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Abstract

This article focuses on the economics of digital markets with particular emphasis on those features that are commonly deemed critical for Antitrust. Digital markets are often concentrated due to network effects and due to the need of large amounts of Data for production. We review papers characterizing the nature of social harms caused by market power and the role of competition FOR the market and IN the market to relief some of that harm. Special emphasis is given to the role of (i) human attention (which is monetized and is a key input in advertising markets), (ii) Data (which is the oil that powers these markets) and (iii) innovation (incentives, entry for buyout and killer acquisitions).

JEL Classification: L1, L4

Keywords: Digital Markets, network effects, Innovation, killer acquisitions, Economics of attention

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Market Power, Competition and Innovation in digital markets: A survey[1]

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Abstract

This article focuses on the economics of digital markets with particular emphasis on those features that are commonly deemed critical for Antitrust. Digital markets are often concentrated due to network effects and due to the need of large amounts of Data for production. We review papers characterizing the nature of social harms caused by market power and the role of competition FOR the market and IN the market to relief some of that harm. Special emphasis is given to the role of (i) human attention (which is monetized and is a key input in advertising markets), (ii) Data (which is the oil that powers these markets) and (iii) innovation (incentives, entry for buyout and killer acquisitions).

Digital markets are at the forefront of the public policy debate because of the central role played by tech giants in today's economy and because of their influence, among other things, on cultural diversity, political pluralism and privacy. Any policy argument requires to understand deeply the functioning of these markets. This article focuses on the economics of digital markets with particular emphasis on those characterizing features that industry observers commonly deem as being particularly thorny from an antitrust perspective.

Section 1 focuses on network effects. Network effects are an obvious source of concentration due to a "rich get richer" dynamics, whereby more users enhance the dominant firm's attractiveness leading to even more users. In extreme cases, network effects cause markets to tip to monopoly. Concentration maximizes gross consumers' surplus when network effects are in place, but its benefits have to be weighed against costs due to market power. Multi-sidedness (i.e. indirect network effects) enriches the picture. The literature on multi-sided markets shows that the interplay of cross-side externalities affects firms' pricing in distinctive ways.

The fact that digital services are often offered for free does not mean that concerns over concentration are unfounded. Section 1 concludes by reviewing platforms' incentives to exert their market power in dimensions other than price. Particular emphasis is given to the concept of "intermediation bias" and its consequences. The basic trade-off platforms face is that between revenues per interaction and quantity of interactions. Do search engines or social media outlets provide us with the best possible product? In other words, do firms have an incentive to `tweak' their algorithms to increase revenues at the expense of consumers' surplus?

Section 2 presents a more recent literature bound together by the idea that in a world with rapid innovation, potential and actual entry may mitigate the social costs of concentration. That is, we look at the potential of competition FOR the market to discipline incumbents. In particular we present the notion of "incumbency advantage," capturing the idea that an installed base of consumers may prevent entrants from penetrating the market despite these latter being endowed with better quality products. The three key questions that arise in this context are: what is the source of the incumbency advantage? How and to what extent can such advantage be exploited to extract supra competitive rents? Are there factors that can mitigate the anticompetitive potential of network effects by fostering competition FOR the market? What about multi-homing? That is, what about the widely documented habit of trying out new services *before* quitting the old ones or patronizing two competing platforms at the same time?

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[1] This survey is largely based on work commissioned to one of the authors for the Competition and Markets Authority.

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Despite concentration being a widespread phenomenon in digital markets, there are plenty of cases with competition occurring IN the market, perhaps because consumers have idiosyncratic preferences for quality or varieties. Section 3 reviews the standard case with different platforms coexisting although often adopting different business models.

Section 4 looks at a particular class of actors, referred to as "attention platforms." A large fraction of the Internet is basically powered by advertising money. Many websites and apps are in the business of harvesting and reselling human attention. These firms are essentially platforms operating in multi-sided markets: advertisers wish to place their creatives on outlets that have a large audience while consumers typically dislike ads. These markets received a special treatment in the economics literature for a number of reasons that go beyond their obvious relevance. There are often no prices on the consumer side of the market, so firms do not internalize consumers' willingness to pay. Multi-homing is widespread, and this makes it difficult to use traditional measures of market power. New technologies that use data to profile users and follow them as they traverse the internet (e.g. cookies) scale down competition for attention at the individual level. Finally, advertising is a key input in product market competition when consumers are not informed about the quality and quantity of products on the marketplace.

Section 5 focuses on innovation. The potential threat to incumbents coming from innovative start-ups requires to look at the incumbent's strategic response with a focus on foreclosing strategies and the use of mergers and acquisitions to protect market dominance. Can firms protect their rents by targeting innovative start-ups before they enter the market? How does this change the incentives to innovate? Moreover, the relevance of innovation in digital markets warrants a fresh look at an old theme: the potential impact of mergers on research activity. Indeed, this issue has been hotly debated in the antitrust community after the *Dow/Dupont* EC case sparking a flurry of theories.

A final and fundamental piece of the picture refers to the role of data. The quintessential task of many digital platforms is that of making prediction of various sort. Search engines need to predict the relevance of URLs to a consumer query. Matchmakers need to predict the value of a match in order to find good prospects for their users (for instance, employees and employers, single men and single women and so on); content distributors, such as Spotify, need to predict their user tastes to keep them entertained; mapping services need to predict traffic conditions and so on. Data is the oil that powers these predictions. Section 6 reviews empirical and theoretical papers shedding light on the map from the quantity and quality of Data to prediction accuracy (thus ultimately to product quality), on the incentives to sell, share or license Data and, finally, on the potential for Data to act as a barrier to entry.

Many enforcers and think tanks have moved their attention to the competition policy in digital markets and several reports have been recently released.[4] They share a common concern for the intrinsic tendency to concentration of these ecosystems and suggest, as a general approach, reducing the risk of under-enforcement. Competition policy remains a central player and traditional tools should be adapted in light of a true understanding of the functioning of these markets and of the empirical evidence of the different effects simultaneously at play. A stricter merger control and a focus on foreclosing strategies are the central areas of intervention. At the same time there is a common view in these reports that tech giants should be monitored also through ex-ante regulation, defining a code of conduct that may guide their practices. Data mobility and interoperability, open standards and data openness are key in keeping open these markets to new rivals.

The positive theoretical and empirical results reviewed in this paper offer a rich set of economic insights that should help enlighten the debate and assist policy makers in drawing sensible public policies.

[4] See for instance the report by Cremer et al (2019) prepared for the DG Competition of the European Union, the report by Furman et al. (2019) drafter for the UK Treasury, the report by Scott Morton et al. (2019) for the Stigler Center of the University of Chicago.

1. *Direct and indirect network effects*

In its simplest incarnation, the term "network effects" refers to the fact that in some markets, a firm's total demand or market share has a *direct* effect on consumption value of its product or service. For instance, the value of joining a social media outlet or a communication service is clearly increasing in the number of other users a consumer can potentially interact with. In other markets, the link is subtler. "Network-like effects" sometimes arise due to demand-driven dynamic economies of scale, i.e. learning by doing. For example, users of search engines typically do not care directly about the engine's market share. However, the quality of search results is intimately connected to the scale of operations.[5]

By lowering a range of costs, the internet has facilitated the creation of new businesses marked by the interaction of various types of economic agents which can be charged different prices. In these markets, feedbacks may link one group of economic agents to another group and in this case network effects are said to be *indirect*. With indirect network effects a firm's sales of a given product or service to a certain group of agents has an effect on the value of a different product or service purchased by a different group of agents.[6] A classic example is that of operating systems ("OSs") such as Google's Android or Apple's IOS. Users value choice. Thus, systems that boast more apps are clearly more attractive. Vice-versa app developers value access to larger users' pools. Nobody wants to incur in the fixed cost of developing an app for a system that only a few adopt. Another notable example are content providers such as Yahoo.com. Much like their off-line counterparts (e.g. Free-to-Air broadcasting stations), these harvest the attention of their customers by providing valuable content and then resell that attention to advertisers. Notice that in this illustration externalities from advertisers to consumers are negative as consumers typically prefer ad-free content. These firms are typically referred to as "multi-sided" platforms.[7] The value that users on one side of the market assign to the platform depends (positively or negatively) on how many users on *other* sides of the market also patronize the platform.[8]

As the overarching goal of competition policy is that of alleviating the social harm caused by market power, in this section we study the nature of that harm in a simple context with a monopoly platform. The monopoly paradigm fits particularly well in this context because of the "rich get richer" industry dynamics leading to high level of concentration (or market tipping). Furthermore, concentration, allowing to generate network effects, enhances gross consumers' surplus, but its benefits have to be weighed against its costs due to market power.

The first part of the section looks at market power in the context of traditional network businesses. The second part looks at multi-sided markets. These latter are more complex in many ways, so they deserve special treatment.

The last part recognizes that platforms shape economic outcomes by controlling dimensions other than price and reviews the literature on market power and product design choices: algorithms, rankings and search diversion.

Market power with direct network effects

Market power refers to the ability of a firm to profitably raise prices above marginal cost. Its *extent* depends on how far prices are from these marginal costs. When choosing how much to raise prices, i.e. when choosing

[5] Search engines typically "learn" about relevance of URLs to particular queries by observing and analysing users' behaviour on search result pages. URLs that are clicked more often are obviously more likely to be relevant. More users therefore imply more accurate results.

[6] In this sense indirect network effects, involving externalities between distinct groups of agents, are different from the case of complementary goods, characterized by a positive effect of one product on the utility of some other product purchased by the same agent.

[7] There is no universally accepted convention of what the term "platform" means, as it has been widely used in at least four disciplines: economics, management, marketing and law. Platforms are basically economic intermediaries that either enable or facilitate the interaction between market participants (this definition is close to that provided by Hagiu and Wright (2019) in a recent important contribution).

[8] Of course, there is a very large literature on multi-sided platforms pioneered by Caillaud and Jullien (2003); Rochet and Tirole (2003, 2006) and Armstrong (2006) and surveying that literature is vastly beyond the scope of this document.

mark-ups, firms typically trade off quantity (less units sold) for prices (higher price charged for all other units sold). At the optimal (internal) solution the two effects perfectly balance each other. Of course, whether this trade-off leads to a large or small mark-up depends crucially on the elasticity of consumer demand to price, that affects the relative impact of the two effects. More elastic demands induce lower mark-ups and vice-versa. That is, market power is inversely related to the elasticity of demand.

A first important point is what is the impact of network effects on demand elasticity. To build intuition, consider the following exercise. Starting from any price consider the effect of a 1% price increase. A first direct and familiar consequence is that demand, assuming consumer expectations about what other consumers will do are unchanged, goes down as consumers at the margin between buying or not now prefer to drop out. But of course, being this a network good, the lower quantity sold reduces all consumers' willingness to pay, further reducing demand and so on. This second effect is entirely new and goes through consumer expectation over network size. The stronger these network effects, the larger the elasticity. In extreme cases (for instance, goods which work only if some critical mass is reached), small price changes can wipe out demand entirely.

Thus, other things equal, network effects induce *smaller* mark-ups. The larger these effects, the smaller the mark-ups. To formally illustrate the additional role played by consumer expectations over network size, it is convenient to parametrize (somewhat unconventionally) the demand in a way that highlights its dependence on expectations. Let $P(q, q^e)$ denote the inverse demand. Specifically, this is the price at which a monopolist can serve q consumers when all market participants operate under the conjecture that q^e consumers will be served (i.e. join the network). Clearly it must be that in equilibrium $q = q^e$. Hence, in principle, one could write $P(\cdot)$ as a function of q only. The advantage of rewriting inverse demand in this way is that it allows to decompose the effect of a quantity increase isolating the role of consumer expectations over network size in price formation. As usual, the monopolist chooses the quantity q that maximizes its profit $(P(q, q^e) - c)q$. It equates marginal revenues to marginal cost assuming that expectations adjust accordingly: $\left(P'_q + P'_{q^e}\right)q + P = c$. This leads to the pricing equation:

$$P = c \overbrace{-P'_q q^\star}^{\substack{\textit{classic markup} \\ > 0}} \underbrace{-P'_{q^e} q^\star}_{\substack{\textit{externality discount} \\ < 0}} .$$

The first two terms are familiar. Price is equal to marginal cost plus a positive mark-up which reflects market power and depends on the curvature of the inverse demand function (recall that demand is negatively sloped: $P'_q < 0$). The last term captures the effect of network externalities on monopoly prices. Specifically, $P'_{q^e} > 0$ measures the price effect of more optimistic expectations. In other words, it measures the change in the agents' willingness to pay as a result of the increased network size. Since increasing quantity (or equivalently decreasing price) enhances such willingness to pay by increasing network size, the monopolist is more inclined to do so. Therefore, it charges lower prices. The stronger the network effects (as measured by P'_{q^e}) the lower the overall mark-up over price.

The result the mark-ups in the presence of network effects are smaller than without network effects goes against the intuition, and an often-used argument, that successful platforms can charge higher prices *because* of the benefit of network effects. Two observations are in order. First, as we shall see, network effects can potentially shield a firm from competition and are thus a *source* of market power. In this paragraph we *assumed* market power and characterized its exercise. So, there is no contradiction. Second, for users who are away from the marginal point, their willingness to pay coming from the network effects increases with quantity. If a firm were to engage in price discrimination this could potentially allow for higher markups than in markets without network effects.

The above observation tackles an old and important question in network economics that goes back to Liebowitz and Margolis (1994). Do monopolists internalize network effects? That is, when making their choices, do they take into account the extra value created by increasing quantity for all network participants? The answer is yes, but only up to a point. The reason goes back to the classic contribution of Spence (1975).

Recall that the market price reflects the willingness to pay of the "last" consumer; that is, the consumer just indifferent between purchasing or not. So, the effect of a change in quantity (for instance, one less unit sold) on price simply reflects how much that "last" consumer values consumption. However, there is no reason why the marginal consumer should have preferences that are representative of all other consumers served. To see this via a simple illustration consider a social network. In analogy with Spence's work, one could think of network size as a "quality" dimension of the monopolist's product. It makes sense to assume that heavy users of a social network enjoy more interacting with other users than consumers at the margin. However, if this is the case then the monopolist fails to internalize loyal customers' taste for interactions and thus provides, other things kept equal, a suboptimal quality. If marginal consumers care about quality less than infra-marginal ones, then monopoly power would lead to both high prices and suboptimal quality.

While mark-ups in digital markets may be significantly lower due to network effects, there is a sense in which these markets are doomed to not achieve full efficiency. The idea is that because an individual's consumption choice has a positive externality on all the other consumers, in order to induce choices that maximize the overall industry surplus, one would need to charge prices below the marginal cost of production. That is, negative mark-ups. Since no firm would ever find it profitable to charge below cost there is no market structure (i.e. there is no amount of competitive pressure) that would support such an outcome. A notable exception is the case of multi-sided platform markets where negative mark-ups on a given side can be supported as these losses can be recouped by charging other market participants (other sides).

Suppose that the economic surplus (i.e. utility) that a consumer gets is equal to some stand-alone value, denoted B, plus a component proportional to the size of the network $b \times q$, where q denotes network size. That is: $U = B + bq$. For instance, think about a web-mapping app such as Waze or Google Maps. The stand-alone value refers to the value of having maps and directions at your fingertips. The network component reflects the value of having the stand-alone utility being complemented by crowdsourced information. That could be information about real-time traffic conditions or the opening hours of local shops. Clearly, when making purchase decisions, a consumer takes into account only the private benefits $B + bq$.. However, the social benefits created by having an extra consumer on board equal the private benefit plus the extra surplus that all other consumers would get due to the increased network size minus the cost of serving that additional consumer. Thus, when joining, consumers exert a positive "adoption externality" on all other customers as they increase the payoff of others.

A basic consequence of adoption externalities is that even if the price were set at marginal cost (in short mc), the outcome would still be inefficient from a total surplus maximizing perspective. To see this, firstly observe that consumers adopt if and only if $B + bq$ is not lower than the price $p = mc$. The "last" consumer adopting is just indifferent as his private benefits are exactly equal to the cost of serving that consumer. However, if this consumer were to join, the overall surplus would exceed the cost of serving that consumer. Thus, even if $p = mc$, there is suboptimal adoption. In other words, there is scope in these markets for below marginal cost pricing. The stronger the network effects, the wider the gap between cost and price that would restore efficiency. If one considers consumer surplus (as opposed to total surplus) as the relevant welfare measure, then prices should be even lower as, in that case, the losses incurred by the platform drop out of the equation. In the plausible case with very small marginal costs (a characterizing feature of many digital markets), then efficiency would warrant negative prices.

Market power with indirect network effects

Next, consider multi-sided markets. A first difference is that adoption externalities due to network effects go *across* sides. As in the one-sided settings, platforms can use prices to account for that, making consumers internalize those externalities. However, assuming a platform is able to discriminate and, therefore, charge different prices to agents belonging to different sides, the problem is more complex. A side-specific price plays a double role here. On the one hand, it allows to extract rents as in traditional settings. On the other hand, by shaping consumption choices on that side, it ends up affecting the value that agents place on joining the platform on *other* sides.

For concreteness, we start by outlining the nature of market power in the simple context introduced above with one platform and constant marginal costs. The only difference here is that network effects are indirect. It is convenient to frame the platform's problem as that of choosing how many consumers to serve on each side; in other words, the platform has to choose a pair of quantities. Total revenues are equal to the sum of the revenues on each side. This problem is similar in spirit to the classic problem of a multi-product monopolist. When choosing whether to serve an extra agent, firms typically trade off price (lower price for all units sold) for quantity (one more unit sold). However, one less unit sold also *changes* the price that agents are willing to pay on *other* sides. That is, the monopolist also takes into account how much value is created (or destroyed in the case of negative network effects) on other sides. Thus, other things equal, indirect network effects induce *smaller* mark-ups if externalities are positive and *larger* mark-ups otherwise.

Let $P_i(q_i, q_j^e)$ denote the inverse demand. That is, the price that q_i agents of side i would be willing to pay if they expected q_j^e agents on side j to materialize. The monopolist problem is:

$$max_{q_A,q_B}\ P_A(q_A, q_B^e)q_A + P_B(q_B, q_A^e)q_B - mc_A q_A - mc_B q_B$$

As usual, the monopolist equates marginal revenues to marginal cost on each side assuming that expectations adjust accordingly. Taking the derivative of the above and rearranging leads to the pricing equation:

$$P_i = mc_i \quad \overbrace{-\frac{\partial P_i}{\partial q_i}\, q_i^\star}^{\textit{classic markup > 0}} \quad \underbrace{+\ \frac{\partial P_j}{\partial q_i^e}\, q_j^\star}_{\substack{\textit{cross-subsidy for value} \\ \textit{created on side B}}}$$

The first two terms are familiar. Price is equal to marginal cost plus a positive mark-up which reflects market power and depends on the curvature of the inverse demand function. The last term captures the effect of network externalities on monopoly prices. If externalities are positive and strong, then the last term could overcome the second and below cost pricing might occur.[9]

When participation on one side exerts a positive and sufficiently large (in relative terms) externality, then mark-ups could well be negative: sides that create a lot of value for other sides should be subsidized. This means that platforms can sometimes increase profits by making losses on one side while recouping those losses on other sides.[10] An example is a content provider (say a news outlet) financing operations through advertising. If advertisers care more about the number of consumers that can be reached than consumers care about the quantity of ads, then we would expect consumption to be subsidized (perhaps with a negative or zero price). A key insight is that negative mark-ups or prices are by no means an indicator of low market power as one should evaluate all sides simultaneously.

To further gain insights on the nature of market power, the earlier literature (e.g. Rochet and Tirole (2006)), spelled out the problem of a monopolist as a combination of two sub-problems. A first problem is, given a total price, how to allocate that price across the two sides. A second problem is how high that total price should be. That is, platforms need to pay attention both to the overall price *level* and to the price *structure*. As in the one-sided setting the monopolist has an incentive to choose prices that mitigate the effects of the adoption externalities across groups. In loose terms, it aims to get both sides "on board". So, while market power clearly translates into high price levels, the incentives towards the price structure can be aligned.[11] That is, there is not necessarily a wedge between the private (profit maximizing) and social incentives over the price structure. The intuitive reason is that monopolists capture a fraction of the surplus created in the

[9] This effect reminds the pricing of a monopolist selling complementary products: the internalization of positive externalities across goods leads to lower prices with respect to an oligopoly equilibrium.

[10] The problem shares some similarities with the optimal pricing of a multiproduct monopolist, that requires mark-up to be inversely related to the demand elasticities of the different products.

[11] This relates also to the pricing problem of a multiproduct monopolist with fixed costs and its optimal regulation under break-even. Although the level of prices is higher in the former case, in both cases mark-ups are inversely related to demand elasticities.

market, so they obviously have an incentive to increase the size of that surplus. The higher the overall interaction surplus, the larger the monopoly rents, which are a fraction of that.

Let i and j index sides and suppose that the economic surplus that an agent from side i gets is equal to the sum of a stand-alone benefit B_i and a per interaction benefit that increases with the quantity of agents on the opposite side $b_i \times q_j$. That is $U_i = B_i + b_i q_j$. From the consumers' perspective, B_i is the quality of content while b_i is the marginal value (perhaps negative) of advertising. From the advertisers' perspective, B_j is the value of one's product being associated with this particular content provider (e.g. "as seen on TV") and b_j is the expected present value of informing an additional consumer about the existence of a product. A textbook example is that of a bar where men and women hope to find a partner. B_i is then the value of enjoying a drink in a laid down environment while b_i is the value of having one more potential partner entering the bar.

Perhaps the simplest way to show why the price structure matters is to forget about profit maximization for a moment and look at the simple benchmark where prices are set equal to the respective marginal costs, that is $p_i = mc_i$ and $p_j = mc_j$. Would total surplus be maximized? Once more, the answer is no. Again, the reason is that agents do not internalize the basic economic fact that their choices affect the utility of other agents. In particular, when making their adoption choices, they compare their *private* benefit $U_i = B_i + b_i q_j$ to the price, neglecting the fact that an extra agent on side i changes the surplus of all agents on side j by an amount equal to b_j. The "last" agent served on each side is just indifferent, equating her *private* benefit to the *social* cost of serving that agent mc_i. Thus, if indirect network effects are positive, below marginal cost pricing on at least one side would also be warranted in this context.

So far, no difference with the one-sided setting. However, here one may ask whether it would be possible to increase total surplus by changing the prices in a way that keeps profits equal to zero. That is whether it would be possible to increase the total surplus by making losses on one side while recouping those losses on the other side. The answer to this question is typically yes. To see this, suppose that $b_i < b_j$, so that agents of side j care relatively more than agents of side i about interacting with agents of the opposite side. To simplify the argument let everything else be symmetric on the supply and demand sides. That is let $mc_i = mc_j = mc$. Now, consider starting from a price of $p_i = p_j = mc$. Can one increase the total surplus without incurring losses? Clearly, since $b_i < b_j$ one possibility would be to drop one customer on side j (which is not particularly appreciated by customers on side i) and attract one more customer on side i. Whether this would be profitable depends on how much it would cost to attract an extra i agent (that is how much should the price p_i be lowered) defrayed by the extra revenues on side j due to above marginal cost pricing. Thus, whether this would be profitable ultimately depends on the relative curvature of the demand functions. However, in a symmetric setup, these two would cancel out. As the total number of agents served does not change, the total cost would stay constant, while $b_i < b_j$ implies that the total surplus would obviously go up. Therefore, the assumption that $b_j > b_i$ suffices to establish that, in first best, side i should be subsidized (i.e. pay a price below cost), while side j should be taxed to recoup those losses. Notice that if $p_i = c - b_j q_j$ then side i agents would fully internalize the adoption externality. That is the marginal agent on side i would equate social benefits to the social costs. This approach captures an intuitive result in this literature, which is that sides that create a lot of value for other sides should be subsidized. If b_j were very large, then p_i could well be negative. In the examples above, if advertisers' care more about consumers than consumers care about advertisers then we would expect consumption to be subsidized (perhaps a negative or zero price). Similarly, in the bar example, if men care more about "interacting" with women than women care about "interacting" with men then the pub owner should subsidize women (say allowing them for free) and charge men.

The fact that dominant firms may set some prices equal to zero makes it difficult to apply the traditional antitrust approach to platform markets. Two related issues have been particularly troublesome for competition authorities: the definition of the relevant market and the assessment of market power. Let

consider as an example the broadcasting industry and traditional free-to-air operators. It was claimed that since viewers receive content for free, there is no commercial relationship of the TV operators with viewers, the basis to establish the existence of a market for viewers' attention. Hence, in a number of cases the relevant market for free-to-air operators was restricted to the sale of advertising space. Relatedly, there was no possibility to establish the exercise of market power of broadcasters on viewers, even in the case of a monopolist free-to-air TV.

The literature on two-sided markets has clarified that the definition of the relevant market should include all services provided to the groups of agents on board, and the assessment of market power should be done looking at the overall price level that includes charges on all sides. In this perspective a monopolist platform will charge an overall positive mark up even when opting for a very unbalanced price structure where one of the sides is served below cost or even for free. A separate assessment by side, by missing the cross-side externalities that shape the specific charges, would erroneously interpret as absence of market power a case when one side is subsidized while market power is exerted though huge mark ups on the other side.

Market power in dimensions other than price: intermediation bias and manipulation

Platforms perform their "balancing act" through other instruments besides prices. They also make a number of "design" choices that shape economic interactions. Most notably, they design the technology that allows users to interact. From a public policy perspective, one may wonder if concentration can also lead to suboptimal "design" choices. This section reviews the literature that characterizes the dark side of concentration in dimensions other than prices typical of digital markets.

The economic literature has looked at the concept of "intermediation bias," whereby the platform uses its technology to "direct" user interactions. For example, search engines provide a ranked list of websites and advertisers relevant for a given query; social media filter content in a way that affects user engagement; e-commerce websites and OTAs, upon being queried, provide a subset of products and services related to the user query and contextual information. Some of these behaviours have already been sanctioned by antitrust authorities such as Google's promotion of its own subsidiary websites in the Google Shopping case.

These platforms provide advice to consumers and collect money from the advised firms. A relevant question is whether these informational intermediaries distort their advice to consumers providing a compensation maximizing rather than a users' surplus maximising ranking to consumers. One of the earlier contributions on this issue is Hagiu and Jullien (2011). They show that an intermediary has an incentive to "lower" the quality of the interaction provided by the platform in exchange for higher revenues per interaction. In their model the platform trades off revenues per interaction for quantity of interactions. In a series of papers, De Corniere and Taylor (2014, 2016) study the determinants of such bias and its consequences. The first paper looks at search engine bias and its effect on websites' strategies. The latter generalizes some of the ideas, looking at an intermediary who is willing to divert uninformed consumers in exchange for a price. It is shown under what conditions on preferences and technology a market failure arises. Bourreau and Gaudin (2018) and Calvano and Jullien (2018) look at biases within widely used recommender systems. These are algorithms designed to greet consumers landing on a website with personalized recommendations about goods from the catalogue that they might enjoy or need. Netflix, Amazon, Spotify and many other platforms employ a version of these highly sophisticated algorithms which basically use big data to predict consumer tastes. Recommender systems are extremely popular because they help boosting consumer engagement, a key driver of business retention and creation. Bourreau and Gaudin (2018) look at the issue of biased recommendations in a context where some products/consumer choices are more profitable than others. They explore a trade-off whereby distortion enhances revenues (given participation) but obviously depresses demand as consumers anticipate that the content is not the one that they would have chosen for themselves. Calvano and Jullien (2018) show that recommendation bias is very robust, emerging even in settings where there are no pecuniary incentives. That is, even in contexts where the service provider has no preference over which object ends up being consumed. The idea is that consumer trust in these recommendation systems is very fragile. If a product recommendation (say a movie) turns out to be wrong, then consumers

will not trust anymore these recommendations in the future and as a result their willingness to pay will be lower. They show that in these contexts recommender systems engage in inefficient risk taking: they are excessively cautious. That is, they recommend too often products which on average do not risk disappointing.

Teh and Wright (2019) analyse the properties of a Symmetric Informative Equilibrium with Steering (SIES) in which informational intermediaries collect fees from advised firms if the product is purchased and provide a personalized ranking to consumers. Since these latter can always reject the suggestion and stay with the outside good, demand is elastic and low if the suggested product does not match the user's tastes. Platforms therefore face a trade-off: if they supply a "commission maximizing" ranking, they collect high fees but face a low demand from consumers. So they conclude that If consumers' demand is sufficiently elastic, then, the platform internalizes consumers' surplus and provides an informative ranking, that is advice that matches the user's tastes.

2. *Competition FOR the market*

If network effects are strong and the products provided by competing platforms are close substitutes, then concentration would be intuitively both the outcome of competition and the outcome that maximizes network effects. These latter benefits should then be contrasted with the exercise of market power. Indeed, most of the current academic debate takes as given that network effects lead to market tipping and looks at the potential of competition *FOR* the market to discipline incumbents. The idea is that in a world with rapid innovation, potential and actual entry possibly mitigate the social costs of market power.

The main aim of this section is to discuss some recent work on the notion of "incumbency advantage". That is the idea, illustrated below, that an installed base of consumers may prevent entrants from penetrating the market despite better products.

To understand what "incumbency advantage" means, consider the following prototypical situation, reminiscent of many digital markets. There is a monopolist with 10.000 customers each deriving the equivalent of 50 dollars of surplus from interacting with the other 9.999 customers. Now, suppose a potential competitor appears on the market. The competitor is endowed with a better technology in the following sense: if all consumers switched, their willingness to pay would be strictly larger than 50 dollars. Biglaiser et al. (2018) say that there is an incumbency advantage whenever the entrant *fails* to conquer the market despite its superior technology. Some early contributions (discussed below) refer to this as "excess inertia."

The four key policy questions in this context are: what is the *source* of the incumbency advantage? How and to what extent can such advantage be *exploited* to extract supra competitive rents? What are the welfare effects of rent extraction on the different groups of agents? Are there factors that can mitigate the anticompetitive potential of network effects?

Switching costs as a source of incumbency advantage

Three important early contributions by Farrell and Saloner (1986), Katz and Shapiro (1992) and Fudenberg and Tirole (2000) pointed at switching costs. In its simplest incarnation, the idea is that once a consumer makes a purchase, she cannot change her mind. That is, consumers adopting earlier technologies are "stranded" in case a new, perhaps superior technology arises at some later stage. Switching costs and more generally "stranded" consumers are an obvious source of incumbency advantage. Importantly, they also imply a different normative benchmark in which entrants need not necessarily conquer the market. The intuition is that if entrants can only offer marginal improvements in quality, it would be more efficient to stick to the old technology. This would allow to save on switching costs while at the same time fully exploit network effects. Following this logic, Farrell and Saloner (1986), Katz and Shapiro (1992), among others, show that there could be *excessive momentum*. That is, incumbents are displaced "too often" from a total surplus maximizing perspective. The intuition is that consumers coming in at a later stage fail to internalize the utility of the "stranded" ones. So, when making their adoption choices they jump too often onboard the entrant. Fudenberg and Tirole (2000) follow up on this thread by looking at the incumbent's incentives pre-entry. They show that switching costs induce incumbents to be aggressive early on. The idea is that establishing a wider user base deters entry of potential competitors in future stages.

While switching costs clearly played an important role in the early development of software, hardware and Telco's industries, today's digital markets are usually characterized by very low switching costs. Subscribing to a service, installing an app or signing up on a website does not require to invest in new equipment or sink in time to learn new skills. With the exception of personal data,[12] these frictions are very low. Therefore, the more recent literature has been relooking at the incumbency advantage issue in this frictionless context. Early on, Katz and Shapiro (1994) pointed to "established reputations, well-known brand names, and ready visible access to capital"[13] as potential other sources of an incumbency advantage. However, these would be a competitive advantage in any industry.

Favourable expectations as a competitive asset

A common theme in recent work is to look at consumer "coordination" (or lack thereof). To fix ideas, consider the following situation. A competitor with a slightly superior technology (in the sense described above) wants to challenge an incumbent. The entrant is a subsidiary of a large firm with a well-established reputation and the services offered are very similar to those of the incumbent. There are no switching costs and the price offered by the entrant is not higher than that offered by the incumbent. This situation seems to better capture the current landscape (of course up to the assumption of higher quality) with several firms failing to displace incumbents despite deep pockets, established reputation, famous brands and frictionless switching. For instance, Microsoft's efforts to challenge Google in the search engines market; Google's effort to challenge Microsoft in office productivity apps or Google's effort to displace Facebook in social networking. In this situation, from a collective standpoint, all consumers would be better off migrating to the entrant. The only reason why an entrant might fail to conquer the market is because of a widespread belief that not enough consumers will migrate. That is everyone believes that all the other consumers believe that no one will migrate. In multi-sided markets this issue is exacerbated. For instance, unestablished OS developers (e.g. Windows phone OS) need to persuade simultaneously consumers and app developers. They thus face a "chicken and egg" problem, with consumers' waiting for app developers to join and app developers waiting for the OS to gain market shares so as to recoup their investments.

Can these "beliefs" be thought of as strategic assets ("coordination capital") that shield incumbents from competition? What strategies will firms use in order to build or exploit this comparative advantage?

To tackle these issues, Caillaud and Jullien (2003) and, more recently, Halaburda, Jullien and Yehezkel (2016) and Halaburda and Yehezkel (2016) developed the notion of "focality". That is, they explicitly formalize the intuition that incumbents face favourable beliefs. They are motivated by the observation that big market players are typically expected to dominate the market in future interactions. For example, the pre-orderings of new vintages of iPhones often beat expectations despite the lack of apps that exploit its new functionalities. By pre-ordering such a product, consumers basically bet that Apple would remain dominant and thus that there would be a flurry of apps for the new device. An incumbent is "focal" if consumers make their choices conjecturing that all other consumers will not switch. It can be easily shown that in a static (one shot) model of competition for exclusive services between a relatively inefficient "focal" incumbent and a "non-focal" entrant, the incumbent conquers the market "too often". The reason is that the only way for the entrant to gain market share is to make it a dominant strategy for consumers to migrate. That is, consumers should find it convenient to migrate no matter what other consumers do. Thus, the only way an entrant can gain market share is by offering additional stand-alone (i.e. network independent) services or by charging relatively low (or, if possible, potentially negative) prices. Clearly the entrant would be willing to invest resources to induce consumers to switch only if it expects to recoup those investments in the future. Therefore, entrants will find it profitable to conquer the market only if the quality gap is large enough. This leads to the static inefficiency whereby some higher quality entrants might fail to conquer the market.

Halaburda, Jullien and Yehezkel (2018), Halaburda and Yehezkel (2016) and Biglaiser and Cremer (2018) recently relooked at this issue embedding dynamic considerations. They look at competition between an incumbent and a sequence of potential entrants over a large number of periods. They wonder whether the

[12] Personal data can be useful to an entrant to provide comparable quality and therefore may be a source of switching costs.

[13] Katz and Shapiro (1994), p. 107.

fact that current success brings focality (and thus future incumbency advantage) could give the entrant an incentive to invest (i.e. incur losses) in the short run to harvest rents in the future. Persuading consumers in the face of unfavourable beliefs is costly but on the other hand allows to recoup those investments through monopoly prices thereafter. Clearly, relative to the static model discussed above, entrants should be willing to invest more (i.e. incur larger losses) in the short run to conquer the market. These papers deliver two clear messages. First, they generally show that the static inefficiency extends to the dynamic setting: focal, lower quality incumbents can stay dominant. Thus, long-term considerations do not necessarily restore efficient outcomes. In particular Halaburda, Jullien and Yehezkel (2018) show that this inefficient outcome occurs when firms are not very patient. This is intuitive, as one would expect a dynamic model offering the same results as the static model. Importantly, they also show that the inefficient outcome also arises with very patient firms. Cremer et al (2018) further show, however, that the inefficiency is considerably mitigated in dynamic models (relative to static ones). Specifically, they show that the incumbent has little ability to leverage its focality advantage to gain rents beyond the rents they would get in a static (one-shot) interaction. The reason is that precisely for these long-run considerations, entrants become very aggressive, charging very low prices thus competing away the dynamic portion of the monopoly rents.

Biglaiser, Cremer and Veiga (2018) identify a different source of incumbency advantage: the incentives of consumers to wait until the entrant's user base is large enough. In their model, consumers do not choose simultaneously whether to migrate to the entrant. Instead, at every point in time, an opportunity to migrate arrives with some positive probability. This equilibrium model captures a well-known fact in the industry, that is consumer reluctance to join entrant platforms early on. Being an "early adopter" comes at the cost of giving up the network effects linked to the incumbent's larger user base. However, their reasoning goes, if every consumer waits for the others to join first, the entrant will find it difficult to penetrate the market despite providing higher quality. To separate this source of incumbency advantage from the "belief-based" one presented above, the authors assume favourable beliefs *for the entrant*. That is, when making their choices, consumers conjecture that all other consumers would migrate as soon as given the opportunity to do so. Yet, despite these beliefs, waiting for those consumers to join first can be optimal, leading to suboptimal adoption. Furthermore, they link the inefficiency to the way consumers become aware about the existence of the entrant.

How do indirect network effects and multi-sidedness change the nature and outcome of competition? Caillaud and Jullien (2003) and Jullien (2011) show that the static inefficiency due to "focality" or "coordination bias" extends to multi-sided markets. In these papers, "focality" means that agents on one side expect agents on the opposite side to stay with the incumbent. For instance, think about a classic textbook example of a two-sided market like that of videogames. Even though new entrants, such as Microsoft Xbox, might bring to the market a more powerful hardware solution, conquering the market at the expense of incumbents (at that time Sony PlayStation) is still hard under unfavourable expectations. The idea is that if game developers expect consumers to stick with Sony then it would be difficult for Microsoft to persuade them to develop titles for the new console. Similarly, if consumers expect game developers to stick with Sony, then they would be reluctant to buy a console that they expect will not carry many titles.

An interesting additional insight of these early models of two-sided platform competition is that the presence of multiple sides *reduces* the focality advantage because it allows to employ "divide and conquer strategies" (Caillaud and Jullien (2003)). That is, the entrant needs only persuade (perhaps heavily subsidizing) one side of the market to switch. Once one side is effectively "on board" the other side will follow. Strictly speaking, this is a consequence of the fact that in a two-sided context a platform can discriminate among agents belonging to different sides. Another consequence of "divide and conquer" strategies is that they greatly reduce the extent of market power. The reason is that competition to secure one side of the market (i.e. the "divide" part of the strategy) tends to be very aggressive, forcing firms to give away a large portion of their rents to users through generous participation subsidies. However, if we look at "divide and conquer strategies" as a preliminary phase followed by monopolization, the initial advantages to the subsidized side may be balanced later on once the market tips. These dynamic effects, quite common when we look at predatory pricing strategies, may further enrich the welfare analysis of such strategies.

Factors mitigating the anticompetitive potential of network effects: local networks and contingent prices

A number of papers noted that network effects are often "local" and not "global" in nature (for instance Banerji and Dutta (2010)). That is, consumers typically care only about the adoption choices of other users they want to interact with. For instance, in communication networks, what matters is which service providers friends and acquaintances choose to subscribe to. Similarly, in software industries, the utility to a user of adopting a particular software and thus a particular file format depends on how many other *collaborators* of that user adopt the same software. Local network effects allow for multiple firms to cohabit in the marketplace at the same time. Also, they make a hypothetical entrant's task much simpler.

There is a vast literature on network effects and pricing of network goods. The idea is that entrants might be able to persuade reluctant consumers by either compensating them (i.e. low or negative introductory prices) or by insuring them against coordination failures. That is by charging prices contingent on network size. On the one hand, these instruments may potentially reduce the incumbency advantage. On the other hand, incumbents might react by charging even lower contingent prices to retain their user base. Weyl and White (2018) consider the problem in the context of a multi-sided market. They show that competition in "insulated tariffs" sometimes leads to inefficient fragmentation (too many firms active at the same time) and never leads to excess tipping.

Factors mitigating the anticompetitive potential of network effects: multi-homing

In digital markets, switching costs are typically low for a variety of reasons. As noted by Evans (2017), Internet platform businesses typically leverage on OSs for non-core software and hardware functionalities. In contrast with classic network industries, users do not have to make capital investments to access other service providers. For example, switching one's social network does not require buying a new device or learning to operate in a different OS environment. Moreover, usage costs are typically low. In many instances, the products are distributed for free. Consequently, users typically try out new services *before* quitting the old ones and patronize two competing platforms at the same time. This behaviour, usually referred to as "multi-homing", is the norm more than the exception in digital markets. This simple fact has deep consequences. Clearly, the "rich get richer" argument introduced earlier assumes that the opportunity cost of switching to an entrant is giving up the network of the incumbent. This implicitly presumes some friction that does not allow consumers to stay hooked up to both networks at the same time. Without that friction, it is obviously easier to induce consumers to "try out" one's product.

One key distinction put forward by Biglaiser et al. (2019), among others, is whether network effects result as a by-product of consumer *signing up/ installing* on an app or *using* that app. To see why this distinction is crucial, Biglaiser et al. (2019) contrast communication services with social networks. What matters for the success of a communication service is its network. For instance, if a user installs both WhatsApp and Telegram, then she can be reached through either app. On the contrary, social networks on the one hand need their users to "sign up" while on the other hand they also need them to curate their profiles and engage with the service. That is what some refer to as "multi-homing in usage". If usage is costly (for instance, since curating one's profile is time-consuming), then the mere act of multi-homing does not change the fact that in practice consumers still use one app. That is, for what concerns competition, they are single-homing. An illustrative case in point is Google+, Google's "me too" social network. Despite Google easily signed up all of its Google account holders, the network has been eventually discontinued due to lack of engagement.

How does the option of multi-homing affect the incumbency advantage? Absent switching costs, there could still be scope for incumbency advantage through focality. The option of multi-homing clearly does not wipe out the focality advantage. However, it makes the marketplace much more contestable. To see this, notice that in the simple theory discussed above, in order to penetrate the market, an entrant needs to guarantee to early adopters a value at least as high as that offered by the focal incumbent. However, with multi-homing, switching occurs whenever the entrant offers non-negative surplus. That could be achieved via negative prices or by bundling the network good with some complimentary service. Indeed, many online platforms offer several freebies (Gmail in Google, news in Yahoo, Messenger in Facebook) to keep their users hooked up.

This reasoning suggests that policies encouraging the extent of multi-homing should increase market efficiency, although more research is needed.

Multi-homing has been mostly studied in the context of platform competition. Armstrong (2006), studied competition in a model where one set of users always multi-homed while the other was assumed to single-home introducing the well-known notion of "competitive bottleneck". To see what that means through an example, consider marketplaces such as Amazon.com or Taobao.com. Suppose, for the sake of illustrating the notion, that there are two or more competing marketplaces and that buyers single-home. That is, they always shop on their preferred website. Then, given consumer behaviour, platforms become the only means through which sellers can access the buyers. Thus, given buyers' choices, platforms can insist on sellers paying the monopoly price for accessing their exclusive turf of buyers. Basically, single-homing on the buyer side shuts down competition on the seller side. To make this more concrete, notice that if buyers segregate in a platform of their choice then a seller's choice of joining one platform (say Amazon.com) does not depend on whether it joins some other Taobao.com. Since the user bases do not intersect, the two choices are separate. But since acquiring buyers allows to extract fat monopoly rents on the opposite side of the market, there will be fierce competition for buyers. Armstrong (2006) concludes that we should observe relatively lower prices (even negative ones) on the single-homing side of the market.

The more recent literature on multi-homing recognizes that the choice to multi- or single-home is often endogenous. Firms can control some of these choices by designing their offers in a way that induces their preferred outcome. The first paper along these lines is Armstrong and Wright (2007). They show that the competitive bottleneck outcome arises endogenously if one side of the market (in their paper, sellers) sees the platforms as homogeneous (of course controlling for the size of the network) while the other side of the market (buyers) has strong preferences for using one particular platform over the other, i.e. there is horizontal differentiation. On the contrary, two-sided single-homing is the natural outcome when agents on both sides have strong preferences. In a similar vein, Tremblay and Jeitschko (2018) characterize competition between platforms in two-sided markets allowing both types of agents to multi-home. In contrast with Armstrong and Wright (2007), they look at a different source of demand heterogeneity. In their model agents differ on how much they value interactions. That is, they look at the effect of heterogeneity in the indirect network effect b_i. The paper basically maps consumer preferences (thus demand) and firm technology (thus supply) to platform market outcomes. This model is able to rationalize a wider spectrum of market outcomes. In particular, they provide conditions under which mixed-homing equilibria arise, with some sellers and some buyers dealing with both platforms while others single-homing.

An important means through which multi-homing can be effectively hindered are exclusive dealing arrangements. If a firm unilaterally insists on exclusivity on one side of the market, then multi-homing outcomes are obviously ruled out. But can a platform profit by doing so? What about end-user surplus?

Armstrong and Wright (2007) look at this issue when platforms are *not* differentiated. They show that two identical platforms can cohabit despite being perfect substitutes if one side of the market multi-homes. They show market outcomes where all sellers join both platforms while buyers divide equally between platforms (a similar insight can be found in Caillaud and Jullien (2003)). Again, being this a competitive bottleneck outcome, competition on the seller side is shut down, so their surplus is fully extracted. On the other hand, buyers are subsidized. In extreme cases, all surplus extracted on the seller side of the market is given back to buyers under the form of low prices attempting to persuade them and profits are zero. They show that the effect of allowing for exclusive contracts is that of inducing market tipping. As discussed, on the one hand this development leads to static efficiencies. Since the two platforms were identical to start with, if there is even a small cost that sellers have to bear to multi-home, then one big platform is obviously more efficient. On the other hand, it creates dynamic inefficiencies due to the incumbency advantage.

Peitz and Bellaflamme (2019) look at this question with a model that allows for idiosyncratic tastes on both sides of the market. They contrast outcomes in the competitive bottleneck world (in their model, sellers multi-home while buyers single-home) with outcomes in the two-sided single-homing world (sellers and buyers single-home). To see how a platform can gain by having sellers sign exclusive deals notice that in the competitive bottleneck world the possibility of exploiting those valuable multi-homing sellers builds a lot of

competitive pressure to bring buyers on board. Exclusive contracts help raise profits as follows. On the one hand they create competitive pressure on the seller side. On the other hand, they relax competition on the buyer side. This is profitable if what you give up (i.e. monopoly rents on the seller side) is less than what you get (larger duopoly rents on the buyer side). Indeed, they show that platforms prefer to impose exclusivity to sellers if, other things held constant, the sellers' stand-alone benefit value is small enough.

Carroni et al. (2018) look at platform competition in a context where some users (say a superstar music artist or a blockbuster movie) are more valuable than others. Signing these superstar users on exclusive terms provides a competitive advantage. Of course, these contracts are somewhat expensive since platforms need to compensate superstar users that cannot interact with the consumers of the rival. They show that exclusive contracts arise endogenously whenever the platforms products are close substitutes. Also, and most importantly, exclusive contracts can be procompetitive as they induce more content providers to multi-home and therefore increase the overall content consumption, despite reducing competition downstream.

3. *Competition IN the market*

Here we complement the analysis on competition highlighting two notable cases widely discussed in the literature, where there is competition IN the market *despite* network effects: network interconnection and product differentiation. What links these two is the fact that market fragmentation is not necessarily an outcome that reduces the gross surplus of consumers when network effects are in place. This is linked to either consumer preferences or technology.

Two networks/customer bases are said to be interconnected if their respective members can interact. Under interconnection there is obviously no more network-driven scope for tipping. Indeed, the earlier literature on network effects has focused on the issue of compatibility and interoperability as a way to restore competition in the market while preserving network effects (a good starting point is Laffont and Tirole (2001)). A textbook example is termination in Telcos. Taking mobile operators as an example, customers of operator A can call customers of operator B if there is an agreement between the two on call termination charges or if termination is regulated.

Compatibility and interoperability are not perceived as a viable option in today's digital markets arena. One reason is that interoperability requires an agreement on what standard services should be guaranteed to consumers served by different firms. While it is reasonable to think about agreements detailing what a telephone call "is" and what quality means in that context, it is much more difficult to do so in the context of social media or enhanced communications services such as WhatsApp or Instagram.[14]

A notable exception to the view that compatibility is not an option is a recent contribution by Gans (2018). The paper puts forward a notion of "identity portability" as a possible policy response. The idea is that individual users should have a "right" to their identity and to its verification if they change digital platforms. The idea is that if a user wants to interact with some other users whose identity is clearly defined, then platforms should allow that interaction by sorting out some way of interconnecting the user bases mitigating switching costs and promoting competition. A similar proposal, labelled "graph portability", has been put forward by Zingales and Rolnik (2017).[15]

If products are sufficiently differentiated, then two or more platforms could obviously cohabit. Consumers with tastes "very close" to an entrant's product will choose that over an incumbent despite the incumbents' installed base. That is, if the relevance of horizontal product differentiation is large enough relative to the strength of network effects then the natural tendency to tip can be overcome. Armstrong (2006) and Rochet and Tirole (2003) look at fragmentation/shared market equilibria in two-sided markets. Analogously to the one-sided settings, they show that if platforms differentiate their products, catering to different idiosyncratic

[14] Still, even in more standardized telecommunication services full compatibility and level playing field access provision is not a simple issue. In fixed lines telecommunication services, where there is usually an incumbent network to be opened to service operators through unbundling solutions, the possibility that the incumbent degrades access services to competitors has been addressed by regulators in UK and Italy by creating a monitoring trustee that controls that no technical discrimination by the incumbent is tempted.

[15] https://www.nytimes.com/2017/06/30/opinion/social-data-google-facebook-europe.html.

tastes, then two or more platform can cohabit in the same market much as in traditional ones. However, despite the absence of tipping, network effects still play an important role in shaping prices and outcomes. For instance, a key insight of Armstrong (2006) is that network effects intensify competition. Stealing business from a side of a rival carries a double dividend. On the one hand, it makes the platform more attractive to all consumers on the opposite side, inducing some consumers to switch. On the other hand, it reduces the rival's attractiveness (whose network shrunk), inducing even more customers to switch. Stronger network effects amplify this channel, greatly limiting the extent of rent extraction as compared to traditional industries. That is, indirect network effects *amplify* the effect of competition on prices. The larger the externalities, the lower the prices charged.

Market fragmentation is not surprising nor necessarily inefficient in settings where consumers disagree as to what is the "best" product due to their own idiosyncratic tastes. Some recent contributions showed that fragmentation can occur *despite* consumers agreeing on which platform provides the "best" service (Ambrus and Argenziano (2009)) and despite consumers perceiving the two platforms as providing identical services (Calvano and Polo (2018)). Ambrus and Argenziano (2009) look at a context in which some consumers value interacting more than others. In jargon, they look at the effect of heterogeneity in the indirect network effect b_i. In order to understand their argument, it is useful to draw a parallel with a seminal contribution by Mussa and Rosen (1978) and Shaked and Sutton (1982). These papers endogenize the quality of a consumer product, allowing firms to endogenously provide different "qualities" or "versions" of the same product. Shaked and Sutton (1982) show that if consumers carry different tastes for a marginal increase in "quality," then *ex-ante* identical competing firms can successfully relax competition by choosing different qualities and serving different subset of consumers. T One firm provides "high quality" services focusing on those consumers who value quality a lot while the rival provides a "low-quality" product focusing on those with a low willingness to pay for quality. Ambrus and Argenziano (2009) show that one can use the "size" of the network in a way akin to quality. One of their motivating examples are job market matchmakers such as Monster.com. They document that back in 2009 the two major US platforms carried quite distinct groups of agents. One platform was basically free on the job seekers side. So, it carried a large pool of those. On the other hand, it charged a small pool of selected employers a hefty price to post a vacancy and access that large pool. The main rival platform adopted an opposite model. It had many more job postings due to lower prices on the employers' side. However, job seekers had to go through a costlier process to post their resumes. They rationalize this and other anecdotal evidence by providing a model of competition where one platform is cheaper and larger on one side, while the other platform is cheaper and larger on the *other* side. Their argument can be seen as an extension of the classic papers on vertical differentiation once one notices that the quantity of agents on one side is the "quality" of the platform for agents on the opposite side.

Calvano and Polo (2018) go one step further providing a model of strategic differentiation by business model that does *not* rely on users having different tastes for quality but rather on the "two-sided" nature of these markets. They show that two otherwise identical platforms can relax competition by cornering different sides of the market. The motivating example are broadcasting markets, where Free-to-Air (FTA) operators cohabit with Pay-TVs. Their respective business model is to subsidize viewers (providing free content) while charging advertisers for the privilege of accessing those viewers and charging viewers providing ads-free content. The key intuition is that business models are strategic substitutes. Loosely speaking, if one operator supplies more advertising and decreases or eliminates subscription fees (i.e., shifts towards the FTA model), it heightens its competitor's incentive to offer "high quality" ads-free content and raise fees accordingly (moving towards the Pay-TV model). The Pay-TV operator, in turn, makes advertising revenues attractive for the rival, that becomes the only channel for advertisers to reach viewers.

4. *Markets for attention*

A large number of digital products and services are offered free of charge to consumers and paid for with advertising dollars. In the US alone, the internet advertising industry totalled revenues of almost $90 billion in 2017, with growth rates in the double digits. These firms include the top online businesses. Indeed, 7 of

the 10 most visited websites in the US[16] are in the business of harvesting attention by means of content or service provision and resell it to advertisers. Some refer to these firms as "attention brokers". The industry is highly concentrated. For instance, the top 10 online platforms get almost three quarters of all online advertising revenues.[17] Wu (2018) describes and supports the approach of considering platforms reselling attention as being in the same market regardless of their "functional definition" (e.g. search engine) as a way to address the "blind spot" in current Antitrust practice. Where to set the thresholds and identify those operators that compete for attention and exert each other competitive constraints, the very exercise of market definition, is however not an easy task. We face a risk of under-inclusion that tailors the relevant market to the identity of specific firms and, on the other side, one of over-inclusion that would dilute any dominant position (see also Franck and Peitz (2019)).

Attention brokers are essentially platforms operating in multi-sided markets. Advertisers wish to place their creatives on outlets that have a large audience. Thus, their willingness to pay increases with the number of eyeballs the platform attracts. However, consumers' willingness to pay typically decreases with the amount of advertising supplied. That is, advertising is often seen as a nuisance. So, at first pass, the literature on multi-sided platforms surveyed in previous sections already provides a number of insights on the functioning of these markets.

However, these markets received a special treatment in the economics literature for a number of reasons that go beyond their obvious relevance:

- human attention is a scarce and valuable resource and thus one naturally wonders if the market is inducing any allocative distortions;
- the fact that prices are often not used on the consumer side of the market creates new theoretical and empirical challenges. Competition for eyeballs is in the quality dimension and the absence of price variation makes it hard to estimate the demand system and thus to measure substitutability and consumers' surplus, which is key in merger cases;
- new technologies allow advertisers to "target" audiences in a number of dimensions: demographics, physical location, time of the day, personal tastes, browsing history and so on. These "new media" are different from "traditional media". Targeting means that competition is scaled at the individual level. In extreme cases, one can think of the attention of a single, identified individual being first contended between media outlets and then auctioned off;
- because multi-homing is a widespread phenomenon, traditional supply-side market shares defined separately for different types of operators or market segments are not informative of the extent of competition;
- advertising is a key input in product market competition. Thus, the functioning of the advertising markets has consequences for product markets as well.

Anderson and Coate (2005) in an early and influential contribution provided a first model of "competition" for attention. Specifically, they study the allocative properties of a market with two competing attention brokers such as free news outlets. The main focus is on the trade-off between quantity of advertising and number of viewers. Would competing platforms over-supply or under-supply advertising? What is the likely effect of a merger? A key modelling assumption is that the stations compete for the *exclusive* attention of viewers. That is, viewers have to choose where to get their news and cannot patronize both websites: they single-home. Thus, their model is a special case of the competitive bottleneck model studied before with one less control (consumer price).

Comparing the duopoly outcome with the choices of a hypothetical monopoly owner of both stations, they find that a merger leads to an *increase* in the quantity of advertising. This is very intuitive. Notice that, being a nuisance, advertising can be thought of as some "shadow price" that consumers have to pay in order to satisfy their content needs. A merger, by reducing competition, typically leads to higher prices. Thus, the merged entity increases the quantity of ads to secure eyeballs. What about efficiency? The normative

[16] https://www.alexa.com/topsites/countries/US last accessed in January 2019

[17] Silverman, David. 2017. "IAB Internet Advertising Revenue Report." PwC.

analysis is more nuanced. Because of the absence of prices on the consumer side of the market, the stations fail to internalize the effect of an extra advertisement on viewer welfare. Concentration therefore leads to inefficient overprovision.

The more recent literature recognizes that users typically satisfy their content needs on multiple platforms, that is users typically multi-home. For example, ComScore reports that the largest online advertising networks[18] serve pretty much the same eyeballs. How does the fact that competition is for *shared* users change the conclusion above? Ambrus et al. (2016) consider the incentives of a platform to provide an extra ad in this context, assuming that the platforms provide content that is not substitute. For example, think about a search engine competing with a social media. Clearly, being advertising a nuisance, when quantity goes down, the platform will lure some new users onboard. In the Anderson and Coate's model with single-homing viewers, that new business is "stolen" from the rival. In this context with multi-homing users, the platform will instead "share" some previously unshared business with the rival. A key insight is that these shared eyeballs are less lucrative than exclusive eyeballs. This is because as both platforms can deliver those eyeballs to advertisers, competition leaves more of the rents associated to those eyeballs in the advertisers' pocket. This is referred to as the "incremental pricing principle" in this literature, according to which each platform can charge only the incremental expected value of an additional exposure of the user to the commercial. Thus, the incentives to acquire new eyeballs through lower quantity of ads or higher quality are quite different than those in traditional models. Also, concentration (for instance, through a merger) changes substantially those incentives. This is because some previously shared business becomes post-merger exclusive of the merged entity and thus more lucrative. Broadly speaking, these papers identify novel forces that reflect outlets' incentives to control the *composition* of their customer base. The model can explain several empirical regularities that are difficult to reconcile with existing models.

Athey et al. (2018) and Anderson et al. (2016) look at a similar model with more emphasis on implications for the type of content provided rather than the quantity of ads. The starting point in Athey et al. (2018) is that advertising campaigns on multiple outlets are wasteful when consumers multi-home because some consumers are reached too many times while others are missed entirely. The reason is that while tracking technologies, such as "cookies", allow to control how many times a given consumer has been impressed with a particular ad on a given platform, such as on Facebook.com and the associated websites, there is no way for owners of *other* platforms to know which ads a multi-homing consumer has been exposed to. Advertisers seeking broader "reach" (i.e. more unique users), while avoiding inefficient duplication, anticipate this and tend to prefer *larger* platforms to minimize waste. This has implications for content provision: publishers invest in quality to extend the number of users. Anderson et al. (2016) show, among other things, that due to the incremental pricing principle platforms may bias content against multi-homers. Gentzkow et al (2014) provide an empirical structural application in the newspaper industry. They show that preferences over one's audience composition and in particular the fact that multi-homing readers are less valuable can explain the political orientation of hystorical local US newspapers.

Prat and Valletti (2018) look at implications of attention market concentration on product markets. The starting point is that entrants need to make consumers aware of their existence. That is, consumer attention is an essential input for entrants in product markets. Attention markets and their concentration, then, affect entry and competition in the product markets. Clearly, incumbents may foreclose entry by buying large amounts of attention of each user for a large number of users (in the limit, by buying all attention of all users). The cost and foreclosure effectiveness of this incumbent strategy, and therefore ultimately its profitability, depend on the number of competing attention brokers delivering individual users. When the attention market is concentrated total advertising shrinks and the number of outlays to saturate falls, making this exclusionary practice of incumbents in the product market more attractive. The indirect effects on the advertised product markets are also affected by mergers. Consider a merger between two attention brokers patronized by the same group of users: pre-merger they represented for an entrant two alternative options to reach the attention of these users. After the merger, however, the new entity becomes an attention

[18] An advertising network is an attention broker that serves ads on multiple websites (some of which are owned and run by independent third parties) and can track users as they move across these websites.

bottleneck to reach them, making it easier for incumbents to keep out entrants from the market for that users ultimately hurting consumers. This finding goes against conventional wisdom. Mergers between attention brokers indeed might have important effects on consumers via higher prices in the product markets. Clearly the negative effect depends on the extent of usage overlap. If two attention brokers have no user in common, there is no effect. The paper is able to rationalize apparently puzzling behaviour such as "brand" keyword advertising, a practice used by most major corporations whereby a company advertises for keywords containing their brand, despite organic links obviously appearing on top of the page.[19] The idea is that those ads contribute to push further down competitors' link in organic search and to keep them out from sponsored search.

5. *Innovation in digital markets*

One of the features of digital markets is rapid innovation both of the drastic type (mainly performed by entrants) and non-drastic/incremental type (mainly performed by market participants).

Start-ups often sell-out to incumbents before even serving their first customers. In section 5.1 we review the literature on this phenomenon which is known as "entry for buyout" and that on the extreme event where acquirers discontinue the development of the new product known as "killer acquisition".

Another important issue is whether a merger between equal sized competitors would further strengthen or dampen the incentives to innovate. The recent decision by the EU Commission in the *Dow/DuPont* case sparked off a debate among scholars. In section 5.2 we review recent contributions showing that the Commission's hypothesis, namely that mergers *hamper* innovation, is not unambiguously supported by economic theory.

5.1 ***Entry for buyout and killer acquisitions***

A widespread practice in digital markets is that of entrants selling out to incumbents very early in the product life-cycle. This is known as entry for buyout (Rasmusen (1988)).

The theoretical roots of this argument go back to an early seminal article by Richard Gilbert and David Newbery (1982). They argue that institutions such as the patent system create opportunities for existing incumbent firms to maintain their monopoly power by taking pre-emptive actions meant to decrease the prospective profits of potential competitors. One such action is what they refer to as "pre-emptive invention". They show that incumbent firms have incentives to patent new technologies before potential entrants in order to protect their rents. To see this point through a simple model, consider the following situation. There is an incumbent whose profits are π^M and a potential entrant whose profits are equal to 0. An innovation opportunity for a substitute variety of the incumbent's product arises. If the innovation is patented by the entrant, then there will be a regime of symmetric duopoly with firms earning a profit of π^D each. If the innovation is patented by the incumbent, then the incumbent will jointly sell both varieties and earn a profit π^{JM}. The maximum willingness to invest to innovate of the potential entrant is equal to the profits he would make in case of innovation minus the profits he expects to make otherwise. That is equal to π^D. The incumbent's maximum willingness to invest is equal to π^{JM} minus the profits he expects to make otherwise. As duopoly profits are larger than zero, it is reasonable to expect that the entrant would invest if the incumbent does not. It follows that the incumbent's maximum willingness to invest is $\pi^{JM} - \pi^D$. The incumbent has thus stronger incentives to invest if and only if $\pi^{JM} - \pi^D > \pi^D$. That is, if and only if $\pi^{JM} > 2\,\pi^D$. This condition simply states that the incumbent has stronger incentives whenever the total industry profits in regime of monopoly are larger than those in regime of competition. This condition is likely to be satisfied unless there are strong diseconomies of scale. This is what in the literature is referred to as "efficiency effect".

The above argument assumes that there is no further cost beyond patenting to bring a product to the marketplace. Now, suppose that whoever patents the innovation needs to further invest in developing it at

[19] Blake et al. (2018) report that "Google searches for the keywords "AT&T", "Macy", "Safeway", "Ford" and "Amazon" resulted in paid ads at the top of the search results page directly above natural (also known as organic) unpaid links to the companies' sites."

cost d. Conditional on patenting, the incumbent develops the new product if and only if $\pi^{JM} - d > \pi^{M}$. The potential entrant develops the innovation if $\pi^{D} - d > 0$. If the innovation is a close substitute to the incumbent's product then $\pi^{JM} \approx \pi^{M}$ which implies that it is never optimal for an incumbent to develop. On the contrary $\pi^{D} > d$ (as otherwise the innovation would not be viable to start with). This means that if products are close substitutes incumbents have a *weaker* incentive to develop than entrants. This is Arrow's (1972) famous "replacement effect": the incentives of introducing new products are smaller for incumbents since some of those products will end up cannibalizing its own rents.

By the same logic, incumbents have stronger incentives than, say, venture capitalist, to acquire entrants in the process of developing a competing product. Once acquired, by virtue of the "replacement effect" they will also have stronger incentives to discontinue those development processes.

The possibility of buying out entrants obviously stimulates entry through innovation and thus investments. Rasmusen (1988) argues that, on the plus side, this limits the scope for entry deterrence strategies, for instance through excess capacity à la Spence (1977). To deter entry, the incumbent needs to commit to be aggressive post-entry *and* to not buy-out prospective entrants. On the minus side, entry for buyout stimulates inefficient rent-seeking duplicative innovation. For instance, because the threat to incumbents is higher when the entrant's product is a close substitute to the incumbent's then entrants will seek to duplicate existing products rather than creating new ones through diversification. Also, because entrants expect to be bought, they would enter even if expected revenues are less than investment costs, provided of course that the entrant can credibly remain in the market. This occurs whenever production costs are low, and all investments are in R&D (and hence sunk). In limited cases, the prospect of being bought out may stimulate entry of inefficient firms (for example, with higher unit costs).

Mermelstein et al. (2019) study the evolution of industries where firms can improve their efficiency through mergers or through direct investment. Merger policy affects the relative profitability of the two alternative options to improve scale economies. It also affects the incentives of outsiders to invest. When a lax merger policy is allowed, investment by new firms take the form of entry for buyout. The authors compare a static merger policy that looks at the current impact on welfare with a dynamic policy that takes into account the effects on investment and entry. They show that an optimal dynamic merger policy may significantly diverge from a static regulation of mergers.

In summary, from a normative stand-point allowing buy-outs reduces the scope for entry deterrence strategies and thus enhances market contestability. On the other hand, it encourages rent-seeking behaviour.

While the literature provides a clear picture of the trade-offs related to pre-emptive buyouts, there is surprisingly little systematic evidence to date. This is mainly because of significant empirical challenges. Ideally, the econometrician would need to observe how much effort is put in the development phase, before and after acquisition. Also, one needs to observe how close these products would be in product space to be able to quantify the incentives to discontinue their development. Finally, as observational data clearly features non-random M&A choices, there is an endogeneity issue as potential drivers of acquisitions may confound the effect of acquisitions on project development.

An exception is a recent paper by Cunningham, Ederer and Ma (2018). These authors gain traction on the problem by looking at acquisitions in the pharma industry. Because the development of drugs is subject to stringent regulatory requirements, the authors are able to follow the development from a very early stage through to launch or discontinuation. Their dataset provides nearly universal coverage. Importantly it provides two key pieces of information. First, it contains the drug's therapeutic market (e.g. "osteoporosis") and the mechanism of action (e.g. "calcium channel antagonist"), which is used to identify substitute products. Second, it contains information on acquisitions collected from multiple sources. They find that molecules acquired by an incumbent are 40% less likely to be developed compared to those that are not acquired. Overall, the estimates indicate that 6.4% of all acquisitions in the market are killer acquisitions. They also consider and rule out a number of alternative explanations. First, they look at human and physical capital redeployments as potential confounding motives for acquisitions. The idea is that the target is not the firm's molecules but rather its human and physical assets. For instance, talented researchers (in the spirit of Ouimet and Zarutskie (2011)) or superior technologies that can be redeployed within the acquiring firm to a

more fruitful use. To rule out the human capital explanation, the authors track inventors over time and across organizations using the Harvard Patent Dataverse. They show that 78% of the inventors from target firms typically move to other firms following acquisitions. Also, the productivity of the 22% staying (as measured by the number of subsequent patents authored) actually drops by 30%. To assess whether and how technologies are redeployed, the authors look at the similarities between the *new* projects of the acquiring firm and the *old* projects of the acquired firm. The idea is that some promising chemical compounds may be used to invent new drugs. To assess similarity, they exploit a measure of distance between chemical compounds widely used in the chemical informatics literature. They find no evidence supporting the hypothesis that technologies are redeployed: new projects by the acquirer are not similar to the acquired project.

Large Internet companies have developed a very active acquisition strategy toward start-up in digital markets. Industry observers and public agencies have interpreted these activities as a case of killer acquisition, raising the concern of a foreclosing strategy that may slow down innovation. Although to the best of our knowledge there is no theoretical or empirical study that has validated this interpretation in the digital environment, there are at least two points that deserve attention. First, innovation in the stand-alone value of network goods may be more often of the vertical rather than horizontal nature, that is the start-up may seek a quality enhancing product rather than a new variety competing with the incumbent one. Secondly, the asset that a large incumbent may bring in is the client base when network effects are relevant. Hence after the acquisition the incumbent may have more incentives to develop the higher quality start up product rather than discontinue it, a form of nurturer rather than killer acquisition. And the network effect may bring a substantial value to the higher quality stand-alone product pushing up investment of the start-up in the perspective of a buyout.

5.2 Horizontal mergers and innovation

The literature on market structure and innovation built over many decades on two influential early contributions by Shumpeter (1942) and Arrow (1962). The former famously argued that perfect competition comes with strings attached. Zero or low profits reduce the incentives to invest in R&D. That is, the engine of innovation is the prospect of temporary market power to reward the innovative activity. Thus, monopoly power should be evaluated by weighting its short-term costs due to high prices against the long-term benefits of more innovation. Arrow (1962) put forward the opposite hypothesis. Monopolists, because they have a vested interest in preserving the status quo have incentives to “rest on their laurels”. The reason is that by introducing new products, they would be basically cannibalizing their own rents. Competition thus spurs innovation. Gilbert and Newbery (1982) added to this debate by showing that Arrow’s point rests on the assumption that the monopolist cannot be challenged. As discussed in the previous subsection, the prospect of entry and being displaced stimulates incumbents to invest even more than potential competitors. Many papers that followed tried to reconcile these opposite views (two notable efforts in this direction are Aghion et al. (2005) and Shapiro (2012)).

Many have recently pointed out that the classic literature on competition and innovation does not really illuminate the debate on horizontal mergers for a very simple reason: this literature has focussed on symmetric market settings in which a reduction in competition affects in the same way all market participants, through a decrease in the number of firms or a lower substitutability among products. A merger, however, is not just a reduction in the number of firms but rather the creation of a structural asymmetry between the insiders participating in the project and the outsiders. In other words, the reduction in competition is localized and asymmetric rather than generalized and symmetric. Indeed, the merged entity combines the assets of the insiders (e.g. plants, capital stock, product lines, know how, technologies) and becomes therefore “larger”; secondly, it internalizes the strategic externalities among the combined assets. For instance, the merged entity takes into account how the activity of one division affects the rents of the other. Third, the combined assets may give raise to efficiencies that reduce costs for given technology, further enriching the asymmetries with respect to the outsiders. Finally, in the medium terms a merger may change the incentives to invest in R&D, affecting the rate and direction of innovation. All in all, a proper analysis or mergers requires to better characterize the impact of a merger on competition and how this effect further

affects the innovative activity of insiders and outsiders. The rest of this section focuses on a number of papers that have recently contributed to this debate along these lines. We pay particular attention to a number of papers that formalized the discussion following the *Dow/Dupont* decision of the Commission.

By and large the theoretical and empirical economic literature reviewed below has identified several effects of mergers on innovation, some of which suggest a reduction in R&D but others that instead push up the innovative effort of the merged entity. All these effects seem a-priori empirically relevant rather than being academic curiosities, suggesting a case by case balancing analysis rather than a general negative or positive presumption. In particular, the nature of R&D makes efficiency gains much more realistic than in traditional unilateral settings calling for additional scrutiny by the authorities rather than relegating this practice among the "efficiency defences." See Jullien and Lefouili (2018), Denicolò and Polo (2018b) and Federico et al. (2019) for recent surveys of this debate. Below we report on a number of very recent, selected papers that are at the forefront of the debate and are a good entry point to further dive into the literature.

Federico, Langus and Valletti (2017) study the unilateral impact of a merger on innovation identifying a "cannibalization effect". That is, they look at whether, other things held constant, the fact that one merged entity can coordinate the R&D choices of two previously separated firms leads to more or less innovation. This exercise is the same in spirit as the unilateral price effects exercise in merger control. Specifically, they look at a model in which *N* identical firms compete to bring a new product to the market. Innovation is modelled as a stochastic process. The probability of succeeding depends positively on investment. Furthermore, the ex-post rents from innovating depend on how many firms successfully innovate. The larger the number of such successful innovators, the lower the rents. Clearly, when investing an extra dollar in R&D, a firm lowers the expected return on investment of all its rivals. The intuition is that the probability of sharing the market with one or more firms goes up for the rivals, which thus get lower rents in expectation. Federico et al. (2017) then consider a merger that would transform the two separate firms in two divisions. Internalizing the negative externality of the research effort of each lab on the other requires to lower R&D. They also argue that the (equilibrium) reaction of the rivals would lead to more investment of the outsiders but not as much as needed to overturn the initial reduction. All in all, mergers reduce innovation according to the cannibalization effect.

Denicolò and Polo (2018a) argue that the above conclusion relies on the hypothesis that the overall R&D effort of the merged entity run by the two labs is not coordinated after the merger. When the two labs develop similar research protocols, what we can call duplicative research, there are different ways in which the negative externality highlighted in Federico et al (2018) can be internalized after a merger. One way, captured by the cannibalization effect, is to reduce the research effort symmetrically in both labs, paralleling the reduction in output on each plant of the traditional analysis of mergers. Alternatively, the merged entity can reallocate the research effort across labs to minimize the duplications and, in the limit, shut down one lab and concentrate all the resources in one. If having one research lab with twice as many resources is more productive than having two independent labs, then the merger will spur innovation, at least as an initial effect. Which of the two models is more realistic depends on the particular case at hand, and in particular on the potential gains of the innovation and the decreasing returns of research activity. As Denicolò and Polo (2018a) show, this "coordination effect" may lead to an increase, rather than a decrease, in innovation after a merger.

A third effect, that we can label as output driven, is analysed in Motta and Tarantino (2018). The authors look at a market with differentiated products and study the incentives to invest in cost-reducing process innovation. They find that, absent merger-induced efficiency gains, such a merger leads to a decrease in the overall R&D. The intuition goes as follows. The merged entity has a clear unilateral incentive to reduce quantities, which captures the standard market power effect of mergers. But the benefit of lowering marginal costs is greater the larger the quantity produced. Hence, the merged entity has less to gain from innovating as long as cost reductions are specific to each of the varieties offered, and therefore has weaker incentives. The output-driven effect of mergers on innovation, therefore, replicates the output contraction of a merger also on the innovation effort, aligning the traditional unilateral effect in the product market to the adjustment in the research activity. The authors consistently argue that absent important R&D spillovers on competitors (i.e. appropriability issues) and efficiency gains, a merger reduces the incentives to innovate.

Denicolò and Polo (2018b) consider the same setting of Motta and Tarantino (2018) and focus on an additional effect on mergers labelled as "innovation sharing". They argue that a natural feature of innovations is to be applicable to a range of processes and products larger than those initially considered by the innovator. Imitation and reverse engineering are indeed very common phenomena that allow rival firms to take advantage of the innovator's effort, and patent law and IPR are a way to regulate these processes. Then after a merger the new entity can apply the results of its R&D activity to a wider range of products, boosting the incentives to innovate. Denicolò and Polo (2018b) show that this positive effect may positively affect research after a merger both in case of incremental and radical innovations.

Bourreau, Jullien and Lefouili (2018) also challenge Federico et al. (2017)'s conclusion that concentration hampers innovation identifying a "demand driven" effect. They build a model in which the main objective of the R&D effort is to "escape competition". That is, when one firm innovates, say by creating a new differentiated product, it moves *away* from its rivals in product space thus relaxing competition. This kind of innovation *increases* the demand of one's rivals. Thus, the innovation externality is positive: when investing, a firm does not internalize the *positive* impact of that investment on the rivals' profits. Thus a merger, allowing these firms to internalize the externality, increases the incentives to invest leading to higher R&D both inside the merged party and outside, in the industry at large.

In a more recent contribution, Federico et al. (2018) look at how the above considerations interact with the classical unilateral price effects. Mergers obviously reduce price competition and the fact that pre- and post-innovation margins are different has implications for the incentives to innovate above and beyond the ones described above. The idea is that if price competition is more important in the post-innovation phase and if it is strong enough, then higher prices lead to larger returns from investment and therefore boost the incentives to innovate. They show through simulation that which effect prevails depends on the specific assumption made on the nature of competition and therefore it is ultimately an empirical question.

The recent very active debate has offered several arguments both for anti-competitive and competitive effects of mergers on innovations. A first insight that we can draw rests on procedures: all papers recognize that synergies in R&D activities may spur innovation after a merger. However, efficiency gains in research, namely an increase in research productivity when previously separated groups of researchers may work together, seems a phenomenon much harder to assess than the traditional production efficiencies. However, innovation sharing is a much more general property of innovation and does not require synergies in research, but simply the application of innovations across assets. The empirical relevance of this effect suggests therefore to consider it in the core assessment of mergers rather than relegating it to a later stage of efficiency defences.

Secondly, the different effects in place are a-priori all empirically relevant. Then merger analysis should proceed case by case and be empirically grounded. There are few papers that have analysed the impact of mergers on innovation in particular industries. They may be a useful methodological reference also in merger cases. Ornaghi (2009) investigated the effects of mergers on the long run performance of big pharma firms in the period 1988-2004. He shows that these deals have a negative impact on R&D spending in all years following the merger of about 1 percentage point. This decline is shown not to be matched with an increase in productivity. The number of patents goes down relative to the no merger counterfactual by 30%. The most recent attempt to empirically measure the effect of mergers on innovation is Haucap et al. (2018). They also look at a sample of pharmaceutical mergers, focussing on those reviewed by the European Commission between 1991 and 2007. They use expert market definitions of the European Commission to identify substitute products and thus competitors for each merger case. They document a large decline in innovative activity of the merged entity and among non-merging competitors. Similarly, the paper of Cunningham, Ederer and Ma (2018) discussed at length above supports the same negative conclusion.

As a final comment we observe that the recent debate on mergers and innovation is for sure relevant also for digital markets, characterized by a very intense rate of technical progress, although no contribution has specifically addressed these issues theoretically or empirically taking into account the specific features of these markets.

6. *Market power, competition and big data*

Many digital firms' core business is that of making *predictions* of various sorts.

Search engines need to predict the relevance of URLs to a consumer query. The higher the relevance of the URLs shown in consumers' search results page, the more likely it is that they will keep using the same search engine for their future queries. Social media and social networks need to predict how interesting a piece of content is to a particular user to build interesting content feeds. The more engaging those feeds are, the more likely it is that consumers will keep engaging with the app in the future. Matchmakers need to find good matches for their users (for instance, employees and employers, single men and single women and so on). They then charge their users for the service of being matched. E-commerce websites need to forecast consumer demand in order to manage their inventories. Other attention platforms such as online portals, newspapers and blogs monetize user attention through ads. They are paid according to user engagement with those ads (say per click). In order to serve more relevant ads, they need to predict the likelihood that a particular user would click on a particular ad. Better targeting translates in more clicks and higher revenues. Content producers and distributors, such as Netflix or Spotify, need to keep their users entertained. In order to do so they need to predict consumer tastes to make recommendations about items already in the catalogue that users are not aware of. They also need predictions to make production choices. Gans and Goldfarb (2018) discuss a variety of Machine Learning and AI algorithms making predictions of various sorts thus enabling new business propositions.

These predictions are made through statistical models (i.e. algorithms) fed by the vast amount of data that online businesses harness on their consumers. These datasets, characterized by a high *volume*, high *velocity,* high *variety* of formats are typically referred to "Big Data". Big data is generated as a by-product of consumption. By naturally engaging with the service, consumers transmit information that is used to improve the predictive power of the algorithms and therefore the quality of service. Web mapping services (such as Waze or Apple maps) pull information on traffic conditions from users roaming the streets while using their apps. Search engines learn about relevance by observing the behaviour of their users on search results page. Content providers (such as Netflix or Spotify) learn about quality by observing user engagement with titles and songs. Second, data is fed back as a production input.

The use of data as an input is widespread since the emergence of the modern industrial firm. One may think about, for instance, the use of survey data about customer satisfaction to improve one's product. However, because big data is a key input when making predictions and predictions are at the core of the value proposition, data-driven businesses are profoundly different from those that simply use data to marginally improve processes and products.

Antitrust authorities and practitioners have voiced concerns that in digital markets data gives incumbents a competitive advantage. The goal of the remainder of this section is to review recent empirical and theoretical papers contributing to this debate.

As discussed, data powered economies of scale are a possible foundation of the "positive feedback loop" hypothesis. That is, the "rich get richer" dynamics in which (i) firms with a larger installed base are able to amass more data; (ii) more data allows to improve service; (iii) improved service commands more customers thus more data and so on.

To understand how data might give that advantage, it is useful to first explain how data is actually used for prediction purposes. Typically, prediction algorithms use data for two different goals. First, data is used to *train* these algorithms. That is, to estimate the parameters of the statistical models used to make those predictions. Second, data is used to actually *use* those statistical models. To understand the difference, consider the task of assessing the relevance of a piece of content (say a news article) on a social media website to a particular audience. By crunching data on how different people behaved with that content in the past (did they click on it? Did the like it? Did they engage with it?), the social media website harnesses information on potential appropriate future audiences for that content. Given the statistical model constructed and calibrated through the data of users, then the model can be used to select the content more appropriate to a specific consumer. When a new consumer logs in, the website feeds the data on that

consumer (for example demographic characteristics) to the algorithm which then uses the estimated parameters to output its best prediction on the likelihood that this consumer will find the content interesting.

Given this, the debate revolves around three key issues:

data substitutability: to what extent the incumbent's data can be replicated, dispensed of or purchased on the market by an entrant? That is, to what extent the incumbent data is "essential" to make those predictions?

data complementarity: many contend that combining *diverse* data may give an advantage. For example, Google can improve its search results pages by using the clicks of other users making similar queries. That is, it can learn by leveraging on its scale. Or it could improve / personalize its search results by combining data coming from its email app Gmail or other lines of business;

data returns to scale: that is, whether and up to which scale increasing the size of a dataset increases prediction accuracy. Decreasing returns would suggest that the advantage of a larger and larger sample vanishes at some scale. And if that scale is small enough, even small entrants can challenge incumbents.

Of course, data held by two sources can be both complement and substitute at the same time. The discussion below helps clarify the distinction between data substitutability and complementarity in basic statistical learning theory.

Suppose we are trying to predict the value of some variable Y and there are two datasets X and Z containing relevant information. For instance, if Y is a binary variable telling whether a particular user is interested in purchasing a given product then X could contain the activity of the user on social networks and Z could contain her activity on the world wide web, say her browsing history. Clearly adding Z to X or X to Z allows mechanically for better prediction. But how much? Typically, variables in X and Z are correlated. Individuals tweeting about technology are more likely to visit online electronic retailers. This correlation reflects substitutability among data sets. That is, to some extent both data sets contain the same information when it comes to predict if a consumer would be interested in buying a new product for advertising purposes. If firms are paid on the basis of how accurate their predictions are, substitutability alone means that the willingness to pay for data set Z is lower for firms who already have data set X compared to those who don't. Or, in other words, that the value of the bundle X+Z is lower than the sum of the value of having X and the value of having Z alone. Complementarity, instead, reflects the idea that the willingness to pay for Z is higher for firms who already have X. This may occur, for instance, if the covariates interact somehow. Tweeting about a product may be a better predictor of the intention to buy it if the consumer has looked up this product on an e-commerce website. X and Z can be both complements and substitutes at the same time. Which one prevails depends on whether the willingness to pay for Z is higher or lower for those who already have X relative to those who don't. While complementarity is certainly a theoretical possibility, there is no empirical evidence to warrant the claim that complementarity would swamp substitutability.

The theoretical arguments and the empirical evidence available in the literature on the above three key aspects is still scarce and not univocal.

Lambrecht and Tucker (2015) argue that big data is not inimitable nor rare. They point to the existence of many alternative data sources and to a flourishing marketplace for data that entrants can access to in order to power their statistical models. There are plenty of examples of large data brokers (such as Acxiom) offering databases which allow, for example, entrants wishing to compete for advertising money to profile users. Also, they point out that often it is the statistical model used (i.e. the algorithm) rather than the size of the data set what enhances prediction accuracy.

Bajari et al. (2018) provide systematic evidence on the scale issue using proprietary data.[20] They look at the effect of "more data" on accuracy in the context of Amazon retail demand forecasting system. This is a critical task. If demand turns out to be higher than forecasts, Amazon runs out of stock hence leaving money on the

[20] Proprietary data represents a relevant issue for public policies and academic research. Our discussion of big data as a barrier to entry suggests different arguments and effects in place, implying that the ultimate answer is empirical. However, the data to test the different hypothesis are proprietary and typically not released to authorities or academics. The external review of empirical results coming from academic peers or public authorities is therefore severely limited.

table. On the contrary if demand turns out to be lower than expected, precious warehouse space is wasted, and there might be a need to markdown these products to free some that space. The specific goal is to predict the weekly sales of each product belonging to 36 different product lines (books, apparel, electronics and so on). They feed their statistical models with data playing with two dimensions: the number of products N in the same category and the number of periods T for which a particular product has been up for sale. They find that the prediction accuracy of their models increases with the time dimension, though with diminishing returns to scale. That is, additional data on previous forecasts and the subsequent realization of retail quantities improves the accuracy of retail forecasts for a particular product although at a diminishing rate. They also find that expanding by adding data on other products in the same category has no effect. Thus, they do not find evidence supporting the "feedback loop" hypothesis wherein big retailers, by selling many products, have a competitive advantage. What matters most is the time dimension (for how long one has been selling a particular product) and the learning curves become quickly flat. Schaefer et al. (2018) provide a similar exercise in spirit in a radically different context. They use observational data from Yahoo.com to assess whether there are economies of scale in internet search. They ask questions such as: how much data is needed for optimal quality? And what type of data? They show that more data enhances predictions as predicted by statistical learning theory and in line with the evidence by Bajari et al. (2018). In addition, they show that personal information (for instance, the ability of the search engine to track the browsing behaviour of specific users) amplifies the speed of learning. Their findings are consistent with an incumbent data advantage due to possession of personal information. Chiou and Tucker (2017) rely on a natural experiment to study whether the amount of historical data affected the accuracy of search results. They surprisingly find little evidence that historical data improves accuracy. Neumann et al. (2018) look at the performance of Data brokers in targeting specific demographics given some data on user behaviour (for instance cookies with their browsing history). Interestingly, they document that brokers that receive bigger datasets do not perform necessarily better.

To date, there is no paper yet tackling explicitly the issue of data complementarities. Thus, claims that diversity enhances accuracy are not based on rigorous systematic evidence.

The rest of this section surveys a recent literature that takes as a given the fact that data gives incumbents a competitive advantage and looks at consequences. To fix ideas, it is useful to think of data as being some essential input that entrants simply lack (the remainder follows closely the analysis of Biglaiser, Calvano and Cremer (2019)).

Clearly, a first, natural question in this context would be: why wouldn't an incumbent which holds such a valuable input be willing to either sell it, share it or license it to other downstream firms? If data is the competitive bottleneck, the argument goes, then the data holder should in principle be able to appropriate all the rents associated. This issue has been extensively studied in the literature on vertical restraints (Hart, Tirole, Carlton, & Williamson, 1990; Rey & Tirole, 2007), in the literature on patent licensing (for instance Gallani, 2002) and in the literature on premium content distribution in media markets (Armstrong, 1999). A very robust "Chicago style" insight coming out of these works is that frictionless markets typically allocate assets in a way that maximizes total surplus. Thus, if data licensing creates value, we should always expect firms to do so, bargaining over their respective share of the surpluses. The literature has thus been looking for reasons why the market may fail to efficiently allocate data linked to its peculiar nature. For instance, trade could be hindered due to legal barriers such as privacy protection laws. Rubinfeld and Gal (2017) provide a thorough discussion of these peculiarities. Further, there is a widespread issue of contract incompleteness in data trading and licencing, since data can be used for multiple purposes, some of which are hard to describe and foresee at the time of contracting.

A second relevant issue pertains the effects on market equilibria of an informational advantage on data by the incumbent. Prufer and Schottmüller (2017) show under which conditions a data advantage leads to market tipping studying a dynamic model of R&D competition. In their model the data advantage of the incumbent is modelled as follows: in every period, firms can increase the quality of their product at some cost which is decreasing in market share. The resulting quality advantage makes it impossible for entrants to compete. Furthermore, they show that disadvantaged entrants have an incentive to disengage leading to an overall inefficiently low rate of innovation. Finally, they show that if data collected in the primary market is

also useful in lowering marginal costs in other, connected markets then incumbents will have a tendency to expand creating big conglomerates much as we observe in many digital markets.

DeCorniere and Taylor (2019) study data-driven mergers in a context where data owned by the upstream firm is useful for price discrimination purposes in the market downstream. They show that a merger affects both competition in the downstream market and the incentives of upstream firms to collect data. In particular, they show that data trading is often better than vertical mergers, as the merged entity has weaker incentives to collect data. Of course, this can be good or bad for economic efficiency depending on the application. In their model data is collected by the upstream firm by providing low priced services in other markets. Then weaker incentives translate in higher prices and thus lower consumer surplus in those market.

Reimers and Shiller (2018) and Cosconati and Santoro (2019) look at the role of data collected by telematic devices (black boxes) installed on cars in the market for automobile liability insurance. Data on past drivers' behaviour mitigates the effects of adverse selection, as it "reveals" consumer types, and moral hazard, as it "monitors" driving. Their paper quantifies empirically the magnitudes of these effects and the benefits that data portability measures would bring. Interestingly, Reimers and Shiller (2018) show that almost all of the gains are in the moral hazard dimension, providing little supporting evidence that the ability of insurance companies in gathering on their drivers' abilities through these devices is a barrier to entry in this market.

7. *Conclusions*

This paper looks at digital markets and their specificities with a focus on the leading concepts of competition policy: sources of concentration and market power, forms of competition and scope for innovation.

The starting point recognizes that direct and indirect network externalities are a first and robust source of concentration, since economies of scale on the demand side create an advantage for larger operators and may lead to market tipping. Monopoly pricing of goods and services in context with network effects leads to lower markups that can be even zero or negative in multi-sided markets. However, below cost, or even zero prices do not necessarily imply anticompetitive behavior and can be part of the exercise of market power. As a result, the traditional framework in the assessment of anticompetitive pricing is inadequate. Moreover, the strategic tools that platforms can use to compete include additional instruments that affect users' choices, with a concern for intermediation biases.

The natural tendency towards concentration / market tipping suggests that competition FOR the market by entrants (as opposed to competitive pressure from other firms already IN the market) may be the relevant disciplining force. We discussed elements that enhance an incumbent's advantage reducing the contestability of digital markets. Switching costs and expectations may slow down or even impede the migration of users towards new operators offering better products. On the other hand, the nature of network externalities is often local, involving a large number of non-overlapping small groups. In this case the position of an incumbent may be eroded by entrants targeting segments of clientele. Similarly, the tendency to use several platforms simultaneously, what is known as multi-homing, may induce users to try new services without losing the benefits of large established networks.

These latter phenomena suggest that market tipping and concentration are not necessarily the only market configuration in digital environments. We then turn our attention to competition IN the market when different platforms coexist. Interconnection and interoperability may facilitate the construction of market-wide rather that firm-specific network externalities, a process that we have observed in traditional telecommunication services but that may be not as easy to implement in digital markets. Taste for variety may be a second source that allows differentiated platforms to compete in the same market.

Given their wide diffusion and importance, operators that harvest attention through (free or paid) content and offer it to advertisers received special focus. The case of free content is quite common in attention platforms as it allows to reach large audiences. Attention platforms include a large set of different operators,

from the old off-line media to the new social networks and search engines. They all compete for the pool of advertising budgets of firms, posing to antitrust enforcers a non-trivial issue of substitutability and market definition. The ability of digital platforms to track individual users' preferences creates a wedge that corners traditional media, unable to personalize their advertising at the level of individual users. The impact of these dramatic changes in the allocation of advertising money across old and new media and operators poses important questions and concerns on pluralism and democracy beyond the scope of competition policy.

The assessment of competition in a static environment needs to be enriched by considering the rapid pace of innovations that characterize digital markets. Two are the relevant themes we address. Quite often we observe new firms, the start-up, to be purchased by established incumbents in the very early phase of their development. A competitive concern arises, motivated by the intense M&A activity of large platforms, on whether this pattern may prevent the emergence of independent competitors able to challenge the market position of incumbents. In the limit, large established operators may acquire start-up's just to eliminate a rival and then discontinue the innovative process of the acquired entity. Empirical evidence of these killer acquisitions have been found in particular in the pharma industry, whereas similar results are still lacking in the Internet environment. A second theme in an antitrust perspective refers to the impact of mergers on the incentives to innovate, an issue that has been recently on the frontpage after the *Dow/DuPont* decision of the European Commission. We reviewed a series of very recent contributions that have highlighted both positive and negative effects of mergers on innovation, motivating a case-by-case approach in enforcement.

Finally, the very activity of digital platforms is very often based on the ability to predict preferences and behavior of their users. Big Data, collected through usage of services, allow digital platform to calibrate their algorithms and profile their clients. In an antitrust perspective Big Data has been considered a source of incumbency advantage and a barrier to entry for new, small competitors. Substitutability or complementarity between different dataset, the pattern of economies of scale in collecting and processing data and the role of information brokers are key empirical issues to assess whether a new firm offering a superior product may challenge the market position of a large platform.

The recent outbreak of new research papers surveyed in this literature review suggests that the economics of pre-digital information markets that also exhibited network effects, need to fight for attention, and learn from available data does not give a good handle to understand today's key policy issues in digital markets. A deeper knowledge of the functioning and of the specificities that characterize these markets is crucial to adapt old antitrust and competition policy tools to new challenges.

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