# A DEFINITION OF PLATFORMS WITH MEANINGFUL POLICY IMPLICATIONS

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## I. INTRODUCTION

Although strongly implicated in the 2013 global surveillance revelations by Edward Snowden,[2] popular interest in the potentially harmful role of "tech platforms" arguably truly came to prominence following the 2016 U.S. Presidential election, whereby data obtained from Facebook's advertising platform was instrumental in influencing its outcome.[3] During the COVID-19 pandemic, Alphabet's YouTube, Meta's Facebook and Twitter all came under similar scrutiny for inadequately handling the spread of misinformation, conspiracy theories and anti-vaccination rhetoric,[4] arguably leading to thousands of unnecessary deaths.[5]

Over the last ten years, these and other flash points have led to a surge in inquiries on the role of "tech platforms," including by U.S. legislators which have argued, for instance, that *"today's big tech companies have too much power — too much power over our economy, our society, and our democracy."*[6] Responding to this increased pressure, in 2020 the CEOs of Amazon, Apple, Meta (Facebook) and Alphabet (Google, YouTube) agreed to testify before

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[2] See, for instance, Gellman, B. and L. Poitras (2013). U.S., British intelligence mining data from nine U.S. internet companies in broad secret program. *The Washington Post.*

[3] See Kirchgaessner, S., Cambridge Analytica used data from Facebook and Politico to help Trump, *The Guardian*, October 26, 2017.

[4] See Alba, D., The surgeon general calls on Big Tech to turn over Covid-19 misinformation data, New York Times, March 3, 2022. https://www.nytimes.com/2022/03/03/technology/surgeon-general-covid-misinformation.html.

[5] See Duffy, B. and D. Allington (2020). Covid conspiracies and confusions: the impact on compliance with the UK's lockdown rules and the link with social media use. *The Policy Institute, King's College*.

[6] This quote is attributed to senator Elizabeth Warren via her 2020 Presidential campaign website in an article entitled *Break Up Big Tech.*

the Subcommittee on Antitrust, Commercial, and Administrative Law[7] about the nature and influence of their services. Overwhelmingly, the four executives argued the case that their firms were engaged in fierce competition, contrary to the popular (mis)conception that the four firms exert *de facto* monopoly power in their respective markets.[8]

In academia, discussions over what distinguishes "platforms" from other services in the context of competition and policy have been ongoing in the research literature for nearly twenty years. Central to such discussions is a new market phenomena which fundamentally challenges economists' preconceptions over what misuses of market power entails in the 21st century. This essay takes aim at describing this phenomenon through its past and present interpretations in the literature, with the ultimate goal of arriving at a definition of platforms that is useful for the purposes of policy debates.

## II. ORIGINS IN THE RESEARCH LITERATURE

The study of *network goods*, sometimes referred to as "system goods" or "information goods" has for the last forty or so years been a tenant of research in industrial organization. One way of defining such goods is as 'products and services which behave as components in a system or network whose value is significantly enhanced by the presence of other components.'[9] For researchers, such goods are interesting because they differ from 'traditional' goods in that technology decisions are often made by consumers/end-users rather than firms. That is, whereas for traditional goods (such as cars, refrigerators or television sets) firms coordinate — formally and informally — around certain technologies which become standards,[10] for

[7] From the 2020 session "Online Platforms and Market Power, Part 6: Examining the Dominance of Amazon, Apple, Facebook and Google" held by the Subcommittee on Antitrust, Commercial, and Administrative Law in the Hearings of the House Committee on the Judiciary. Available at: https://www.congress.gov/event/116th-congress/house-event/110883. Accessed on November 7th 2022.

[8] See Jarsulic, M. (2020). Using antitrust law to address the market power of platform monopolies. *Center for American Progress*.

[9] Definition by Varian, H. R. (2006). *Intermediate Microeconomics–A Modern Approach*.

[10] A *standard*, as is well established, defines the technical specifications for a product or service which producers must adhere to in order to ensure compatibility between architectural components (Eisenmann, 2007): Eisenmann, T. R. (2007). *Managing proprietary and shared platforms: A life-cycle view*. Division of Research, Harvard Business School Boston, MA.

network goods *consumer adoption* is what determines which technologies or *platforms* eventually reign supreme.

### *A. The Importance of Early Adopters*

Because early adopters of new technologies are limited in their ability to predict the future, their decisions as to which new technologies to support are reached largely based on the value of a technology/service at the time of its purchase. That is, an early iPhone buyer was in 2007 paying mainly for the physical and functional attributes of the phone, as they were unable to predict to what degree the phone would become a valuable network good (a component in a larger system of applications, accessories, services and so on) later on. That is to say, although such adopters might also have *predicted* that a significant number of other adopters will be attracted in the same way and so expect[11] that their cumulative adoption *might* garner an "ecosystem" of complementary goods and services, strictly speaking this was pure speculation at the time of purchase in 2007.

Whereas early adopters are paying for the good itself *plus* their expectations about future network benefits, later adopters are paying for the good itself, their expectations about future network benefits plus *present* network benefits which are a function of previous adoption. Early adopters of network goods are in other words at a significant disadvantage to later adopters in the information they possess about a good's ultimate network benefits (and so appropriate price). When their expectations are wrong, they might over-pay for goods whose network benefits in the end turn out to be of limited value. Buyers of Windows phones from 2010-17, for instance, were wrong in their expectations about the future value of the Windows mobile operating system, as the platform was discontinued in 2020. The costs customers encounter when choosing the wrong technology include those related to *opportunity* (missing out on the network benefits of the dominant technology) as well as *switching costs* related to acquiring a new technology (including learning, transferring data, buying new accessories and so on). In many cases, such as for digital services like Uber and Airbnb, the costs of signing up to the wrong service are often limited and strictly related to opportunity (the time spent on signing up and understanding the service). For hardware technologies and technologies which are implemented in large organizations, however, the costs of choosing the wrong system or network can be significant.

### *B. Network Benefits*

[11] See Hagiu (2006)'s work on the role of expectations on two-sided platforms: Hagiu, A. (2006). Pricing and commitment by two-sided platforms. *RAND Journal of Economics 37*(3), 720–737.

The effect that an additional user of a network good or service has on the value of that good or service to others[12] is referred to as a *network externality*. Strictly speaking, network externalities are consumption externalities which can be either *direct* ("same-side") or *indirect* ("cross-side or cross-group"). In cases of positive direct network externalities, the value of a service increases as more users looking for similar functionality choose the same technology/join the same network. Users of the telephone, for instance, benefit as more people buy telephones because they will have more people to call. Indirect network externalities, in turn, arise when a greater number of complementary services ("complements") become available as the network grows. Traditional examples include the increased availability of software for buyers of computer hardware as well as greater availability of customer support or repair services with larger installed bases.[13] More modern examples include the increase in the strength of Uber's value propositions to drivers (earn money from driving passengers) and passengers (convenient ride hailing) with increasing adoption by both groups. We tend to refer to such markets as *two-* or *multi-sided* markets, as they consist of multiple, identifiable groups of adopters whose utility from participation are interdependent.

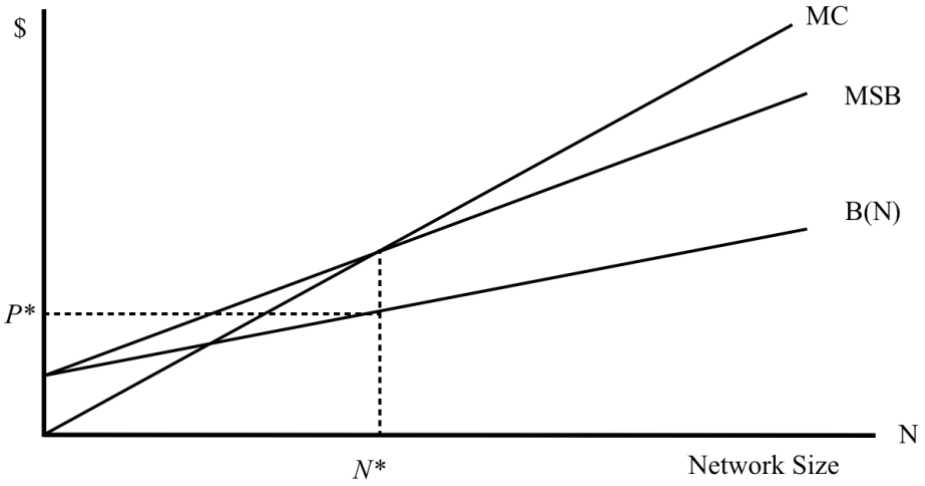


Figure 1: *"The benefit for any individual adopter from participation in a network B(N) relative to the benefit for the network from cumulative adoption MSB and marginal cost of serving additional participants (MC)." From Liebowitz & Margolis (1994).*

[12] See Katz & Shapiro (1985) for the first treatise on network externalities. Katz, M. L. & C. Shapiro (1985). Network externalities, competition, and compatibility. *The American Economic Review 75*(3), 424–440.

[13] See Katz & Shapiro (1985).

To formalize the concept of network externalities, let us consider Liebowitz and Margolis (1994)'s simple model of a network/platform which is owned by a single firm serving adopters who are all identical, generating direct/same-side network externalities. In Figure 1, B(N) is the benefit that any individual adopter derives from participation in the network, measured in dollars. B(N) is a function of the size of the network N and is a sum consisting of the marginal private benefit and average social benefit. The marginal social benefit ("MSB") from adoption is higher than the benefit to any individual adopter B(N) because MSB includes the positive impact that marginal adoption has on *all other previous adopters*.

The cost of serving additional adopters is also shown ("MC"), and in this figure assumed to be increasing with network size. This is intuitive for certain kinds of networks, such as those which involve physical connectivity between nodes which are further and further away from some initial node/cluster of nodes. Examples include wired telephone networks into rural areas, fiber-optic communication networks and charging stations for electric vehicles. As a function of geographical distance, costs increase the further away from the first node the network extends. An argument can be made for a similar cost curve for certain nonphysical networks, if the majority of costs related to serving additional adopters are for support/customer service. As Liebowitz and Margolis (1994) write, *"It is reasonable to assume that the first [adopters] will be those most suited to use the network, requiring the least support for their participation. [...] the Internet was first used by UNIX wizards, not computer neophytes."*

In one case, where we assume increasing marginal costs related to serving adopters (as in Figure 1), the profit-maximizing behavior for the firm that owns the platform is to charge the price P* and accommodate N* adopters, since this equates marginal revenue (MSB) with marginal costs ("MC"). By assuming increasing marginal costs, we implicitly argue that the network has some optimal size N*. Worth noting here is that marginal revenue includes *both* the price paid by the marginal adopter *and* the effect that the marginal participant has on the willingness of other adopters to pay. An alternative version which would result in the same equilibrium quantities would be to equate the benefit to any adopters from joining the network B(N) with marginal costs (MC), but include in marginal costs decreasing customer acquisition costs as a function of the effect that the marginal participant has on the willingness of other adopters to pay. In this version, network externalities show up as demand-side economies of scale.[14] Technicalities set aside, when marginal costs increase with adoption (the line MC points upwards), the optimal size of the network to the owner is *finite*, and in

[14] A term coined in Katz, M. L. & C. Shapiro (1986). Technology adoption in the presence of network externalities. *Journal of Political Economy 94*(4), 822–841.

the competitive case (more than one platform competing for adopters), indeed even a perfectly competitive market.

In cases apart from those described above (physical networks and networks whose costs are primarily related to customer support), it is prudent to question the assumption that marginal costs increase with participation. Take a social network such as Facebook as an example. A communications network at heart, Facebook's value to adopters is (or at the very least, was) strongly positively correlated with the number of other adopters with whom one might interact. The costs related to serving users are infinitesimal at scale (related to bandwidth, data storage and support). One might even argue that support costs could *decrease* with scale due to peers supporting one another and there being increased availability of support through third-party sites which help users through how-to videos, guides and support forums.[15] In such cases, even if marginal costs are assumed to be constant (the line MC in Figure 1 is horizontal), the model turns into one of natural monopoly where, *ceteris paribus*, the optimal size of the network (in terms of providing value to participants) is infinite (or the entire population).[16] Here, naturally, we begin to approach territory which will be of interest to political leaders and policy makers.

### *C. Pricing and Market Power*

It is quite a testament to Facebook's achievement that the company has managed to grow their network to an estimated 39.8 percent of the global population.[17] Although far from infinite, a network of more than 3.1 billion people certainly constitutes a considerable barrier-to entry for potential competitors looking to establish a similar offering. However, although Facebook's users number in the billions, this figure is actually of limited value in attempting to discern to what degree the firm is dominant in its industry. This is a key point, and one that is often overlooked, especially by journalists and pundits.

In order to understand market power in two- or multi-sided markets it is helpful to first consider the stereotypical example of a multi-product pricing scheme such as that first

[15] Consider for instance the value of how-to videos on YouTube and articles on WikiHow, as well as support forums such as Quora and Stack Exchange.

[16] For a more thorough discussion of this case, see Liebowitz, S. J. & S. E. Margolis (1994). Network externality: An uncommon tragedy. *Journal of Economic Perspectives 8*(2), 133–150.

[17] Estimates of Facebook user numbers vary and fluctuate, but according to Statista as of 2022 the estimated percentage of the worldwide population with a Facebook account was 39.8 percent. Available at: https://www.statista.com/statistics/241552/share-of-global-population-using-facebook-by-region/.

employed by Gillette in the commercialization of disposable razor blades.[18] The now well-known pricing scheme works as follows: First, sell a razor at a low price (at or even below marginal cost) such that as many people as possible are able to buy one. Next, sell razor blades to the same buyers at a price well above marginal cost. Because the razor blades are non-durable/consumable and the buyer now has a sunk cost in the razor, over time the profits from the sale of razor blades will far exceed the potential profits from the sale of a "traditional" razor with a fixed blade. Subsidize sales of one good in the present in order to maximize sales of a complementary non-durable good in the future — or as King C. Gillette put it: "Give em the razor, sell em the blade!" Today, the model is ubiquitous.

Although Cournot observed that discounting the price of zinc sells more copper in the brass market as early as in 1838,[19] the development of comprehensive formal models capturing the economics of multi-product pricing strategies first occurred in the 1970s and early 80s.[20] A key insight is that unlike for simpler products, *"a multi-product firm must decide about the structure of its relative prices as well as its overall price level."*[21] Firms must thus identify multiple optimal prices (for both the razor and the razor blade) in order to produce optimal quantities. And so, although (when viewed in isolation) the price of the razor below marginal cost might be suspicious, when viewed as one component in a multi-component system, its subsidized price is perfectly in line with the expected behavior of a profit-maximizing firm.

The key to understanding how platforms are different from traditionally, vertically integrated firms (or resellers) is to understand this distinction. Market power in two- and multi-sided markets with network externalities cannot be assessed by only looking at one "component" such as Facebook's market share or the profit margin of Apple's App Store. The system or network *as a whole* is the proper unit of analysis.

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[18] Analogy first employed by Rochet and Tirole (2003): Rochet, J.-C. & J. Tirole (2003). Platform competition in two-sided markets. *Journal of the European Economic Association 1*(4), 990–1029.

[19] Anecdote from Parker and Van Alstyne (2005): Parker, G. G. & M. W. Van Alstyne (2005). Two-sided network effects: A theory of information product design. *Management Science 51*(10), 1494–1504.

[20] The literature generally credits Baumol, P. & J. Panzar (1982). Contestable markets and the theory of industry structure. *New York* and Bailey, E. E. & A. F. Friedlaender (1982). Market structure and multiproduct industries. *Journal of economic literature 20*(3), 1024–1048.

[21] See Armstrong, M. & J. Vickers (2018). Multiproduct pricing made simple. *Journal of Political Economy 126*(4), 1444–1471.

## III. A NASCENT THEORY OF PLATFORMS

> *"The starting point for the theory of two-sided markets [...] is that an end-user does not internalize the welfare impact of his use of the platform on other end-users."* — Rochet and Tirole (2006)

It was Rochet and Tirole (2003) who twenty years ago first observed that subsidization across two- or multi-sided markets formally bares close resemblance to subsidization across components in multi-product systems such as Gillette's razor and razor blades scheme. In both cases firms need to identify not only an optimal price *level*, but also an optimal price *structure* in order to determine equilibrium quantities. Their paper, first published in *Journal of the European Economic Association* entitled 'Platform Competition in Two-Sided Markets' identifies platforms as very distinctive businesses *"characterized by the presence of two distinct sides whose ultimate benefit stems from interacting through a common platform."*[22] A main contribution of the paper is its demonstration of what sets such businesses apart from the single-sided businesses that had been treated in the "traditional" economic literature up until this point.

**The Monopoly Case.** Rochet & Tirole's analysis centers around a two-sided platform such as e.g. a payment system where both consumers (buyers) and merchants (sellers) are better off if they coordinate and use a single platform such as VISA or MasterCard. The main value proposition of such a platform might be described as "the facilitation of transactions between buyers and sellers." A monopoly platform charging users per transaction is looking to maximize transaction volume, but its profits are affected by the mix of buyers and sellers *as well as* the total level of participation. Similar to how Gillette needs to consider the optimal quantities of both razors and razor blades in order to maximize profits, the platform needs to optimize participation levels among both buyers and sellers in order to maximize the value of belonging to the network. Network effects, thus, dictate prices, as this is the main mechanism the firm has for regulating participation. Only if both groups' demand functions are identical should both sides pay the same for access to the network, as this is the only point at which equal participation is the optimal mix of buyers and sellers (in terms of maximizing the transaction volume on the platform).[23] Price discrimination is thus a key strategic instrument in establishing platforms in two- and multi-sided markets.

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[22] See Schmalensee (2014) for a thorough review of Rochet & Tirole's paper and its impact.

Schmalensee, R. (2014). An instant classic: Rochet & Tirole, platform competition in two-sided markets. Competition Policy International 10, 173–175.

[23] *Ibid.*

A related, similar analysis of platforms where adopters pay based on *participation* (rather than usage) was published a few years after Rochet & Tirole's influential paper.[24] Similarly as in the per-transaction case, profit-maximizing prices on such platforms indeed depend on network effects and so may both be below marginal cost (of participation) as well as highly skewed towards one group. In both cases, most if not all of a platform's profits may be earned from only one group of adopters, and policy makers should have no issue with the credibility of this outcome. A profit-maximizing platform is simply aiming to stimulate the optimal levels of participation such that all adopters are deriving as much value as possible from participation in the network. Thus, in assessing market power, the conclusion must be that price on one side of a two- or multi-sided market alone, even in the monopoly case, is essentially uninformative to any sound welfare analysis.

**The Competitive Case.** In cases where platforms are competing over adopters on one or several sides of a two- or multi-sided market, in addition to network effects, optimal prices hinge on the properties of the firm's value proposition and whether or not it is convenient and useful for adopters to belong to one or more platform(s) simultaneously. The best example of the latter is arguably Rochet & Tirole's example of the market for card payments, as both consumers and merchants can here comfortably utilize several platforms simultaneously. An additional card in a buyer's wallet isn't much of an inconvenience, but might be useful in cases where one service is experiencing an outage. Merchants similarly are not greatly inconvenienced by supporting multiple payment platforms, as payment terminals these days are generally supplied through third-party services which add support for the largest payment platforms in accordance with the demand among merchants for such functionality. Referred to as "multi-homing" in the literature, such symmetric cases are useful in demonstrating how competition among firms in two-sided markets with network effects is indeed often similar to competition in traditional markets.

The picture changes in cases where there is an asymmetry in multi-homing such that one side of a two- or multi-sided market is best served by belonging to a single platform rather than multiple. Such cases are arguably where policy makers' attention is most warranted, as single-homing on one side is conducive to higher degrees of market power for incumbent platforms. The best example of such a market is perhaps that of smartphone operating systems, where developers of applications and games typically multi-home (develop for both iOS and Android) in order to reach the entire market of smartphone users. Users, however, generally only belong to either iOS *or* Android, as carrying two phones simultaneously is inconvenient and expensive. In such cases, which arise as a function of the particular two-

[24] See Armstrong (2006).

sided value proposition of the platform, "competitive bottlenecks"[25] can occur where there is intense price competition for users on the side of the market where multi-homing is inconvenient. The outcome, at least in theory, is a price level which is more favorable for participants — as competing platforms will drive down prices. Regardless of outcome, the potential for such a "natural duopoly" arises *due to the nature of the value proposition of smartphone operating systems* rather than e.g. predatory pricing strategies or other forms of anti-competitive behavior.

**The Illustrative Case of Google and Facebook.** Google's apparent dominance in the web search market is a much-cited example of platform dominance in the popular debate. Estimated to process as much as 92 percent of all internet searches worldwide in 2022, from the outset, such scrutiny indeed seems warranted.[26] However, as Google's price to consumers for search is (and always has been) zero, using traditional methods it is difficult to discern exactly where the company's dominance leads to sub-optimal consumer welfare *on that side of the market*. Users are of course free to instead choose competing services, and *ceteris peribus*, competing firms are free to offer a similar service at the same or even a lower price point.[27] Neither of the main technologies at the heart of Google Search rely on unknown technologies, network effects or intellectual properties. Any company can build web crawlers to index websites to a database and offer a simple front-end user interface. Google does so supremely well at a remarkable scale, but with sufficient funding any new start-up company could arguably do the same. Baidu, for instance, dominates China's search market with an estimated 76.5 percent market share in 2022.

Of course, Google isn't a nonprofit organization. The millions of searches through their search engine are valuable, despite being priced at zero. However, rather than being an example of predatory pricing (where users' prices will be higher in the long term as a result of artificially low prices in the short term), like Gillette and the examples used in Rochet & Tirole's paper, rather than monetize search, in order to maximize profits Google chooses to fully subsidize this part of its value proposition. This because doing so generates higher expected profits for a related value proposition: advertising. Maximizing participation of

[25] Term first coined in Hagiu (2006), elaborated upon in Armstrong and Wright (2007). See Armstrong, M. & J. Wright (2007). Two-sided markets, competitive bottlenecks and exclusive contracts. *Economic Theory 32*(2), 353–380.

[26] Estimate according to StatCounter. Available at: https://gs.statcounter.com/search-engine-marketsharemonthly-202011-202211.

[27] Negative pricing strategies include the use of as coupons and discounts in order to stimulate adoption

searchers — like maximizing the sale of razors — maximizes the value of access to Google's system to advertisers. Advertisers will pay to gain access to searchers just as developers will pay to gain access to smartphone users.[28] Conveniently for this example, Google's parent company Alphabet is a competitor in both of these markets.

Inconveniently, however, the properties of both markets are such that multi-homing can and does occur, leading to fierce competition with other platforms and services for the revenue-generating part of Alphabet's value propositions. Whereas searchers tend to favor one search engine, advertisers are unscrupulous in their preferences for buying advertising from multiple vendors simultaneously, aiming to maximize the exposure of their ads in various different contexts. Similarly, although consumers tend to only carry one smartphone in their pocket, developers of apps and games will utilize cross-platform architectures, frameworks and libraries such that their software can easily be made available to consumers regardless of which smartphone they choose to buy. Thus, although Google in 2022 enjoys a market share of 92 percent in web searches (the subsidized side of its two-sided market), its market share for digital advertising (the profit-making side) was 28.6 percent in 2021. Facebook's share of the same market was 23.7 percent, Alibaba 8.6 percent, Amazon 5.8 percent, Tencent 2.9 percent and others 30.4 percent.[29]

Hardly a monopoly.

## IV. DISTINGUISHING PLATFORMS FROM OTHER SERVICES

Following the first papers of Rochet & Tirole (2003), Armstrong (2006) and Caillaud & Jullien (2003), a stream of papers modeling platform competition, pricing, expectations, entry, openness and governance strategies emerged, the majority of which from researchers within industrial organization, strategic management and technology management traditions.[30] Depending on the topic of such papers, various platform definitions also emerged, each of which emphasizes different attributes, such as *"products and services that bring together groups of users in two-sided networks," "platforms coordinate the demands of distinct groups*

[28] Famously, developers for the iOS App Store and Google Play Store pay a fee of 15-30 percent of all revenue for access to users via these platforms

[29] Estimates according to Statista. Available at: https://www.statista.com/statistics/290629/digital-adrevenue-share-of-major-ad-selling-companies-worldwide/.

[30] See a complete review in McIntyre, D. P. & A. Srinivasan (2017). Networks, platforms, and strategy: Emerging views and next steps. Strategic Management Journal 38(1), 141–160.

*of customers who need each other in some way,"*[32] *"markets involving two groups of agents interacting via platforms where one group's benefit from joining a platform depends on the size of the other group that joins the platform"*[33] and *"platforms enable interactions between end-users and try to get the two (or multiple) sides 'on board' by appropriately charging each side."*[34] The perhaps most widely adopted (and broad) attributes of what constitutes a platform are those described in Hagiu & Wright (2015), which describe platforms as: 1. Enabling direct interactions between two or more distinct sides; where 2. Each side is affiliated with the platform.[35]

The definition most closely aligned with the attributes highlighted in this article is perhaps that provided by Evans et al. (2006), who described *"businesses in which pricing and other strategies are strongly affected by the indirect network effects between the two sides of the platform."*[36] This definition captures the key ingredient that pricing in two- and multisided markets is a function of network effects, however omitting the fact that pricing is also a function of competition, which in turn is a function of the attributes of a platform's value proposition. As we have seen, whether or not a high degree of market concentration occurs on one side of a two- or multi-sided market is mainly a function of the attributes of the value proposition(s) of the platform (e.g. users will only carry one phone), not network effects. Thus, we arrive at an augmented, elaborated form of Evans et al. (2006)'s definition, articulated specifically for policy debates:

**Definition**: *"Platforms exploit value propositions which benefit from demand-side economies of scale by subsidizing across customer groups in accordance with customers' willingness to pay and the nature of the platform's value proposition."*

[32] Definition from Evans, D. S. (2003). Some empirical aspects of multi-sided platform industries. *Review of Network Economics 2*(3).

[33] Definition from Armstrong, M. (2006). Competition in two-sided markets. *RAND Journal of Economics 37*(3), 668–691.

[34] Definition from Rochet, J.-C. & J. Tirole (2006). Two-sided markets: A progress report. *RAND Journal of Economics 37*(3), 645–667.

[35] Hagiu & Wright (2015) clearly set out to define platforms in the broadest sense possible. The downside is that the vagueness of the definition leaves it open to interpretation and potential misappropriation, as well as making it less applicable outside of academia. See Hagiu, A. & J. Wright (2015). Multi-sided platforms. *International Journal of Industrial Organization 43*, 162–174.

[36] Evans, D. S., A. Hagiu, & R. Schmalensee (2006). Invisible engines: How Software Platforms Drive Innovation and Transform Industries. The MIT Press.

This definition aims to capture the key properties that distinguish platforms from other services, namely that 1. The strength of a platform's value proposition is a function of its number, quality and composition of adopters, 2. Subsidization is a strategic instrument employed to optimize the number, quality and composition of adopters and 3. The degree of competition among platforms for adopters hinges on the nature of their value proposition(s).

## V. CONCLUSION

Although research on platforms in two- and multi-sided markets has come a long way in the last twenty years, the field has arguably only begun scratching the surface of important topics related to competition and policy. Among the main issues currently garnering researchers' attention is the question of how to conceptualize and surmise consumer welfare for interconnected, multi-component, multi-sided value propositions such as those offered by companies like Facebook, Apple, Amazon, and Alphabet.

As this article has argued, singling in on isolated value propositions such as e.g. that of Google Search for users is unlikely to lead to meaningful findings in terms of establishing anti-competitive practices. Conversely, looking at price as the single, key determining variable in welfare analyses is also unlikely to capture the essence of consumers' state of well-being in two- and multi-sided markets. Indeed, what perhaps is most needed are new ideas which re-conceptualize the "traditional" notions of consumer welfare beyond the current, limited models of estimated allocative efficiency. Such holistic models should include an emphasis on lock-in mechanisms and switching barriers, complexity and sunk costs — to name a few.