunity to develop innovations by making investments along a research avenue. The research avenue can be either *good* or *bad*; a good research avenue rewards R&D effort with a product innovation at exponentially distributed times, while a bad research avenue never generates innovation. Initially, the firms are unaware of the avenue type, but they learn about it over time through observable research activities and innovation successes of both themselves and their rivals.

Das et al. (2024) show that, in this setting, a merger has three effects on innovation. Firstly, due to the substitutability of innovations, a cannibalization effect arises as the second innovation displaces a portion of the gains from the initial innovation. The merged entity internalizes this negative externality resulting from competing innovations. Secondly, there is an appropriability effect because the merged entity faces less post-merger competition from a potential second innovation, thereby increasing incentives to pursue the first innovation. Thirdly, because a successful innovation by one firm provides information about the quality of the research avenue, there is an informational spillover which reduces incentives to invest due to a free-riding problem. However, the merged entity internalizes this effect and intensifies its research efforts, thereby accelerating the timing of the first innovation.

The authors identify conditions under which the merged entity finds it optimal to block or not block the second innovation conditional on the first innovation being successful. This decision depends only on whether the second innovation is ultimately profitable given that the research avenue has been proved good due to the first successful innovation. They show that when the cost of research is low enough, a merger always leads to positive effects on innovation since the merged entity never blocks the second innovation, and more

resources anticipate the time of the first innovation. However, if the cost of research is neither too small nor too high, the merged entity stops research for the second innovation because it is unprofitable, but devotes more resources to the first innovation.

Marshall and Parra (2023) adopt a dynamic "creative destruction" approach to study the effects of mergers on market structure, the expected time between innovations, the industry-wide R&D expenditures, and social welfare. In their setting, at every instant of time, there is a technology leader that obtains monopoly profits and followers that make no profit. Firms incur a fixed cost to participate in the R&D race. Innovation dynamics generates entry and exit of firms, and this relates to the value of being a leader. When the value of being leader is very high, it attracts entry in the market, which increases the speed of innovation and, therefore, makes the lifespan of the leader shorter. When the value of being leader is very low, there is little entry, which decreases the speed of innovation and increases the value of being a leader.

The authors compare innovation outcomes in the case in which all firms compete and in the case in which there is an unexpected merger that entails R&D synergies, i.e., the merged entity is more effective than the other firms in reaching a breakthrough. This induces more market concentration and exit by some firms. If the merger entails only small efficiency gains, then it has no effect on the speed of innovation but since there is exit of some followers there is less overall R&D expenditure. However, when these efficiency gains are large enough, then the merged entity can achieve an innovation pace that is higher than the pre-merger one. In turn, the merger reduces the waiting time between innovations and induces all inefficient followers to leave the market. Thus, the merged entity and the technological leader remain the sole active players in the market.

The authors finally conclude that mergers with R&D efficiencies are welfare-improving whenever entry into the market is costly and timely. The reason in that in this case mergers that entail R&D synergies either increase the pace of innovation or keep it constant while reducing overall R&D expenditure.

3.1.6 Diversity and direction of innovation

Mergers can affect not only the amount of investments in innovation, but also the diversity of R&D projects and the direction of innovation. This issue has emerged, for example, as one of the main reasons why the Department of Justice, supported by the Department of Defense, opposed the proposed merger between Lockheed Martin and Northrop Grumman in 1998 (Letina, 2016).

Letina (2016), Gilbert (2019) and Moraga-González et al. (2022) study how a horizontal merger affects the diversity of R&D projects. The first two papers find that the merger results in a lower variety of developed projects. Moraga-González et al. (2022) show that the merger distorts R&D portfolios in a way that can have either positive or negative

effects on consumers.

Specifically, Letina (2016) studies the effect of horizontal mergers on R&D portfolios starting from the following trade-off: on the one hand, higher variety of R&D projects increases the probability that the innovation is discovered; on the other hand, more duplication of R&D projects leads to stronger product competition ex post. In the baseline model, Letina (2016) assumes competition between symmetric firms that choose the subset of research projects to invest in. Innovation is stochastic and drastic, with all projects being ex ante symmetric in the probability to succeed, but with different fixed development costs. When choosing the projects to develop, firms face a trade-off because cheap projects have the same probability of success as costlier ones but attract more competitors. The author identifies the equilibrium R&D portfolio and finds that R&D variety would be lower if a merger occurs.[17] To escape competition, a firm can invest in projects that are more expensive, leading to more diversity. As a merger reduces competition, all else equal, it also leads to less variety of funded projects.

Gilbert (2019) extends the framework of Federico et al. (2018) by assuming that firms decide how many R&D projects to undertake.[18] The author shows that the presence of technological spillovers plays a critical role in understanding the overall impact of mergers on the level of investments in R&D and the probability of discovery. First, he shows that absent technological spillovers, the effect of mergers on investments can be either positive or negative, but the overall effect on consumer surplus is negative, as losses from increases in prices outweigh any gain in innovation incentives. Second, if technological spillovers are present and benefit imitators or enable follow-on innovations, then mergers can not only spur more investments in the industry but also have a positive effect on consumers.

Moraga-González et al. (2022) investigate the impact of horizontal mergers on firms' innovation portfolios and consumer welfare. In an environment where firms have a fixed overall R&D budget and invest it in two research projects, the investment of a given firm in a given project has two opposite effects on rival firms. First, it has a negative effect on them because it reduces the probability that they will win the innovation contest for that project. This is the usual *business-stealing externality* . Second, a firm's investment in one project has a positive effect on its rival because it increases the probability that they win the innovation contest for the alternative project. This is a novel effect, that the authors call a *business-giving externality*. A merger between two firms leads to the internalization of these two opposite externalities. The authors establish that when the project that is relatively more profitable is also the more appropriable, a merger raises consumer welfare. The reason for this is that a merger leads to a lower investment in the more profitable project and a higher investment in the alternative project.

[17]Note that this result holds under the assumption that there are no merger-induced efficiency gains.

[18]Each firm has a fixed cost of running the project, but this cost is independent of the number of projects undertaken.

3.2 Empirical evidence

Empirical evidence of the effects of mergers on the incentives for firms to invest has been provided in the context of aggregate and sector-specific analyses. We review some of these studies distinguishing between the two types.

3.2.1 Aggregate studies

In this section, we present three aggregate studies on the effects of mergers on different dimensions of innovation and investments. Aggregate studies are informative, but they are not free from limitations as they can disregard important technological differences that occur at the micro-level (Gilbert, 2022).

Ornaghi (2009) investigates the effects of mergers on firms' performances and, in particular, on innovation in the pharmaceutical industry. He considers the period 1988-2004 in which 27 mergers occurred. The author finds that, on average, following a merger, the acquiring party reduced its R&D expenditure, the number of new patents (and also new important patents) and R&D intensity (measured as the ratio between R&D expenditure and revenues). This descriptive evidence is then further corroborated by an analysis with a propensity score matching technique for which each acquirer and target is matched with a company that has similar characteristics but is not involved in a merger. He shows that while merging and non-merging firms were following similar patterns before the merger, they differ post-merger with the merging firms reducing innovation inputs (i.e., R&D expenditure) and outputs (e.g., patents).

Szücs (2014) presents an aggregate study of mergers that were notified either to the US FTC or to the European Commission, over the period 1990-2009. The author addresses endogeneity and selection problems by relying on a propensity score matching whereby each merging firm is matched to a non-merging firm with similar characteristics that would have predicted the treatment. Then, using a difference-in-difference approach, the author studies the effects of mergers on different innovation-related variables. Szücs (2014) finds that the R&D intensity of acquirers drops significantly post-merger.

Stiebale and Szücs (2022) use a dataset on 194 mergers and acquisitions cleared by European Competition authorities over the period 1999-2007 with the purpose to study whether mergers can explain the higher market power in the economy. When it comes to answering this question, it is not a priori clear how mergers impact merging and non-merging companies. For example, an increase in mark-ups, as a measure of market power, can result from either higher prices or lower marginal costs resulting from merger-specific efficiencies. Which of the two can explain a potential increase in markups is often impossible to verify in the absence of price and cost information. Non-merging rivals, however, are unlikely to benefit from merger-specific efficiencies that their merging

competitors have, and therefore increase in mark-ups is more likely to be explained by an increase in market power. They find that non-merging entities increase their markup by a 2-4% relative to their control group (constructed using a marching procedure) and that their investments and innovation decrease in the medium-run after the years (that is, after 2 years from the merger approval). As they do not investigate whether mergers increase the investment and innovation activity of the merging parties, it is not clear whether these mergers had a negative or positive effect on the total level of investment and innovation.

Cavenaile et al. (2021) build a general equilibrium model where oligopolistic product market competition interacts with step-by-step innovation, exit and entry decisions as well as horizontal mergers. Then, they calibrate the model with actual data from the US DOJ and FTC and conduct a counterfactual experiment where they shut down antitrust enforcement. They find that a resulting welfare loss of 0.49% in consumption-equivalent terms. Moreover, they find that strengthening antitrust enforcement would generate significant welfare gains, with increased innovation and growth rates. However, this policy change raises innovation by superstar firms but decreases R&D activity in small firms due to the negative impact on their option value derived from M&A opportunities.

3.2.2 Sector-specific studies

The relationship between mergers and investments has been investigated in depth in different sectors and shows heterogeneity in the main findings. The key advantage of sector-specific studies is the possibility to account for sector-specific technological differences and to run counterfactual analyses simulating the effects of mergers on market outcomes.

Valentini (2012) focuses on a specific market segment, that is, the US medical devices and photographic equipment industry, over the period between 1988 and 1996, and finds that mergers had a positive effect on patenting output, but decreased patent impact, originality, and generality. The author argues that one potential explanation for these findings is that mergers generate efficiencies that result in a higher number of patents but also put pressure on managers to achieve short-term results, which has negative effects on the quality of patents measured by their impact, originality, and generality.

Genakos et al. (2018) collect a large dataset from the telecommunications industry in OECD countries over the period 2002-2014. The authors focus on mobile network operators that obtained a license to use the spectrum.[19] They study the effects of market consolidation in the industry and identify a potential trade-off for consumers. On the one hand, mergers lead to an increase in the price for consumers, but, on the other hand,

[19]They discard mobile virtual network operators, who however were not systematically present across OECD countries over the period of interest.

they lead to more investments per operator.[20] In particular, the authors find that a hypothetical average 4-to-3 symmetric merger in their data would lead to an increase in the customer bills by about 16.3%, and an increase in investment per operator by about 19.3%. They also use their model to predict the effects of actual mergers that occurred during the considered period. For instance, according to the model predictions, the 2013 merger between Orange and 3-Hutchinson in Austria led to a price increase by 6.6% and an increase in investment per operator by 13.3%.

Lin et al. (2020) provide an empirical analysis of a hypothetical merger between T-Mobile and Spring in the US cellphone service market where four big providers (AT&T Mobility, Verizon Wireless, T-Mobile, Spring) operate. Specifically, they simulate the effects of a hypothetical merger in 2016 between the two providers on the deployment of 4G-LTE technology by national providers using granular data at the firm-census block level. They find that relative to the baseline setting in which no merger occurs, the potential merger between T-Mobile and Spring reduces total entry in local markets by 23%, leading to an increase in the population that is under-served. They explain this result by the fact that the merger would reduce the number of potential entrants, leading to more isolated areas being under-served.

Aimene et al. (2021) examine recent mergers in the European mobile market and their impact on consumer surplus when technological progress is involved. The underlying consideration made by the authors is that technical progress, in the mobile operator market, is much higher with data than voice and, therefore, the impact of mergers on prices and consumer surplus can be different between data-intensive and voice-intensive markets. To test this hypothesis, the authors use data from 21 European countries, of which 5 were exposed to mergers in this sector (Austria, Germany, Ireland, Italy and Norway). Some of these mergers occurred in periods in which operators' revenues were voice-driven, whereas others occurred in periods where the revenues were data-driven. They show that mergers tend to decrease the unit prices of data and increase those of voice. They show that mergers have a positive (respectively, negative) net effect in those contexts in which data usage (resp. voice usage) grows larger than voice usage (resp. data usage). For example, mergers in Austria and Germany took place when the voice usage was predominant, thereby leading to a negative effect of the merger on consumer surplus. On the contrary, mergers in Ireland, Italy and Norway took place when the data usage was predominant and in this case consumer surplus increased following the mergers. They further find that a market dominated by data (4G, 5G) maximizes its investment at a lower level of competition than a market dominated by voice (2G, 3G).

Haucap et al. (2019) provide a theoretical and empirical analysis of the effects of horizontal mergers on innovation. They consider 65 mergers that occurred in the phar-

[20]The impact on total investments is, however, not conclusive.

maceutical industry between 1991 and 2007 and went under scrutiny by the European Commission, and find that, overall, mergers led to less innovation by merged parties relative to non-merging firms. They employ propensity score matching (to identify suitable untreated firms) and run a difference-in-difference approach to estimate the average effect of the merger on patent applications by the merging parties. Consistently with their theoretical predictions, they find that horizontal mergers have, on average, a negative effect on innovative activities three years from the merger and an even stronger effect four years from the merger. Moreover, they show that the negative effects of mergers on innovation are concentrated in markets that, before the merger, feature high innovation intensity (measured by the average value of the patent stock by all firms active in the related product market).

Chen and Gayle (2019) argue that horizontal mergers can theoretically give rise to two countervailing effects. On the one hand, mergers can give rise to efficiencies that can result in higher quality, e.g., in the case of airlines, better coordination of flight schedules. However, mergers soften competition, resulting in a lower incentive to invest in product quality, as consumers now face fewer alternatives to consider. The net effect depends on the relative magnitude of these two forces. They show that if pre-merger competition is weak (i.e., there is little substitutability), post-merger product quality increases as in this case the coordination benefit resulting from the merger is strong. However, if pre-merger competition is intense (i.e., there is strong substitutability), post-merger product quality decreases as in this case the coordination benefit stemming from the merger is limited. Moreover, the magnitude of the quality change can be U-shaped in the intensity of competition.

These predictions are tested using data from the airline industry, where the intensity of competition between airlines is route-dependent, as operators serve multiple markets. The authors study the effects of two important mergers— the Delta/Northwest merger in 2008 and the Continental/United merger in 2010 —on product quality, which is measured by the percentage ratio of nonstop flight distance to the product's itinerary flight distance used to get passengers from the origin to the destination.[21] Using data covering the time span 2005-2013 (before and after the merger), Chen and Gayle (2019) find that the two mergers were associated with an increase in routing quality when they were not competing with one another before the merger, but with a decline post-merger in the presence of pre-merger competition.

Another industry that has undergone significant market consolidation is the hard disk drive industry, which is studied by Igami and Uetake (2020) and Bennato et al. (2021). After continuous consolidation, in 2010 this industry featured only five players, Seagate, Western Digital, Toshiba, HGST (owned by Hitachi) and Samsung. In 2011 a wave of

[21]For example, the routing quality of a direct flight has a maximum value of 100.

mergers began. Two mergers were notified in April 2011: the first involved Western Digital and HGST, and the second involved Seagate and Toshiba. This second merger was approved by the European Commission (together with the US authorities) subject to the divestiture of a business line to Toshiba (qualifying the latter as a third merger).

Igami and Uetake (2020) use a structural model to estimate the effect of mergers, entry, and exit, in the hard disk drive industry during the period 1996-2016. First, they find that the relationship between competition and R&D investments is likely to be increasing, with a plateau in the number of firms. Specifically, the incentive to innovate increases drastically when moving from a monopolistic market structure to a duopolistic/triopolistic market. However, starting from the fourth firm, the incentive to invest becomes less sensitive to the increase in the number of firms. The authors also simulate the effects of merger enforcement and adopt as a baseline model the case in which there are a number of firms equal to 3 in the market. This represents a reasonable approximation of the rule of thumb used by the US FTC in its merger control, blocking mergers from 3 to 2 and 2 to 1 firms. Their empirical evidence supports this rule of thumb.

Differently, Bennato et al. (2021) use a structural model to identify the effects of (two) mergers (from 5 to 3) that occurred in 2012 in the hard disk drive industry and their impact on product innovation. The authors rely on a matrix completion method to derive suitable counterfactuals for their analysis and consider as controls firms operating in the flash memory technology market. They show the presence of two main effects. First, investments in R&D increased. Second, there was a reduction in the number of patents, which can be explained by a reduction in duplication and defensive patenting. Third, the citation intensity of the patents increased.

Bennato et al. (2021) also identify potential synergies among merging parties— more specifically between Samsung and Seagate who already had cross-licensing agreements before the mergers— which might have led to an increase in the number of models relative to the counterfactuals. Western Digital instead reduced its output after the merger. The heterogeneity in the results on innovation outputs are explained by the authors with the differential treatment that merging parties had from antitrust authorities: Western Digital (and Hitachi) was subject to stricter remedies than Seagate (and Samsung) and implied the acquisitions of the 3.5-inch desktop HDD manufacturing lines by Toshiba.

Igami et al. (2024) study the relationship between competition and innovation in the liquid crystal display (LCD) industry over the period 2001-2011. They use a structural model to identify the welfare effects of both process and product innovation in this industry. They find that without product innovation, overall welfare would have been 70.6% lower, whereas without process innovation, overall welfare would have been 38.9% lower. They also find heterogeneous effects depending on the segment, with process innovation having stronger effect in the notebook and monitor segments whereas product innovation,

particularly the introduction of larger products, had a stronger impact in the TV segment.

Moreover, they simulate the impact of various mergers on welfare and innovation. When simulating seven-to-six mergers, they find that some mergers would have led to substantial increases in the incentives to innovate (i.e., 1.3%-5.1%), whereas others would have had limited impacts (i.e., 0.2%-0.8%), depending on the combination of firms involved. They also extend this analysis to simulate other mergers involving all possible combinations of firms. They find that, on average, innovation incentives tend to increase in six-to-five and five-to-four mergers, while all other mergers lead to a decrease in innovation incentives. Furthermore, on average, all mergers result in a reduction in overall welfare.

4 Acquisition of innovative entrants

Startups play a critical role in the generation of new ideas and products. A key aspect of the current debate on mergers and investments is whether large companies should be allowed to engage in the acquisitions of startups. In this section, we discuss recent papers that study how acquisitions of potential competitors by incumbent firms can affect the incentives to invest of both the acquiring party and the acquired party.[22]

4.1 Theory

Merger policy can affect firms' decisions to enter a given market. In particular, a more lenient merger policy can make entry more attractive by reducing the competitive pressure faced by an entrant or by increasing the probability that the entrant gets acquired by an incumbent. The latter strategy, known as *entry for buyout* (Rasmusen, 1988), is particularly relevant for startups (Eisfeld, 2024).

Norbäck and Persson (2012) are among the first to study the relationship between merger policy and the incentives of the entrants to innovate. They consider a model in which an innovator invests in an R&D project that, if successful, results in a product that would displace rivals' sales (otherwise, the innovator fails, and there is no new product on the market). The first result is that more competition (measured by a higher degree of product substitutability) generates a higher incentive for a buyout exit rather than for entry into the market.

They also consider how the degree of competition impacts the incentives of innovators. First, conditional on the entry of the innovators, more competition reduces their incentives to innovate because the prospect of competing with the incumbent reduces the marginal

[22] A more recent literature has emerged to analyze the effects of *acquihiring*, that is a firm's acquisitions of startup talent (Benkert et al., 2023; Bar-Isaac et al., 2024). A review of these studies is beyond the scope of this paper.

gains from innovation. Second, conditional on the buyout, more competition has an ambiguous effect and can lead to either more or less innovation activity. This depends on the return to innovation, which is interpreted in terms of the acquisition price. More competition has an effect on the willingness to pay by affecting both the profit obtained under acquisition and the profit obtained under no acquisition. If competition intensifies, there is a negative effect on the profit obtained when there is an acquisition. However, competition also has a negative effect on the profit obtained when there is no acquisition. As the two terms decrease, it is not a priori clear what the effect is on the overall acquisition price and, therefore, on the return to the innovators' investment.

A stricter merger policy, in turn, increases the number of incumbents competing in the market. The authors find that such a policy would increase the incentive of the innovator to sell its innovation relative to the case in which it enters directly the market. As a result, there is more innovation for sale. Finally, Norbäck and Persson (2012) study how merger policy impacts the innovator's effort. They find that the incentive to innovate for entry decreases the stricter the merger policy, whereas there is a U-shaped relationship between the number of firms and the incentive to innovate if there is innovation for sale. The incentive to innovate increases (resp. decreases) with a stricter merger policy if the number of firms in the market is less than or equal to (resp. larger than) two.

Mason and Weeds (2013) argue that four main effects should be considered when designing an optimal merger policy that accounts for the incentives of firms to enter a market. First, there is an *entry encouragement effect* as a more lenient merger policy creates more incentive for entrants to enter the market. This effect is positive as it leads to an increase in social surplus (irrespective of whether the merger actually occurs). Second, there is a *competition effect* as the merger reduces the social surplus when it takes place relative to the case in which the entrant and the incumbent compete. Third, the latter adverse effect can be reduced if there are *merger-specific synergies*. Finally, there is a *sunk cost effect*, as more entry generates higher expected sunk costs. They show that the optimal merger policy amounts to choosing a threshold for the entrant's profit below which a merger is allowed and above which it is blocked. Therefore, their approach provides a theoretical foundation for the failing (or "ailing") firm defense story.

This analysis is extended by Jaunaux et al. (2017) who show that a competition authority may find it optimal to be more lenient toward the acquisition of successful, rather than unsuccessful, entrants. To this end, the authors consider a simple setting in which an entrant decides whether to enter (or not) a market in which post-entry profits are uncertain. The entrant observes the behavior of the antitrust authority that can ex ante commit to its behavior toward merger proposals. This ex ante commitment is modeled by the authors as the probability that the merger will be cleared, conditional on the state of the world.

The authors show that the competition authority should be lenient in priority in the state of the world where the ratio between the loss in ex post consumer surplus and the gain in the entrant's expected profit induced by the merger is the lowest. Applying this general rule to a setting in which uncertainty is about the entrant's marginal cost of production, they show that there are circumstances in which the competition authority should be more lenient towards the acquisition of unsuccessful entrants, but there are also circumstances under which it should be more lenient towards the acquisition of successful entrants.

Bisceglia et al. (2024) examine the interaction between exit policy and entrants' investments. They consider a market in which an incumbent that has committed to invest competes in quantities with a competitor that has an exit option. In their model, the entrant has to decide whether to undertake an investment before learning of its demand. Once demand is realized, the entrant has the option to exit the market or compete with the incumbent. A possible exit strategy, on which we focus hereafter, is to be acquired by the incumbent.

The authors use this setting to compare two opposite merger policies. Under a strict merger policy (which prohibits acquisitions), the exit value of the entrant is equal to zero, as it cannot be acquired by the incumbent. In this case, the entrant invests to the extent to which the marginal gains from the investments are greater than their marginal cost. Under a lenient merger regime (which allows acquisitions), different outcomes are possible depending on whether the entrant has invested or not. If the entrant has not invested, the incumbent has no incentive to acquire the "zombie" entrant. The logic behind this follows from the fact that the "zombie" entrant would at most generate weak benefits from monopolization of the market that would not compensate for the takeover price. If the entrant has invested, the acquisition is more likely to be profitable as the benefits from monopolization and the entrant's higher-quality product (due to investments) are more likely to be larger than the takeover price. The authors show that if the acquisition is profitable for the incumbent, post-acquisition the incumbent always has an incentive to shut down the acquired firm's product. Interestingly, the authors show that a more lenient regime induces the entrant to increase its investments, and this occurs both in the scenario in which it is acquired by the incumbent and in the case in which it is not acquired by the incumbent. Therefore, the authors show that a more lenient merger policy can lead to both *innovation-for-buyout* (even if a buyout does not occur) and situations in which the incumbent shuts down the entrant's product post-acquisition.

Cunningham et al. (2021) investigate the important current concern of competition authorities that startup acquisitions may generate adverse effects on competition and innovation. The authors contend that incumbents' acquisitions of innovative entrants might be motivated by their incentives to preempt future competition. In their model,

several incumbents compete in the market by selling a differentiated product and there is an innovative entrant that has a project. If an incumbent chooses to acquire the entrant, it must decide whether to pursue or abandon the acquired project. The latter case, which the authors label as a "killer acquisition", can only occur when there is an overlap between the projects of the acquiring incumbent and the acquired entrant. In this context, the entrant would develop the project absent the acquisition but the incumbent may decide not to develop it post-acquisition.

Some startups may not be actual or potential competitors of incumbents but could still affect competition in the market by representing inputs that allow an incumbent to get a competitive advantage over other incumbents. Bryan and Hovenkamp (2020) consider a model in which an incumbent competes with a less efficient rival. In the market, a new startup is present and provides a promising input technology. The authors identify the inefficiencies that can arise with respect to the diffusion, diversity, and rate of innovation under a laissez-faire regime. For instance, the incumbent may have the incentive to buy the startup even if the latter would not directly benefit the incumbent in terms of higher quality. The reason is that any acquisition from the rival would reduce (vertical) product differentiation and therefore make competition more intense.

Motivated by the acquisitions made by Big Tech companies over the last few years, Motta and Peitz (2021) examine the effects of merger policy on innovation incentives in a setting where an incumbent can acquire an innovative entrant (e.g., a startup). In their paper, the entrant has a project (e.g., prototype, blueprint, innovative idea) that requires incurring some fixed development costs and additional resources (e.g., data, expertise) and has an uncertain outcome. Before a project is developed, the incumbent can acquire the startup and then decide on the development of its project. Depending on the fixed development cost and the probability that the innovative idea is successful, several outcomes can emerge.

The authors consider two scenarios depending on whether the startup would have the resources or not to develop its project absent the acquisition. If the startup lacks such resources, the decision of the incumbent after the acquisition takes place depends on the relative expected profitability of the project net of the fixed development cost. If the development cost is low, an *efficient upgrade* takes place, and an innovative product that otherwise would not have been developed is ultimately brought to the market. If the development cost is high, the acquisition results in a *dead project*, and in this case, only the incumbent will be active in the market.

If the startup would have had the resources to develop its project, two additional equilibria can arise depending on the relative expected profitability of the project net of the fixed development cost. If the development cost is low relative to the expected net profitability of the project, the incumbent finds it optimal to develop the project, which

results in an *upgrade with suppressed competition*: the start up's innovative product is developed but competition does not take place. If the development cost is high, instead, the incumbent does not develop a project that would have been developed by the entrant, resulting in a *killer acquisition*.

In a similar setting, Fumagalli et al. (2024) focus more on the interplay between acquisitions and the behavior of competition authorities. In their model, a startup has a project that, if developed, allows it to compete against an incumbent. The startup may be either *viable* (i.e., it has the resources to develop the product even if not acquired) or *unviable* (i.e., it cannot develop the project on its own). As in Motta and Peitz (2021), the key trade-off is the following. On the one hand, the acquirer may decide to shelve a project that would have been developed by the startup absent an acquisition. On the other hand, the acquisition may allow the development of a project that would otherwise not be developed due to a lack of resources. A major contribution of this paper is to show that the price paid for an acquisition generates relevant information regarding the anti-competitive potential of such an acquisition. Specifically, the authors show that a competition authority who does not know the type of the startup but observes a low takeover price, learns that the startup is unviable, which implies that its acquisition has a (weakly) positive effect on welfare. However, if the competition authority observes a high price, it does not learn the type of the startup. Despite this, it turns out that the optimal merger policy is to prevent high-price acquisitions (and clear low-price ones). Under such a policy, an incumbent only faces two options: offer a low price (and develop the project) or make no offer. This implies that the merger policy generates a "selection effect" as it encourages acquisitions that focus on unviable startups. This explains why this policy is optimal even though it prohibits high-price takeovers that may be welfare-beneficial.

Katz (2021) adds to the literature by studying merger policy in a context in which competition is for (rather than in) the market and an incumbent can acquire a potential competitor. He considers a dynamic game in which in each period an incumbent decides whether to remain active in the market, and a potential entrant, which arrives with an exogenous probability, can invest in a new technology. After entry occurs, the incumbent can decide whether to merge with the entrant or compete with it. If competition takes place, in the following period one of the firms exits the market (because there is competition for the market). He shows that mergers always occur if not prohibited and that two cases can arise. In the first case, the merged entity only uses the new technology (of the entrant) and shuts down the old one; in the second case, the merged entity only uses the old technology and shuts down the new technology (of the entrant). In the latter scenario, there is an effect similar to that of a killer acquisition as the new technology is dismissed immediately after acquisition, but as consumers enjoy network effects, this is not necessarily inefficient. The reason is that absent a merger, the market moves to the new network

and technology, whereas with the merger and the use of old technology, consumers stick with the old technology (under some conditions) and this is socially efficient. However, even if killer acquisitions can be efficient, he shows that in the presence of competition for the market, a lenient merger policy has a positive effect on the entrant's incentives to invest if the merged firm adopts the entrant's technology and a negative effect on the entrant's incentive to invest if the merged firm retains the incumbent's technology.

Gilbert and Katz (2022) study the effects of mergers on the entrant's ex ante incentives to invest, where the entrant has the possibility to imitate the existing incumbent's product or produce a differentiated product. They examine the entrant's decision and show that it might have the incentive to choose to differentiate itself from the incumbent to soften competition. However, there is also a countervailing force at play if the entrant is also vertically differentiated relative to the incumbent: in this case, it might have the incentive to minimize the differentiation from the incumbent and sell products with a higher price.

The prospect of a merger affects the ex ante incentives of the entrant. If the entrant is differentiated ex ante, post-acquisition the incumbent can sell two horizontally differentiated products and benefit from price coordination. If the entrant is not differentiated from the incumbent, post-acquisition the incumbent benefits from the removal of the competitive pressure, but this implies that the entrant can leverage its bargaining power relative to the incumbent. Gilbert and Katz show that the entrant will choose less (resp. more) differentiation if more differentiation would otherwise generate more (resp. less) profits for independent firms than for a multi-product monopolist

The long- and short-run effects of acquisitions are also studied by Denicolò and Polo (2023) in a Schumpeterian model of repeated innovation and acquisition. In the short run, acquisitions are pro-competitive because the prospect of being acquired increases the entrants' incentives to innovate (the so-called *invention-for-buyout effect*). However, in the long run, acquisitions are anti-competitive because they increase the incumbent's market dominance (the so-called *entrenchement-of-monopoly effect*), which makes future innovators' incentives to innovate lower regardless of whether they are acquired or not.

In light of these results, the authors argue that acquisitions should be assessed considering their cumulative effects, taking into account the degree of market dominance. In particular, they show that it may be optimal to have a merger policy that is lenient as long as market dominance is low but becomes restrictive if repeated acquisitions makes the dominance of a given incumbent too strong.

The prospect of an acquisition can affect not only the level of innovation but also its direction, that is which R&D projects are selected by innovators. Letina et al. (2024), Dijk et al. (2024a) and Dijk et al. (2024b) study these aspects.

Letina et al. (2024) examine the decision of the incumbent on which project to invest and how much for any given project. Ex ante there are multiple projects with heteroge-

neous investment costs, but ex post only one project succeeds. Moreover, they allow for the innovation to be drastic and non-drastic with some probability, meaning that, in the former case, there is a monopolistic market structure and, in the latter case, there is a duopolistic market structure with a potential entrant.

The authors compare the case in which acquisitions can take place and the case in which they are prohibited. In their model, an incumbent owns a technology and invests in R&D, whereas an entrant can sell an innovative product only after having invested in R&D. In the first investment stage, firms decide how much to invest in different research projects, and this determines the probability that (drastic or non-drastic) innovation occurs. In the second stage, the incumbent decides whether to acquire the entrant (if acquisitions are not prohibited). Finally, the firm holding the patent can decide whether to commercialize the technology, and firms receive their payoffs.

The authors identify conditions for which, absent merger control, the incumbent acquires the entrant and then decides whether to dismiss its product (resulting in a killer acquisition) or commercialize it (the authors refer to this as a *genuine* acquisition). Specifically, the incumbent has the incentive to acquire the entrant if the latter has a patent for a non-drastic innovation, and commercialization depends on whether its value (net of its commercialization cost) is relatively high or small.

They also consider the effects of an outright prohibition of startup acquisitions and show that this policy has a weakly negative effect on innovation because of the lack of an exit option (i.e. the possibility of being acquired by the incumbent). Moreover, such a prohibition has an effect on the duplication strategies of the entrant and the incumbents. In particular, the authors find that conditional on an entrant investing in a project, the incumbent has a higher incentive to duplicate it under no-acquisition than under a laissez-faire regime, as in this case investments are preemptive. Likewise, the absence of exit reduces the incentive to duplicate projects. The authors conclude that an outright ban on acquisitions may lead to more competition but less innovation.

Dijk et al. (2024a) consider a market in which an innovative startup has to allocate its funding across two different projects. The two projects differ in whether they are rival to the incumbent's product: one project, if successful, will represent a higher quality version of the incumbent's product, whereas the other project is a non-rival project. The entrant finds it optimal to distort its investment decisions towards a rival or non-rival project depending on the post-acquisition rents of the incumbent. If the acquisition rents are high enough, the startup has an ex ante incentive to put more effort into the rival project and to reduce its effort on the non-rival project. If the acquisition rents are low enough, the startup has an ex ante incentive to distort its effort toward the non-rival project. The authors also investigate whether prohibiting acquisitions increases or decreases consumer surplus and show that both cases can prevail.

In a related work, Dijk et al. (2024b) explore the strategic interactions in R&D investment between incumbents and entrants, particularly focusing on the context of startup acquisitions. Specifically, they study how startup acquisitions may affect not only the portfolio of investments of the target firm but also that of the acquirer. To this end, they consider a market in which an entrant can develop projects in two markets A and B, and the incumbent can develop a project in market A (the *rival* market) as well as a project in a third market C (the *non-rival* market). The entrant moves first, then, upon observing the outcome of the entrant's investments, the incumbent chooses its investment portfolio. If an acquisition takes place, there is a bargaining between the incumbent and the startup. Finally, market outcomes realize.

The authors highlight how the anticipation of acquisitions distorts R&D funding allocation by either increasing or reducing investments in the market where the entrant and the incumbent are potential rivals. For example, they identify conditions under which the entrant, anticipating that the incumbent will cut off R&D funding in the rival market in the prospect of an acquisition, will increase its investments in the same market, reducing thereby investments in the non-rival market.[23] Likewise, there are cases in which the entrant, anticipating an increase in the investments by the incumbent in the rival market in the prospect of an acquisition, will strategically cut off its own investments in that market, moving resources towards the non-rival market. In turn, this change in the direction of innovation can either lead to a higher or lower consumer surplus.

In the context of platforms, Kamepalli et al. (2020) study how acquisitions of entrant firms by an incumbent platform can deter innovation and entry in the digital platform industry, where there are strong network externalities and some customers face switching costs. The authors find a trade-off between static gains from acquisitions and the dynamic loss from reduced entry incentives. In particular, they find that while acquisitions offer lucrative exits for entrants (*innovation-for-buyout effect*), the prospect of being acquired by an incumbent platform can discourage new entry and innovation by potential entrants. This seems counterintuitive to the standard economic argument that acquisitions incentivize entry by offering lucrative exit opportunities and it is due to the role played by network effects.

In such markets, early adopters (like app developers) play a crucial role in facilitating adoption by ordinary customers to a new entrant platform. However, if early adopters expect the entrant to be quickly acquired, they have less incentive to adapt to the new platform since the incumbent will integrate the superior technology seamlessly after acquisition. In turn, this reduced adoption by early adopters discourages entry and innovation by new platforms.[24]

[23]The possibility that an incumbent reduces its own R&D investment because of the acquisition of a rival entrant has been called a "reverse killer acquisition" by Caffarra et al. (2020).

[24]The authors find empirical evidence that venture capital investment and startup deals decline signifi-

Also in the context of platforms, Motta and Shelegia (2024) introduce the incumbent's threat of copying the entrant's product and compare the ex ante incentives to invest of an entrant in such a case with those that would result from the prospect of an acquisition. When entrants anticipate that incumbents might copy their new product, they may focus on creating complementary products, which incumbents are less likely to copy, even if copying is cost-effective and profitable in the short term. This anticipation shifts R&D efforts towards complementary innovations. This result is more likely to occur than in the prospect of an acquisition because, in the latter case, entrants may develop substitutes for the primary product, hoping to be acquired and benefit from the incumbent's intention to avoid competition (even if incumbents might copy entrants' innovations to lower acquisition costs).

Callander and Matouschek (2022) examine the effects of acquisitions on the incentives to innovate in an environment where, conditional on innovating, a firm decides about the novelty of the innovation, that is, how different it is from existing technologies. Innovation novelty is measured along a continuum that varies from very incremental to very radical innovations. The authors show that uncertainty in the outcome of their investments induces firms to be more radical in their innovative effort. However, this comes at a cost for the firm as the most radical innovations are also more distant from the taste of consumers. Callander and Matouschek (2022) investigate whether, once accounting for the novelty of innovation, incumbents or entrants are more likely to innovate. Interestingly, they show that an effect that resembles the Arrow replacement effect is present, but in *spatial* terms. Specifically, because the incumbent would cannibalize existing revenues if it innovates, it has the incentive to move away from existing products to appeal to a broader audience. This makes the incumbent seller have two different types of products and benefit from price coordination. Unlike the incumbent, the entrant does not suffer from Arrow's replacement effect and therefore can erode the revenues of the incumbent when competing with it. This induces the entrant to produce innovations that resemble existing products, thereby engaging in more incremental innovations.

The authors examine how the prospect of an acquisition by an incumbent changes the ex ante incentives of an innovative startup. The prospect of being acquired by an incumbent generates two opposite effects. On the one hand, the entrant may have incentives to follow the strategy of the incumbent that, absent the acquisition, would find it optimal to distance itself from the existing product (because of the spatial Arrow's replacement effect). However, the entrant can leverage its entry threat to extract additional surplus from the incumbent if it competes fiercely with a product that is closer to the existing one. The latter effect is shown to be stronger than the former and therefore there is

cantly in sectors after major acquisitions by big tech platforms like Facebook and Google, suggesting the existence of a "kill zone" effect.

always an incentive for the entrant to moderate its innovative effort and focuses on more incremental innovations.

In the context of Big Tech acquisitions, Cabral (2023) considers a market with a startup, an incumbent, and an agency. The author assumes that the innovation process can lead to a failure, the production of a substitute product, or a complement product. The startup chooses how much to innovate only knowing the probability that an innovation, if realized, can be a substitute or a complement. Then, the incumbent and the startup negotiate an acquisition, and finally the competition authority decides whether to allow the merger. The authors considers different enforcement scenarios including one relying on a balance of probabilities for which a merger is blocked if it is more likely to have an anti-competitive effect than a pro-competitive effect, one relying on a balance of harm for which the pro-competitive effect or anti-competitive effect is weighted by the consumer surplus effect, and finally one in which mergers are banned. He shows that the balance of probabilities is too lenient on mergers compared to the balance of harms. However, the latter case is too harsh relative to a policy that takes into account that a startup can lower its research effort if it anticipates that an acquisition will be blocked. The author then calibrates the model using available data from GAFAM and shows that moving from a balance of probabilities to a balance of harms would generate welfare benefits, whereas a complete ban on mergers would result in a welfare loss.

4.2 Empirical evidence

Some recent empirical papers have shown that pharmaceutical and Big Tech companies have engaged in many acquisitions of startups and that some of these led to the discontinuation of entrants' products. While it is difficult to identify systematically "killer acquisitions" by Big Tech companies (Gautier and Lamesch, 2021), in the pharmaceutical industry, between 5.3 % ad 7.4% percent of acquisitions are found to be killer acquisitions by Cunningham et al. (2021).[25]

Using a data set that includes detailed information on more than 16,000 projects in the period 1989-2010, Cunningham et al. (2021) study the effects of acquisitions on the development of the projects of acquired firms. A central aspect of their analysis is the identification of overlapping projects between the acquiring and acquired firms, which suggests potential substitutability and the emergence of the acquired firm as a future competitor of the incumbent. In their empirical analysis, the authors focus on the likelihood of post-acquisition project development by comparing projects with and without overlaps. The key finding is that acquired projects with overlaps in the acquiring firm's portfolio are less likely to be developed post-acquisition. This result is shown to be

[25]For a comprehensive discussion, see Affeldt and Kesler (2021a). Other papers on GAFAM acquisitions have focused more on the effects on venture capital funding (e.g., Koski et al. 2020 and Prado 2021).

robust across various model specifications.

In several extensions, the authors shed further light on killer acquisitions. First, they examine how the competitive environment influences the probability that a project is not developed post-acquisition. They find that killer acquisitions are more likely to occur in markets with less product competition. In other words, when there are fewer competitors in a market, acquiring firms have a stronger incentive to eliminate potential threats by acquiring and discontinuing the development of similar projects. Second, they study how the prospect of a patent expiration of the acquiring firm influences the probability of not developing the project of the acquired firm post-acquisition. They show that when the relevant patents of the acquiring firm are close to expiration, killer acquisitions are less likely to occur. Finally, they find that most of the acquisitions that are classified as killer acquisitions are below the threshold that requires a notification to the competition authority, thereby avoiding antitrust scrutiny.

Another empirical study on the effects of acquisitions on market outcomes is provided by Eisfeld (2024), which is different in scope and methodology. Specifically, Eisfeld (2024) studies the impact of innovative startup acquisitions on a firm's incentives to enter a market. Using a structural model, she shows that in markets in which firms are often acquired, startups are more likely to enter. Moreover, she finds that acquisitions of mature startups by major incumbents are followed by lower entry. Based on counterfactual simulations, she finds that blocking all acquisitions would lead to a decrease in startup entry, which is in the order of 8-20% in markets in which the profits from competing are low relative to the gains of being acquired. By contrast, she finds that blocking only acquisitions by large, strategic firms would increase entry by more than 4% in the concerned markets.

Fons-Rosen et al. (2022) develop an endogenous growth model to examine the dynamics between incumbents and startups in the context of innovation and acquisitions. Incumbents, which produce a finite number of differentiated products, invest in innovation to boost productivity and out-compete other firms. Startups, in contrast, focus on innovation to enter the market by displacing incumbents. The model introduces two key elements: incumbents can invest in a search technology to acquire startups, and startup ideas require additional implementation investments to become marketable products. This framework allows for differentiation between related acquisitions (where a startup's idea is related to an incumbent's existing products) and unrelated acquisitions (where the startup's idea is unrelated to the incumbent's current offerings).

The analysis in Fons-Rosen et al. (2022) sheds light on the effects of a decrease in the frequency of startup acquisitions (because of exogenous shocks) on innovation and growth. First, such a decrease generally lowers the startup rate (i.e., the number of new startups created in a given period). Second, a decrease in startup acquisitions has *a*

priori an ambiguous impact on the implementation rate of startup ideas because of two opposite effects. On the one hand, incumbents may have lower implementation costs than startups. On the other hand, an incumbent's benefit from implementing a startup idea is lower than the startup's because of a standard "replacement effect" à la Arrow. Finally, lower startup acquisitions also affects incumbents' own innovation rates through general equilibrium channels. In particular, a lower frequency of acquisitions attracts less startups, which reduces the threat of displacement for incumbents. This in turn increases their value and incentives to innovate.

The authors then construct a dataset combining information on acquisitions, patents, and accounting data, and use it to examine the effect of acquisitions on the implementation of startup ideas (relying on patent citations as a measure). A partial equilibrium analysis shows that more frequent acquisitions increase the implementation rate of startup ideas. However, when general equilibrium feedback effects are considered, this effect is reversed; the startup rate declines significantly, with only minor compensations from increased incumbent innovation and startup implementation efforts, leading to an overall decrease in the growth rate. The authors find that a ban on startup acquisitions would increase the (aggregate) growth rate by about 0.03 percentage points by year.

Focusing on the mobile app market, Affeldt and Kesler (2021b) investigate how GAFAM competitors, in a given relevant online market, react to GAFAM acquisitions. The authors measure innovation through app updates and feature updates, where the latter includes changes in app features, while quality is measured by the amount of user data collected, which could potentially result in privacy concerns. To identify the effect of GAFAM acquisitions, the authors employ a difference-in-difference specification, with the treatment group comprising competitors who have been exposed to a GAFAM acquisition, and the control group comprising competitors who have not been exposed to such an acquisition. They find that, following GAFAM acquisitions, competitors tend to reduce their innovative efforts, both in terms of app updates and feature updates.

5 Conclusion

This literature review on market structure and investments has focused on three issues: the relationship between the intensity of competition (captured by the number of firms or the degree of product differentiation) and investments, the impact of mergers between competing incumbents on firms' incentives to invest, and the impact of acquisitions of potential competitors on the investment incentives of the acquiring and acquired parties.

Although the theoretical literature does not offer a clear-cut message regarding the overall impact of changes in market structure (particularly through mergers) on firms' investment incentives, it does shed light on the various effects at play. Our review shows

that these effects depend on numerous factors, such as the initial level of competition in the industry, the technological landscape (e.g., 4G/5G vs 2G/3G in telecoms), the type of investments (e.g., cost reduction vs. quality improvement), and the nature of competition (actual vs. potential).

On the empirical side, there is mixed evidence on the impact of changes in market structure on investments. This is unsurprising considering the ambiguous predictions from the theoretical literature. A potentially more interesting insight from the empirical literature is that similar consolidation practices may yield different outcomes across different industries. Related to this, it is worth noting the relative scarcity of empirical studies on mergers and acquisitions in digital markets, despite the concern they raise among policymakers.

Finally, we have focused on the effects of changes in *horizontal* market structure and neglected to explore how investments can be affected by changes in *vertical* market structure. The effects of vertical mergers on investment are underexplored, especially in light of recent antitrust cases and developments.[26] For instance, in 2022 the European Commission prohibited the implemented acquisition of GRAIL by Illumina, a firm operating in the market for blood-based early cancer detection tests, on the grounds that the merger would stifle innovation.

[26]Recent exceptions include Allain et al. (2016), Liu (2016), Carbonnel (2021), and Chambolle and Guignard (2024).

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