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MULTISIDED PLATFORMS AND MARKETS: A SURVEY OF THE THEORETICAL LITERATURE

Juan Manuel Sanchez-Cartas* and Gonzalo León

Campus de Montegancedo
Universidad Politécnica de Madrid

Abstract. Platforms are everywhere. The rise of Uber, Netflix, and Facebook has attracted a lot of attention to this business model. However, despite its relevance and presence in the digital economy, the definition of platforms, their main characteristics, the intuitions about how they set prices, solve coordination issues, or choose their ownership structure seem to be scattered in many papers. This review attempts to organize the last two decades of research on multisided platforms around three essential elements of platforms: price structure, network effects, and control rights. We highlight which definitions are used in the literature, how they are related to the defining characteristics of platforms, and what research has been made on those characteristics. We pay special attention to the research done on pricing, coordination problems, and ownership structure. We conclude by reviewing the theoretical evidence around monopolization and competition policy in multisided markets.

Keywords. Industrial organization; Multisided platforms; Network externalities; Two-sided markets

1. Introduction

We live surrounded by platforms. Facebook, Netflix, Uber, and Airbnb are only a few examples of these platforms nowadays. They are everywhere, and they are disrupting businesses, behaviors and even governments. They put in touch people, users and developers, viewers and advertisers, creators of content, and consumers, sellers, and buyers. However, platforms are not a new phenomenon.

They are based on the idea of putting in touch two or more groups of people who need each other. Newspapers, academic journals, and even fairs work in this way. They "connect" readers and advertisers, researchers and readers, and buyers and sellers. However, information and communication technologies (ICTs) have allowed us to scale up this idea. Traditional newspapers or fairs have two shortcomings that digital platforms avoid: To benefit from a fair, you have to be there. To read a paper, you need a copy. In both cases, it is costly to print a newspaper or to set a stand at a fair. However, digital platforms allow us to overcome these two issues: You do not need to be physically in some place, and copies can be made for free. These two features have allowed platforms to reach global relevance and to increase the interest in them. The larger the number of users, the more relevant they become.

Although in the last decade, there have been scattered contributions that had reviewed different aspects of multisided platforms, such as competition policy—see Filistrucchi *et al*. (2013) or Jullien and Sand-Zantman (2019)—or specific markets, such as media markets, see Foros *et al*. (2015). There has been no contribution in the industrial organization literature focused on analyzing and clarifying the different concepts of platforms, their defining characteristics, and the research on those distinguishing

*Corresponding author contact +34 911 01 22 02 email: juanmanuel.sanchez@upm.es; Tel.:+34 911 01 22 02.

characteristics despite it could be argued that this literature was precisely born because of the need to define what is distinctive about platform markets compared to traditional ones. In this work, we first introduce the concept of multisided platforms, and how this concept has evolved in the literature. Then, we address the literature around each defining feature of multisided platforms: price structure, network effects and coordination, and control rights. Then, we conclude by addressing the possibility of tipping, and competition policy.

2. Definitions and Concepts

What is a multisided platform?[1] Unfortunately, neither there is an "industry of platforms" in official statistics that we can use as a reference, nor multisided platforms/markets have a clear and widely accepted definition, as it is pointed out by Filistrucchi *et al*. (2010), Evans (2011), or OECD (2009). In fact, *you know a [multi-sided] market when you see it*, Rochet and Tirole (2006).[2]

This identification problem arises because the concept of multisided markets is a refinement of combining other three concepts: *multiproduct firms, network effects, and property rights*. From the multiproduct pricing literature, it borrows the focus on price structure and the idea that price structures are less likely to be distorted by market power than price levels. From the network effects literature, it borrows the idea that there are noninternalized externalities among end-users. And from the property rights literature, it borrows the idea that there is a relationship between prices and rights over essential terms of the interaction.

A heterosexual, singles-oriented club is an illustrative example of a two-sided platform. There are two groups of customers—men and women. Members of each group value the presence of the other group, and normally, they pay different prices to access the club (or they have different access conditions). For example, let us imagine that men pay \$10 and women \$5. The club (platform) provides a place for them to get together and interact freely. By doing so, it enables members of these two groups to capture the benefits of having access to each other. In terms of the previous characteristics, a man/woman does not internalize the impact of his/her presence in the club on other women's/men's welfare. Therefore, there is a *noninternalized indirect network effect* among men and women that the club (platform) internalizes, but not necessarily perfectly.[3] Additionally, if the total price was equally shared (\$7.5), probably, the number of women and men in the club would be different. In other words, *price structure* matters. Lastly, both men and women freely choose their partners. The club does not force them to choose specific partners, so *men/women control with whom interact*. Therefore, we can identify three defining features of multisided markets: the presence of noninternalized externalities among men and women, the focus on price structure, and the control over the interaction terms by men and women.

Despite these features were early explicitly (or implicitly) highlighted by Evans (2003a) and Rochet and Tirole (2003), the trend in the literature has been to define multisided markets using an example-based approach, which has led to the current situation, in which there is not a clear and widely accepted definition. Furthermore, it has also led to ambiguous definitions that partially focus on some of these features.

For instance, when defining multisided markets, some authors have proposed definitions that focus only on the existence of indirect network effects because, in most of the motivating examples, it is by far the more explicit characteristic. Anderson and Coate (2005) uses as motivating example the media industry and define a two-sided market as *one where the participants on each side care directly about the number of participants on the other side*. Although finding examples in which that condition is true is easy, not all the cases with indirect network effects are multisided markets. Following the club example, a heterosexual but couples-oriented dancing club provides a place for men and women to dance together, but the previous price structure would be neutral as long as couples would be able to bargain the total price.

Other definitions considered the platform as a "trading device" or a "transaction technology" that facilitates the interaction among sides that otherwise would not occur. For example, an early definition was that a platform is a technology that minimizes transaction costs, or a technology that creates a value allowing transactions that otherwise would not occur, see Evans and Schmalensee (2005). Implicitly, these definitions take into account the necessity of having several sides on board that need each other in some way, and therefore, the existence of noninternalized network externalities. However, without explicit or implicit mention to the nonneutrality of the price structure, these definitions may encompass markets in which buyers and sellers can bargain the total price. Therefore, this definition is very broad and, virtually, every market could be studied as a particular case of multisided markets.[4]

However, the most common pattern in definitions has been to consider the existence of noninternalized externalities and the relevance of the price structure. The latter has been considered in most of the cases implicitly by referring to the platform as a "multi-product firm that serves several sides," see, for example, Ivaldi *et al*. (2011), Affeldt *et al*. (2013), Armstrong and Wright (2007), Filistrucchi *et al*. (2012), Kaiser and Wright (2006), Schiff (2003), Evans (2003b, 2011), or Weisman and Kulick (2010). In this case, these definitions lack the more subtle part of the features: the necessity of control over essential terms of the interaction. For example, a consultancy firm would be a two-sided platform if it intermediates between clients and freelance consultants by allowing them to interact freely, but a consultancy firm is one-sided if it assigns consultants to projects. In other words, it controls that interaction.

It is common that, at first sight, some definitions seem to lack some relevant features, but those features are later highlighted somewhere in the paper. For example, Hagiu (2004) states that *a market is said to be a two-sided if firms serve two distinct groups of customers who depend on each other, and whose joint participation makes platforms more valuable to each*, or Jullien (2005), who states that *platforms provide services that are used by two types of trading partners to interact and operate an exchange*. In both cases, they add an explicit reference to price structure or network effects later in the paper. Nonetheless, this lack of precision in defining platforms may lead to misclassifications, which may lead to wrong policies[5].

Among those definitions that take into account the three elements, Rochet and Tirole (2006) and Evans (2003a) propose the most interesting ones. Evans (2003a) summarizes the necessary conditions for the existence of a market with two-sided platforms as follows: *a two-sided market requires two or more distinct groups of customers, [it] exhibits externalities which are associated with two or more groups of customers being connected or coordinated in some fashion, [and] an intermediary is required in order to internalise the externalities created by one group for the other group(s)*. This definition considers the presence of network externalities and the multiproduct dimension of platforms by referring to different groups. However, the notion of end-users controlling the interaction is subtle, and it is only considered by stating that they are "coordinated in some fashion," which is quite general.

Rochet and Tirole (2006) define two-sided platforms as: *A market with network externalities is a two-sided market if platforms can effectively cross-subsidize between different categories of end-users that are parties to a transaction*. Therefore, there are *network externalities*. Platforms can effectively cross-subsidize, which implies a *nonneutral price regime*, and end-users that are parties to a transaction, which takes into account the idea of *end-users freely interacting*.[6] However, this last term is ill-defined and has been subject to debate in the literature because the term "transaction" can be broadly interpreted as an interaction, or it can literally be interpreted as a transaction, as some authors have done, see Filistrucchi *et al*. (2013),[7] but more importantly, the allocation of control rights is not properly defined, as in Evans (2003a), which makes those definitions overinclusive. In fact, Rochet and Tirole (2006) recognize that under their definition almost every company would be two-sided, which is a consequence of this lack of proper definition of the allocation of control rights.[8]

Building upon those definitions, posterior works provided refined definitions that, in some cases, keep having the same limitations. One of those is OECD (2009), which defines a two-sided market as follows: *A two-sided platform is characterized by three elements: (1) There are two distinct groups of consumers who need each other in some way and who rely on platforms to intermediate transactions. A two-sided*

platform provides goods or services simultaneously to these two groups. (2) The existence of indirect externalities across groups of consumers; (3) nonneutrality of the price structure. Another work that has proposed a similar definition is Evans and Noel (2008). They define multisided markets as follows: *[platforms that] provide goods and services to several distinct groups of customers who need each other in some way, and who rely on platforms to intermediate transactions between them. […] In particular, they facilitate the realization of indirect network effects. They typically reduce transaction costs and thereby permit value-creating exchanges that otherwise would not occur*.[9]

Despite those advances in defining multisided markets, it seems that the idea of end-users controlling essential terms of the interaction is not well delimited. Hagiu (2007) provides a proper delimitation of control rights by highlighting that the difference between "merchants" and "two-sided platforms" relies on the idea that end-users may have control over essential terms of the transactions, for example, the goods/services traded, or the prices for those goods/services. For example, in a buying/selling platform, it is the seller who sets the price for their goods/services, and in a media platform, it is the advertiser who chooses the ads to display.

Hagiu and Wright (2015) propose a new definition of multisided platforms based on two characteristics that incorporate this idea that the difference between a merchant and a platform relies on the allocation of property rights:

- multi-sided businesses enable direct interactions between two or more sides.
- each side is affiliated with the platform.

By "direct interaction," they mean that two or more sides retain control over the essential terms of the interaction. For example, on the Uber platform, there are two sides, users and drivers. Drivers retain control rights over the car (it is the drivers' car) as opposed to the one-sided intermediaries (taxi companies) that have total control over their fleet. Therefore, this is the main difference between the one-sided and the multisided worlds. By "affiliation," they mean that users on each side consciously make platform-specific investments that are necessary for them to be able to interact with each other directly, for example, paying membership fees or registering. In the Uber example, both users and drivers have to invest time in registering in the app. The affiliation helps to distinguish multisided platforms from input suppliers.

Therefore, this definition apparently makes use of two out of the three essential characteristics of multisided platforms, but the most remarkable contribution of this definition is that it does not require any reference to indirect or cross-network effects. Hagiu and Wright consider that indirect network effects could be a consequence of "affiliation" or "direct interaction." But independently of whether or not network effects are a consequence or a prerequisite, they agree that they are a characteristic of multisided businesses. However, this definition lacks a clear reference to the nonneutral price structure, and this may be the reason behind the lack of use of this definition. Nonetheless, the reference to the nonneutrality is hidden in the notion of "affiliation." Note that the idea that the affiliation generates multisidedness is not new. Rochet and Tirole (2006) highlight that some factors generate multisidedness, such as membership fees, because they could modify the volume of transactions. In fact, Caillaud and Jullien (2003) show that the price structure is neutral without membership fees. More generally, Evans (2011) argues that any transaction cost that prevents the sides from directly solving these externalities generates multisidedness. Therefore, interpreting "affiliation" as a platform-specific investment that generates transaction costs implicitly links this factor to the nonneutrality of the price structure.

Given the complexity of defining a two-sided market, it is normal to find works that consider different definitions. Some authors have shown that reality is very ambiguous, which leads to a multiplicity of definitions, see Filistrucchi and Klein (2013) or Evans *et al*. (2008). That is why it is usual to find works that use versions of the Evans' and Rochet and Tirole's definitions, see Affeldt (2011), Song (2013), Evans (2011), Affeldt *et al*. (2013), Filistrucchi and Klein (2013), Economides and Katsamakas

Table 1. Definitions by Contribution to Key Dimensions.

Price structure	Mentions to: Network effects	Property rights	Articles
Implicit	Implicit	No mention	Evans and Schmalensee (2005), Jullien (2005)
Implicit	Implicit	Explicit	Hagiu and Wright (2015)
Implicit	Explicit	No mention	Ivaldi *et al*. (2011), Affeldt *et al*. (2013), Affeldt (2011), Armstrong and Wright (2007), Schiff (2003), Evans (2003b), Hagiu (2004), Weyl (2010)
Implicit	Explicit	Ill defined	Evans (2003a), Evans and Noel (2008), Rysman (2009), Weisman and Kulick (2010), Wright (2004)
Explicit	Explicit	No mention	OECD (2009), Filistrucchi *et al*. (2012), Kaiser and Wright (2006), Song (2013)
Explicit	Explicit	Ill defined	Filistrucchi *et al*. (2013), Evans (2011), Rochet and Tirole (2006)

(2006), Filistrucchi *et al*. (2013), Kaiser and Wright (2006), Weisman and Kulick (2010), Weyl (2010), or Filistrucchi and Klein (2013).[10]

Lastly, another interesting discussion that has surrounded those definitions is whether or not we should talk about multisided platforms, markets, businesses, or strategies. Rysman (2009) points out that the definition of multisided markets is not correct because it is hard to find "pure multi-sided markets" but, it is easier to find "multi-sided businesses/platforms." He uses as an example Amazon that was a one-sided platform in the market of books and a multisided platform in other markets. He argues that multisidedness is an endogenous decision of firms. The main question is not to know if a market is a multisided one, virtually, all markets might be multisided to some extent. What is relevant is to know how important multisided issues are. Other works such as Cabral (2019) or Filistrucchi *et al*. (2013) have argued similarly. For example, Evans (2011) points out that, in the US newspaper industry, there are examples of different business models with high consumer fees and low level of advertising (The Economist), with a high level of advertising and low consumer fees (Vogue), or free for consumers but with the highest level of advertising (online newspapers), see Evans and Noel (2008), Evans *et al*. (2008), and Evans (2011). Those features are common in social networks too, in which some users pay and have low levels of advertising (LinkedIn premium), or there is advertising but it is free (Facebook). In this vein, it makes much more sense to talk about companies that follow different strategies with different degrees of multisidedness.

In all the previous definitions of platforms, the multisidedness is taken for granted, and the focus is on the company that behaves as a platform, but as Rysman (2009) pointed out, what is relevant is to define multisidedness. Following the literature, we can highlight three pillars that determine the boundaries of multisidedness: network effects, property rights, and price structure. In fact, it is possible to summarize all the previous contributions around these three dimensions, as Table 1 shows. Therefore, multisidedness requires the presence of noninternalized externalities among end-users (i.e., indirect network effects),

the possibility of cross-subsidizing different categories of end-users (i.e., price structure matters), and prices must reflect that end-users that are parties to a transaction retain control over essential terms of the interaction (i.e., control rights). The failure of any of these conditions makes simpler and better understood other models. For example, if network effects are not found, or the platform is price-taker on one side, or the platform behaves as a reseller, traditional one-sided analysis is better suited.[11] Once these three conditions hold simultaneously, the question is to what extent multisidedness is relevant for each market.[12]In summary, definitions are controversial. There is no consensus. In general, the vast majority of authors and international organisms recognize that there is not a universally accepted definition of multisided markets or platforms yet. There is a consensus on the idea of two or more groups of agents who need each other in some way and who rely on platforms to intermediate transactions between them. There is also consensus on the idea that it is more important to determine the linkages between the sides of the market than the market itself, see OECD (2009), Filistrucchi *et al*. (2013), or Weyl (2010). However, as it is pointed out by Filistrucchi *et al*. (2013), *at first sight, it appears to be still some debate on the exact definition of a two-sided market, but the different definitions appear consistent enough to allow the practical identification of two-sided markets*. In fact, when we combine the different approaches found in the literature, it seems that a clear concept of multisidedness emerges around price structure, network effects, and control rights.

2.1 *Typologies of Multisided Models*

With the expansion of the multisided literature, some authors realized that neither all the multisided platforms were equal nor all definitions were suitable for all platform. For instance, Filistrucchi *et al*. (2013) point out that Evans' definitions were more suitable to describe media platforms and, on the contrary, Rochet and Tirole's definition was better suited for payment platforms.

Since the birth of the literature, different authors have tried to classify multisided platforms following different criteria ranging from price policies to sectors or property structures. Those classifications fulfill different purposes, and an exhaustive analysis of them is out of the scope of this work. As it is pointed out by Filistrucchi (2008), antitrust authorities, managers, researchers, and so forth have to have in mind that different typologies of markets should be treated differently.[13]

The first taxonomy we are aware of is Evans (2003b). He considers three categories:

(1) Market makers. They enable members of distinct groups to transact with each other. Each member of a group values more the service if there are more members of the other group. The distinguishing feature is the possibility of monitoring transactions.
(2) Audience makers. They are those markets where platforms match advertisers to audiences.
(3) Demand coordinators. These platforms do not strictly sell "transactions" like a market maker, or "messages" like an audience maker. They are a residual category but economically the most interesting for Evans.

However, this classification presents several flaws. On the one hand, the most interesting category is the residual one. On the other hand, the definition of the categories is either quite restrictive or quite lax. In the case of market makers, platforms should be able to monitor transactions, which is a lax requisite. But in the case of audience maker, platforms must be in the business of advertising, if not, they are in the residual category. These flaws make impractical this taxonomy nowadays, but it was a useful one at the beginning of the literature.

Later, Evans observed four types of two-sided platforms: exchanges, advertiser-support media, transaction devices, and software platforms, see Evans and Schmalensee (2005). However, as the literature grew, and the digital sector became more relevant, other sectoral taxonomies appeared. For instance, Evans (2011) recognizes three different digital platforms: web-based, payment platforms, and

software platforms. Although these classifications have a value from the sectoral point of view, from a theoretical one, it is not clear the advantage of differentiating between exchange and transaction device platforms instead of thinking in "market-makers" (as it was initially proposed). Additionally, from a theoretical point of view, it makes little sense to consider as software platforms all the digital platforms independently of their characteristics.

On the other hand, Filistrucchi (2008) proposes a theoretical taxonomy that is quite relevant nowadays from theoretical and empirical perspectives:

(1) Two-sided nontransaction markets, or media type. In these markets, the transaction is not present, or it is unobservable. These markets only set membership fees. For example, newspapers. Readers read newspapers with ads, but the newspaper does not know if the ads are generating transactions for the advertiser.
(2) Two-sided transaction markets, or payment card type. These markets are characterized by the observability of transactions between the sides, like payments with credit/debit cards. The platform can monitor the transaction, and it can set both transaction and adoption fees.

In comparison with Evans's (2003a), this classification is more useful for research purposes. It is simple and straightforward. However, the only flaw is that the two-sided transaction markets category may attract all the digital platforms because these markets are characterized by the observability of a transaction between the sides. In almost all digital platforms, that is true. However, many of them prefer to use membership fees instead. In this sense, it would be better to classify them in terms of the actual pricing instead of the potential pricing. However, that may lead us to derive wrong conclusions, because we would be assuming that they do not set other prices because they cannot.

As a summary, in comparison with other lines of research, the classification of two-sided platforms has not been so well studied as other features of these markets. This is also because of the lack of a standard definition of multisided platforms. As a consequence, in all the works we have highlighted, those classifications were developed by the authors' necessity to achieve a specific objective (describe some styled facts, develop an antitrust analysis, etc). However, the relevance of such classifications depends on how useful they are for practitioners or researchers. In Section 6.2, we focus on the practical use of those classifications by highlighting the current debate about the use of multisided platform models in antitrust analysis, and the use of the Filistrucchi's classification as discriminating taxonomy among the different techniques.

2.2 *Special Features of Multisided Platforms*

Multisided platforms defy many of our preconceived intuitions about firms' behavior. This is a consequence of the interrelationship among the three defining concepts highlighted previously. For instance, Wright (2004) explores eight common statements in the industrial organization literature that do not apply to multisided platforms. Those eight statements (or fallacies as he calls them) are:

(1) An efficient price structure should be set to reflect relative costs (user-pays).
(2) A high price–cost margin indicates market power.
(3) A price below marginal cost indicates predation.
(4) An increase in competition necessarily results in a more efficient structure of prices.
(5) An increase in competition necessarily results in a more balanced price structure.
(6) In mature markets, price structures that do not reflect costs are no longer justified.
(7) Where one side of a two-sided market receives services below marginal cost, it must be receiving a cross-subsidy from users on the other side.
(8) Regulating prices set by a platform in a two-sided market is competitively neutral.

Despite that all of them refer to price structure, the interrelationship between independent sides is the reason why some traditional insights do not apply. Additionally, recent evidence has shown that there may be more of those "fallacies," for example, taxes on one side may not disincentivize participation on that side, or compatibility between platforms may reduce competition. Thus, many of our traditional insights may be wrong in multisided markets. In fact, Evans and Schmalensee (2013) argue that *one-sided tools often do not apply, at least not without substantial changes, to multisided platforms*.

The difference in pricing between multisided and one-sided markets is the most notable characteristic. Multisided platforms tend to set an asymmetric price structure in which there are profitable and loss sides. But the differences in pricing behavior are not limited to the asymmetric balance. The prices can be disconnected from marginal costs, as it is pointed out by Evans (2003b).[14] Because of the interrelationship between the sides, a platform may respond to an increase in costs on one side with an increase in prices on the other side. Jullien (2005) argues that it is common in multisided markets that the welfare-maximizing prices will not coincide with marginal costs, and Rysman (2009) points out that: *theoretically, it is often hard to establish whether a given price in a two-sided market is higher or lower than socially optimal, or even whether greater competition would make the existing price rise or fall*. All these contraintuitive results have led to a vast literature focused on pricing. During the last decade, many of the long-grounded intuitions about prices and market structure have been revised, and this trend continues as new evidence appears.

On the other hand, grounded on the second pillar of the defining factors of multisidedness, the literature has also focused on the coordination problems that arise as a consequence of the indirect network effects. In network economics and multisided platforms, companies have to solve a coordination problem, in which the role of expectations is essential. In contrast with the canonical network effect model, in which if users believe no one will adopt the platform, the equilibrium is zero adoption (Belleflamme and Peitz, 2015, chapter 20). In multisided platforms, even if one side believes no one is going to enter the platform (pessimistic beliefs), it can get a positive market share if the platform subsidizes one group to attract the other group—divide-and-conquer (DC) strategy—see Caillaud and Jullien (2003) or Jullien (2005).[15] Both pricing and coordination problems account for most of the early contributions, but in contrast with the pricing, the expansion of this branch has been smaller.

Despite the differences with one-sided companies, some intuitions prevail between multisided and one-sided companies. For instance, Reisinger (2004) is among the first ones in proving that the greater the differentiation, the greater the profits for at least one platform. Hagiu (2004) or Evans (2002) also find that differentiation guarantees the existence of several platforms in the same market. Rysman (2009) summarizes this feature as follows: *If [platforms] can differentiate from each other, they may be able to successfully coexist*.[16] Also, another common point is that multisided platforms have an excessive incentive to serve the marginal user, which also leads to an imperfect internalization of externalities, see Kind *et al*. (2008) and Weyl (2010).

3. Pricing in Multisided Markets

Pricing is the most studied topic in the multisided literature by far because the "unusual pricing scheme" of multisided platforms was the focus of many early works, such as Rochet and Tirole (2003), Caillaud and Jullien (2003), or Armstrong (2006). In fact, the eight Wright's (2004) fallacies refer to the price structure in some way.

In the case of two sides, this pricing scheme is characterized by an asymmetric structure in which one side "pays" while the other side is subsidized, for example, free newspapers for readers. Rochet and Tirole highlight that this behavior is the consequence of "the Seesaw principle," and they define it as follows. *A factor that is conducive to a high price on one side, to the extent that it raises the platform's*

margin on that side, also tends to call for a low price on the other side as attracting members on that other side becomes more profitable.[17]

However, this price scheme does not imply that pricing in multisided markets is disconnected from traditional insights. In the seminal work of Armstrong (2006), a two-sided platform differentiated á la Hotelling sets prices as in the classical Hotelling model but adjusted by the externalities. Armstrong also provides evidence of the Seesaw principle, and he argues that a platform will compete for one group more aggressively than for the other, either if that group is on the more competitive side of the market, or if it causes a larger benefit to the other group. Following the nightclub example, it is usual to find nightclubs where women have free access, but men have to pay. In Armstrong (2006)'s model, this price scheme is explained because men value more the presence of women than the other way around. The externality created by women is larger. However, the key insight of Armstrong is to show that indirect network effects increase the elasticity of demand on both sides. Thus, any price cut induces a larger increase in sales on both sides.

After those seminal works, pricing on multisided platforms has become a hot topic in the literature. In this sense, we can recognize two different approaches. On the one hand, those works that have focused on factors that influence the price structure of platforms, and on the other hand, those works that have studied the different pricing policies that platforms can implement. For example, membership or pay-by-use (transaction) fees. The former refers to the price that a user pays for entering the market, for example, the price paid by readers to access a digital newspaper. The latter refers to the price paid each time that a transaction occurs. For example, the commission paid by a vendor when a buyer paid by credit card. They are not exclusive, and they can be found together in some markets. For example, a digital streaming platform that has a monthly subscription but, to access specific content, you have to pay an additional fee.

Although the vast majority of works consider only membership fees, transaction fees represent an additional instrument to extract profit, but also an instrument that makes multisided markets more contestable. More importantly, when transaction fees are not feasible, inefficient market configurations can emerge in equilibrium, for example, "dominant-firm equilibria," because transaction fees are an additional instrument for deviation that increases the available set of strategies for platforms, see Caillaud and Jullien (2003) or Hagiu and Wright (2015).

At first sight, it may be surprising that given such relevance, the literature has not focused more on the combined role of membership and transaction fees. However, Rochet and Tirole (2006) prove that what matters is the "per-interaction price," which depends on both fees, and both pricing structures obey the standard Lerner principles with a reinterpretation of the marginal cost as an opportunity cost. Similarly, Ambrus *et al*. (2016) show that it does not matter if platforms charge per-unit prices plus an entrance fee or fixed payment, platforms face the same optimization problem. This result does not imply that we should treat both fees equally. In fact, several authors have pointed out that we should not ignore the difference between membership and transaction fees. Armstrong (2006) argues that the possibility of setting transaction fees is the main determinant of the structure of prices offered to the groups in two-sided markets, and according to Filistrucchi (2008), this feature is crucial for the development of econometric models and tests like the SSNIP (small significant nontransitory increase in price). The key insight is to highlight that, independently of which kind of fee we pay attention to, the Lerner principles hold. Therefore, the interesting question to ask is what factors influence the price structure or elasticities on a given side.

As the classical market literature shows, many factors may influence the market structure, and multisided markets are not an exception. In the next sections, we focus on some of those factors that influence elasticities or price structure, such as the possibility of consuming more than one platform at a time (multihoming), taxation, switching costs, information, or expectations. In this sense, an exhaustive review of all the works that address multisided pricing is beyond the scope of this work. Instead, we narrow the scope to address theoretical works in areas in which the evidence is well-established.[18]

3.1 *Exclusivity in Platforms. Singlehoming, and Multihoming*

A common feature that we observe in multisided markets is that some agents tend to use several platforms at the same time. For example, drivers that use both Uber and Lyft. Couriers that use Glovo and Deliveroo. Several works have paid attention to the incentive to be on more than one platform at the same time, also known as multihoming. Multihoming is a natural part of a lot of markets. For example, in the newspaper industry, there is no way to prevent readers from reading two or more newspapers, and the same is also true for advertisers.[19] Multihoming is also common in the payment card industry, where many merchants accept both Mastercard and Visa, and consumers have several payment cards. Or, in the digital economy, in which developers may support Android, iOS, or Windows Phone.

The reasons to multihome are diverse. For instance, Rochet and Tirole (2006) point out that *multihoming stems from the users' desire to reap the benefits of network externalities in an environment of noninterconnected platforms*. In a similar vein, Caillaud and Jullien (2001) and Caillaud and Jullien (2003) highlight that multihoming increases the probability of matching, and it allows consumers to save on transaction fees because they can adopt the cheaper platform.[20] On the other hand, Choi (2010) points out that when there is exclusive content on platforms, there is also an incentive to multihome. However, this incentive to multihome depends on the degree of multihoming on the other side negatively. In other words, the incentives to join more than one platform decrease with the number of users on the other side that are common to several platforms, see Gabszewicz and Wauthy (2014). Rysman (2009) also observes that two-sided markets seem to evolve toward a situation in which members of one side use a single platform (singlehoming), and the other side uses several platforms (multihoming).

It seems that multihoming is a great advantage because users can benefit from the network externalities of several platforms. But multihoming may not be as good as it seems. The maximal price multihoming consumers are willing to pay is the incremental value of having access to an extra platform, see Ambrus *et al*. (2016) and Anderson *et al*. (2019). Other things equal, multihoming consumers are thus less valuable than singlehoming consumers. Thus, the singlehoming side is usually subsidized by the multihoming side. So, their desire to reap the benefits of different network externalities leads platforms to increase prices on the multihoming side. In other words, multihoming influences the price structure by increasing competition on the singlehoming side but relaxing it on the multihoming one, see Rochet and Tirole (2003), Armstrong and Wright (2007), and Armstrong (2006). While there is competition for singlehoming customers, there is no direct competition for multihoming ones, even when they are homogeneous, see Armstrong and Wright (2007). This situation gives rise to so-called competitive bottlenecks, see Armstrong (2006). This is a consequence of platforms having monopoly power over providing access to their singlehoming customers. This difference between singlehoming and multihoming sides also leads to an asymmetric price structure, but this time, it is not motivated by the strength of network effects, but by the decisions of consuming one or more platforms.[21]

From a social point of view, because there is no direct competition for multihoming consumers, their interests are ignored, and there are too few multihoming customers.[22] This market failure does not imply larger profits, as Armstrong (2006) argues: *the excessive prices faced by the multi-homing side do not necessarily result in excess profits for platforms, since platforms might be forced by competitive pressure to transfer their monopoly revenues to the single-homing agents*. In other words, factors that induce more multihoming may also induce more competition. For example, if more buyers are attracted by both platforms, platforms may compete harder for their positions.

Nevertheless, some works challenge conventional wisdom according to which multihoming leads to monopoly prices on that side. Jeitschko and Tremblay (2014) show that when the homing decision is endogenous, prices will not converge to monopoly prices on the multihoming side, although those would be larger than without multihoming. But more surprising are the Belleflamme and Peitz (2019a)'s results. They show that it is not necessarily the case that multihoming users pay a higher fee, and singlehoming ones a lower fee. Although we may expect higher prices on the multihoming side because of the

"bottleneck effect," the multihoming side may end paying less than the singlehoming one. The reason for this counterintuitive result is that the platform faces a more elastic demand when the consumers' outside option is quitting the market rather than the competitor's offer. In other words, a fee reduction on the multihoming side may be more effective expanding the demand on that side. Therefore, two economic effects are at work: the market share effect that drives competing platforms to set a lower price than a monopolist and the price sensitivity effect that works in the opposite direction. Belleflamme and Peitz (2019a) conclude that it is impossible to state whether prices would be higher/lower on either side, but we can state that prices on both sides of the market always move in opposite directions. Other authors have also found this flipping behavior between singlehoming and multihoming. Anderson *et al*. (2019) find that multihoming flips the side of the market on which platforms compete. But this effect is not only limited to prices. They also found that multihoming may flip the side that it is impacted the most by a merger or an entry of a new firm.

Lastly, the conventional wisdom by which multihoming leads to monopoly prices has also sparked the literature around those factors that may mitigate multihoming, such as exclusivity contracts or compatibility among networks. For instance, with exclusive contracts, platforms force multihoming consumers to singlehome regardless of competitor's offers. This behavior also breaks competitive bottleneck equilibria. However, by forcing one side to choose one of the platforms, a platform may instead induce consumers to choose the rival one, see Armstrong and Wright (2007). Additionally, exclusivity contracts may create new damages that were unintended because when platforms prefer to impose exclusivity, they hurt at least one group of participants, see Belleflamme and Peitz (2019a).

Instead of making exclusive contracts, another way to disincentive multihoming is by becoming compatible. If platforms are compatible, there is no incentive to multihome because users will benefit from the network externalities of all the compatible platforms. Doganoglu and Wright (2006) find that compatibility mitigates the incentives to multihome, and because profits are increasing with respect to multihoming, platforms are less prone to compatibility. So, platforms have excessive incentives for incompatibility when customers multihome. But more interestingly, compatibility may mitigate price competition in two-sided markets by increasing the market imperfection, see Doganoglu and Wright (2006), Salim (2009), or Sanchez-Cartas and Leon (2017). When platforms are fully compatible, they do not internalize the network effects, and the subsidizing incentives disappear. This is an interesting result because it contrasts with the traditional one-sided literature in which the opposite is true, see Farrell and Saloner (1985) or Katz and Shapiro (1985).[23]

3.2 *The Role of Information*

A critical factor that influences price structure in classical markets is the degree of available information. Should platforms disclose their prices? How do platforms infere the size of network effects? Despite its relevance, the research on this topic is scarce, but the current evidence provides striking results. For instance, Hagiu and Hałaburda (2014) propose a model in which they analyze the impact on the price structure of price disclosure on one side. They prove that a monopoly has incentives to avoid asymmetries in information, but the opposite is true in a duopolistic framework. In other words, the larger the market power, the more likely platforms would inform about prices on all sides. This result is a consequence of network effects, when agents are informed, the effect of a price reduction is amplified. Platforms with more market power benefit because this leads to demand increases. In terms of prices, platforms tend to set higher prices when agents are less informed because demands are less reactive to price changes. Thus, any estimation of network effects based on observed prices would be different depending on the level of agent information. Belleflamme and Peitz (2019b) address the same issue, but they consider partial strategic disclosure on both sides instead of total coordinated disclosure on one side. They find that Hagiu and Hałaburda (2014)'s results are robust to partial disclosure. Interestingly,

if platforms could coordinate their decisions, they would not inform any users, as shown by Hagiu and Hałaburda (2014). Following Hagiu and Halaburda's work, Sun (2018) addresses the same issue, but she considers a market with bundling/tying strategies. She finds that bundling is more effective in stimulating consumer demand when there are more informed consumers, which may amplify Hagiu and Halaburda's insights.[24]

On the other hand, sometimes is the platform that is uncertain about the externalities that each side exerts on the other. In this situation, platforms can use their fees to gradually learn about those externalities by observing participation. But how should the platform set prices under such uncertainty? Lowering fees increases the quantity of information, but it reduces current revenues. By extending Armstrong (2006)'s model, Peitz *et al*. (2017) find that, when there are only externalities/uncertainty on one side, it is optimal to set a fee lower than the myopic model (the price set by a monopolist when maximizing current revenues only) on the side that profit from the externality, and a higher one on the other side. But in a case with two uncertain externalities, the correlation between the direct and indirect effects of lowering fees across the states of the world play an essential role in defining the price structure. The intuitive direction of experimentation is to lower prices, which holds when uncertainty is high, but if this is moderate, it may be profitable to set higher prices than myopic ones on one side. This result implies that the casual chain from lower prices to higher participation levels to more informative outcomes can be overturned by the incentive to extract surplus (on the side that benefits more from the lower experimentation fee on the other side). Nevertheless, their results provide a rationale for introductory prices because the platform starts by charging lower prices on both sides then increase them over time. And more importantly, these results highlight that platforms can alter the intensity of competition by manipulating the information flow to consumers.

3.3 *Taxation and Customers' Behavior*

Taxes are a fundamental factor that alters price structure in classical markets, and they influence multisided markets too, but the way they do it is different.[25] Taxation on digital platforms is more complex than in one-sided markets, and in some cases, it requires a completely new design. *The innate characteristics of digital products and digital platforms modify the effects and the optimal design of taxes in potentially unexpected ways*, see Kind and Koethenbuerger (2018). For example, it is possible that taxing a two-sided platform may increase the number of affiliates on both sides, see Kind *et al*. (2008). They find that a higher value-added tax on one side may be profitable for the platform to shift revenue from that side to the other one (from the heavily taxed to the untaxed side). Because of this balance, the output on both sides may increase. In a similar vein, Kind *et al*. (2013) point out that, in media platforms, even if consumers dislike ads, a tax aimed to reduce ad levels may affect consumers negatively. The cross-relationships among the sides implies that the impact of taxation cannot be limited to consider the side upon which such tax is levied only, because of the network effects, platforms will react by shifting revenues from the sides, which may go against the motivations of the tax.

Up to now, the literature has focused on comparing the effects of value-added and unit taxes on price structure, where effects are quite different. Kind *et al*. (2009) find that a higher specific tax on one side leads to a lower affiliation, as in one-sided markets, but the opposite may be true with ad valorem taxes. Similarly, Belleflamme and Toulemonde (2018) find that transaction taxes hurt agents on both sides and benefit platforms. On the other hand, they also confirm the result found by Kind *et al*. (2008) that ad valorem taxes may benefit users that are taxed, but it may hurt agents on the other side of the market. In terms of welfare, the dominance of ad valorem taxes, which is common in one-sided markets, does not hold in two-sided markets. In fact, unit taxes may yield higher welfare than ad valorem taxes.[26] Interestingly, taxes do not influence the prices only. Kind *et al*. (2013) prove that taxes may affect the

optimal location of horizontally differentiated platforms. In other words, taxes may affect the political views of newspapers too.

Lastly, customers' heterogeneity is a wide branch that has attracted many efforts in the last decades. Heterogeneity may appear in many forms and can be modeled in many ways. One kind of heterogeneity that has a big impact on multisided platforms is the one related to beliefs, either about the participation or about the transaction.

In certain situations, consumers have different beliefs about how many people will join the platforms. This situation implies that consumers have different beliefs about other consumers' preferences. Jullien and Pavan (2019) study this case and find that although the Armstrong (2006) price structure still holds, it is necessary to consider a new term that accounts for agents' beliefs, which can lead to either higher or lower prices depending on whether the preferences on both sides are positively or negatively correlated. Contrary to the complete information framework, prices under dispersed information increase with the intensity of the own-side network effects if preferences are aligned, or decrease if they are misaligned. Intuitively, if preferences are positively correlated, and consumers are optimistic about the participation on the other side, they will expect high participation on the other side, which implies that only the pessimistic consumers are excluded. Therefore, an increase in price on, say, side A drops side-A's demands less than when all consumers have the same beliefs, in other words, demand elasticity is lower, and prices are higher.

Instead of having different beliefs, customers may be different. Not all consumers create the same externality on the other side, some of them are more relevant. Influencers are a clear example of these consumers, and their presence in multisided platforms also influence pricing. Rochet and Tirole (2003) and Hogendorn and Ka Yat Yuen (2009) show that "marquee buyers" or "must-have" components increase prices on the opposite side, and Carroni *et al*. (2019), who coined the term "superstar" to mention those consumers, find that, if only one platform has those superstars, their prices are higher than competitors, and via network effects, the content variety and the number of other consumers on the same side increases. Intuitively, the presence of a superstar in a playlist may make indie artists more likely to be discovered, thus their opportunity costs are lowered, and their expected profits increased. However, this "expansion" effect implies that the superstar should be compensated, and Carroni *et al*. (2019) find that such compensation can be more than two-thirds of the total surplus created. Hogendorn and Ka Yat Yuen (2009) show that, in some cases, a negative price on those special customers could be optimal for the smallest platform.

Nonetheles, customers may be heterogeneous in more than one dimension. Weyl (2010) shows that when consumers have different transaction and membership values, this bidimensional heterogeneity generates two distortions in the prices. First, the classical markup of the market power, and second, the Spence distortion.[27] He points out that the Spence distortion may increase (reduce) prices, but it depends on the source of heterogeneity, transaction, and membership values. An interesting result derived from the sign of the Spence distortion is that it exists the possibility of mitigating the market power distortion with an opposite Spence distortion. Thus, the harm of market power depends on the source of heterogeneity. For example, in the case of newspapers, it may be the case that, if heterogeneity in willingness to pay for content dominates and is correlated with willingness to pay to avoid advertising, then average readers dislike advertising more than marginals, and the Spence distortion is downward, which mitigates the market power distortion.[28]

A common assumption of the literature is to consider that consumers are preassigned to different sides. However, it may be the case that some consumers may choose on which side they want to be. For example, a user today may prefer to be an Uber driver, but maybe tomorrow she would be a user. Choi and Zennyo (2019) address this case by extending Armstrong (2006)'s model, and they find that asymmetric price structures may arise because some sides may be less favored. Users may prefer to be on one side despite large network effects, and that may lead platforms to offer discounts on the other side to convince users of changing sides. This source of asymmetry in prices may lead to the first best

social welfare with competing platforms. Profit-maximizing platforms adjust their prices to enhance the number of transactions, and in the process, they increase consumers' welfare.

As a summary, customers can be heterogeneous in different ways, which have different implications on the price structure. However, up to now, the study of such heterogeneities has been mainly influenced by classical heterogeneities, but there are open questions regarding new kinds of heterogeneities that are unique to digital platforms that may influence the price structure as well, such as privacy policies or digital literacy. Finally, to outline the key works regarding price structure, Table 2 highlights the essential works.

4. Coordination Problems: Chicken and Egg Problem

A key feature of two-sided markets is that platforms have to be able to attract two or more different types of users that need each other in some way. Thus, the market outcome is shaped by consumers' beliefs about participation on each platform. A digital platform with users but without developers has no future, and the opposite is also true. *The demand on each side tends to vanish if there is no demand on the other side … regardless of what the price is. […] The businesses that participate in these industries have to figure out ways to get both sides on board*, see Evans (2003b). This problem is known as "the chicken & egg problem" in the literature, and it broadly refers to any coordination issue arising from network effects, see Caillaud and Jullien (2001).

The coordination problem appears in the simplest equilibrium definitions. In fact, Caillaud and Jullien (2003) state that the uniqueness of equilibrium is hard to justify in many contexts. In the same vein, White and Weyl (2016) point out that *if platforms charge "flat prices" that are not contingent on opposite-side participation levels, then there is a possibility of multiple equilibria*. Thus, one interesting complication of setting prices in multisided markets is that it is not so easy as setting a mark-up over costs. The price structure has to take into account the participation of all sides. But one side only participates if the other sides do, and vice versa. This feedback loop may create a multiple equilibria problem because consumers' decisions (users) are not isolated from other consumers' decisions (developers). If there are multiple equilibria, and we cannot discriminate among them, we cannot make predictions about the success/failure of platforms. Nonetheless, not all modeling approaches suffer this issue, in many cases, such multiplicity never occurs. For example, when horizontal or vertical differentiation is stronger than network effects. Basically, if network effects are not too large, the coordination game has a unique solution, see Filistrucchi and Klein (2013) and Weyl (2010). On the other hand, when network effects are the dominant force, we may need to face a coordination problem.

There is no universal way to deal with the chicken and egg problem in the multisided literature. There have been proposed different approaches, the earliest one was based on expectations or beliefs. If the participation of one group depends on the participation of another group, an intuitive and direct way to solve the problem is by paying attention to how those groups believe the other group would behave. *Whether agents will coordinate on the positive participation level or not depends on their beliefs about what the other side is doing. Thus, beliefs matter and agents only participate if they are confident in the participation of the others*, see Jullien (2005). Intuitively, given a price and expectations, customers in one group can perfectly forecast what other customers in other groups will do, and they will coordinate themselves in the equilibrium that is the best for them. This approach is used to discriminate among equilibria in many works, such as Caillaud and Jullien (2001), Caillaud and Jullien (2003), Doganoglu and Wright (2006), Hagiu (2006), Bakos and Katsamakas (2008), Chao and Derdenger (2013), and Economides and Tåg (2012). However, White and Weyl (2016) point out that it is a risky bet to focus only on consumers' ability to coordinate among themselves. In their vision, although this solution to the coordination problem is a satisfactory one because it allows us to discriminate among equilibria, it implies that consumers can coordinate among themselves almost perfectly, which is not realistic.

Table 2. Essential Works by Dimension and Topic.

Multisided dimensions	Topics	Articles
Price structure	General pricing rules	Rochet and Tirole (2003), Rochet and Tirole (2006), Armstrong (2006), Caillaud and Jullien (2001), Caillaud and Jullien (2003), Weyl (2010)
	Multihoming and bottleneck competition	Armstrong (2006), Armstrong and Wright (2007), Belleflamme and Peitz (2019a), Doganoglu and Wright (2006), Jeitschko and Tremblay (2014)
	Imperfect information	Hagiu and Hałaburda (2014), Belleflamme and Peitz (2019b), Peitz *et al*. (2017), Sun (2018)
	Taxation	Kind *et al*. (2010), Kind *et al*. (2008), Kind *et al*. (2009), Kind *et al*. (2013), Kind and Koethenbuerger (2018), Belleflamme and Toulemonde (2004)
	Heterogenity	Weyl (2010), Jullien and Pavan (2019), Carroni *et al*. (2019), Rochet and Tirole (2003)
Network effects	Expectation-based approach	Caillaud and Jullien (2001), Caillaud and Jullien (2003), Jullien (2005), Doganoglu and Wright (2006), Hagiu (2006), Bakos and Katsamakas (2008), Chao and Derdenger (2013), Economides and Tåg (2012)
	Focality approach	Halaburda and Yehezkel (2019), Jullien (2011)
	Divide-and-conquer	Caillaud and Jullien (2001), Caillaud and Jullien (2003), Amelio and Jullien (2012), Jullien (2011), Jullien (2005), Parker and Van Alstyne (2005), Evans (2003b)
	Insulating tariffs	Weyl (2010), White and Weyl (2016), Cabral (2019)
	Coalitional razionability	Ambrus and Argenziano (2009)
	Ownership structure	Rysman (2009), Evans *et al*. (2008), Evans (2011)
Property rights	Merchants vs platforms	Hagiu (2007), Hagiu and Wright (2015), Hagiu and Wright (2019)
	Open source and not-for-profit platforms	Rochet and Tirole (2003), Hagiu (2004), Choi and Zennyo (2019), Economides and Katsamakas (2006)
	Optimal ownership	Bakos and Katsamakas (2008), Ambrus and Argenziano (2009)
	Partial/total integration	Kind *et al*. (2016), Nocke *et al*. (2007), De Corniere and Taylor (2014), Jullien and Sand-Zantman (2019)

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Ambrus and Argenziano (2009) state that *if there are lots of small consumers in the market, then it is practically impossible for them to get together and make explicit agreements on network choices*. They propose a way to overcome the coordination problem without assuming the consumers' ability to coordinate themselves. A noncooperative solution concept that assumes *players can coordinate to restrict their play to a subset of the original strategy set if it is in the interest of every participant to do so*, they called it: "coalitional rationalizability." However, this solution still requires assuming that consumers can coordinate their decisions to some degree and, in the case of small consumers, that is not realistic.

Other authors have considered that the multiplicity problem relies on timing. If the problem is to attract both sides at the same time, platforms may be interested in changing the timing. That is the proposal to overcome the coordination problem developed by Hagiu (2006). He proposes a model in which software developers arrive before consumers. This asymmetry in timing mitigates the coordination problem on the consumers' side, but it does not mitigate it on the developers' side. However, because it relies on customers' expectations, it suffers the same drawbacks that we described before.

On the other hand, White and Weyl (2016) point out that pricing policies may solve this problem even among heterogeneous consumer groups. Their idea is based on preliminary results of Rochet and Tirole (2003) and Armstrong (2006), in which platforms commit to offering consumers a particular level of utility, thus giving them a dominant strategy. The coordination arises because platforms adjust their price in response to changes in the number of users on the other side, fully insuring users against any change in their utility. Thus, coordination emerges not because consumers have some intrinsic ability to coordinate themselves but because platforms give them a dominant strategy. But both cases have two limitations. First, they rely on a particular preference structure. Second, users are unidimensionally heterogeneous. If users are heterogeneous in more than one dimension, it is not possible to give all consumers a dominant strategy with a uniform price.

Weyl (2010) proposes a model in which users on one side can be heterogeneous along two dimensions, interaction and membership values.[29] To address the coordination problem, Weyl proposes the "insulating tariffs" concept. The basic idea to overcome the coordination problem is to assume that platforms choose user allocations (and not prices) to maximize some objective function. In that way, prices are an insurance instrument of utilities. Platforms charge a price on each side, fixing a utility level, which gives users a dominant strategy. In this way, prices are a function of the number of participants so, from the consumers' point of view, they are isolated from participation on the other side. Following the previous works, White and Weyl (2016) propose the "residual insulating tariffs" as a solution to the coordination problem that is a generalization of Insulating Tariff to environments with rich preference heterogeneity. Despite being a formal and elegant solution, there are not many works in which insulating tariffs are applied. One reason is that the results cannot be compared with works based on other frameworks—see Belleflamme and Toulemonde (2018)—and, in contrast, in the vast majority of models in this literature, platforms set prices and assume a specific allocation of users.[30]

Cabral (2019) criticizes this approach by pointing out that platforms cannot fix a utility level on one side that is independent of the size of the other side because *the platform does not "insure" agents, rather the platform "subsidizes" early adopters to compensate for the low utility of joining the platform at that stage*. However, White and Weyl (2016) argue that *there is an exact correspondence between equilibrium prices in the [Cabral's] dynamic model, and insulating prices in the static [White and Weyl's] model*. However, the idea proposed by Cabral is intuitively closer to the actual managerial practices. In fact, subsidizing early adopters could be understood as the dynamic equivalent of the Weyl's insulating tariffs. Cabral argues that the platform has to subsidize early adopters to compensate them for the low utility of joining the platform at an early stage, or in other words, to compensate them for the low number of other customers on the platform. Therefore, the nature of the coordination problem is independent of the static/dynamic approach. However, the dynamic approach opens new questions that cannot be addressed with static models.

On the one hand, dynamic models allow us to address the growth over time, and therefore, to consider which are the best strategies to get customers on board. In this sense, a usual pattern of platform growth is when the number of users on both sides increases in tandem, see Cabral (2019). In that sense, Filistrucchi *et al*. (2013) state that *it is also fundamental for the platform to attract the different sides in the right proportion*. On the other hand, dynamic models allow us to address the critical mass problem. Evans and Schmalensee (2010) study this issue, and they find that when the critical mass is reached, the positive feedback between the sides drives the market to equilibrium. Nevertheless, the critical mass depends on prices charged, platform features, agent's tastes, etc. These characteristics can modify the critical mass and the stability of the platform.

Nonetheless, instead of focusing on consumers' ability to coordinate, we can focus on platforms' ability to influence beliefs. This is the starting point of focality advantage, which is attracting attention recently. In a broad sense, focality is an incumbency advantage based on consumers' expectations. Intuitively, the idea is that platforms can "influence" customers into thinking that only some equilibria are possible. This advantage implies that, in some unspecified way, a platform can signal consumers that other consumers will join the platform as well, see Halaburda and Yehezkel (2019).[31] However, this concept is rather general, and its definition does not identify how and why this focality emerges. It could be a consequence of branding, reputation, advertising, or other investments. From a practical point of view, the matching technology of the platform could constitute a focality advantage too. Currently, this is the main limitation of this approach because it relies on assuming an exogenous and ill-defined effect to limit the set of potential equilibria. For example, Halaburda and Yehezkel (2019) argue that the success (failure) of Apple (Windows Phone) could be attributed to focality. Apple succeeded because users were buying new and expensive phones even though developers had not developed apps to support all the new features, but users anticipated all those potential benefits. On the other hand, users and developers were skeptical about whether Windows phone could attract consumers from Google or Apple and developers to a platform not different from the others. How those users anticipated all those potential benefits, or how developers became skeptical is not explained. This approach simply assumes that Apple had an exogenous advantage with respect to Windows.[32] At first glance, this approach seems to be similar to the "coalitional rationalizability" in the sense that both reduce the set of equilibria. However, focality relies on assuming that some equilibria are unfeasible because of some exogenous features of platforms, while "coalitional rationalizability" relies on customers' ability to coordinate themselves. The appealing feature of this approach is its simplicity. In contrast with coalitional rationalizability, focality does not require defining a new noncooperative solution concept but just to exclude some equilibria based on an exogenous criteria. Hitherto, this is a promising approach that provides satisfactory answers to why low-quality platforms end being the market winner, even when a high-quality platform is present, see Jullien (2011) or Halaburda and Yehezkel (2019). However, it is necessary to address how and why this advantage arises. Only addressing these questions we can understand the role of platforms' characteristics in cases like the example of iPhone and Windows Phone.

Another intuitively appealing way to overcome the coordination problem is the "Divide and Conquer (DC)" strategy, which was also proposed by Caillaud and Jullien (2001) and Evans (2003b). *[…] [One way to get both sides on board is] to obtain a critical mass of users on one side of the market by giving them the service for free or even paying them to take it*, Evans (2003b). This strategy requires dividing the market between a profit side and a loss side to "conquer" the market. It creates an incentive to join the platform on the loss side, and given the network effects, it creates an incentive on the other side to join the platform. Nonetheless, this strategy has two immediate consequences in markets: It helps reduce barriers to entry, and it increases competition and forces one of the platforms to renounce exploiting network effects, thereby not serving one side, see Jullien (2011). Although this strategy does not completely remove the possibility of multiple equilibria, it can limit the cases in which it appears.

Despite the theoretical discussion about the different ways to discriminate among equilibria, this strategy seems to be closer to real managerial practices like social networks (Facebook, Twitter,

Instagram, etc.), sport apps (MyFitnessPal, Endomondo, etc.), or real state platforms. Some users have the service for free, while others pay for the service. Although intuitively appealing as a way to solve the coordination problem, there are also other problems when giving a product for free. Jullien (2005) argues that the coordination problem is mitigated but, sometimes, it is difficult or dangerous to subsidize users because it can attract users without their commitment to using the platform. This possibility creates both the adverse selection and moral hazard problems that are studied by several works, such as Armstrong and Wright (2007) and Parker and Van Alstyne (2005). In fact, Parker and Van Alstyne find that there is another problem because, sometimes, it is not clear on what side a platform should charge positive prices, which may be risky in environments with demand uncertainty, and accounting for that risk may reduce the effectiveness of the DC strategy, Jullien (2011). Therefore, the consequences can be critical because we can attract a mass of users only because there is a subsidy. One way to overcome this problem is by offering a free complementary product instead of a negative price. One example is Microsoft, it subsidizes developers by giving them the Microsoft Application Programming Interfaces (APIs) for free, which only developers value. So, there is no adverse selection problem because it attracts developers only. In that way, platforms may avoid attracting undesirable customers (free-riders that only want the subsidy), see Amelio and Jullien (2012). Therefore, bundling/tying plays a role as a coordinating device that may mitigate the multiple equilibria problem, see Jullien (2005), Parker and Van Alstyne (2005), Choi (2010), or Chao and Derdenger (2013).[33]

Finally, other authors argue that *it is more natural to observe firms begin with a one-sided model and switch to a two-sided model as they become more established. Doing so allows potential platforms to overcome the "chicken-and-egg" problem*, see Rysman (2009). Evans *et al*. (2008) argue that expectations about the ownership of control rights are essential. If users believe that a platform is going to change its strategy toward integration, it sends a message that the market is not going to fail in providing that good/service. But also, it sends a message that competition will be more aggressive on one side and, therefore, profits will be lower. Additionally, this problem is not the same for all firms, *[…]. The start-up problem is particularly difficult for firms that are based on multisided platforms. In addition to the usual problems faced by new firms they often must contend with the well-known chicken-and-egg problem. […] Little attention has been given to critical issues that entrepreneurs must solve to create a viable platform business*, Evans (2011).

Additionally, in the case of digital platforms, intellectual property (IP) policies and openness of platforms have become a new promising field in which the literature can make significant contributions because the coordination problem may arise as a consequence of how IP rights are allocated. But up to the date, no work has yet analyzed the multiplicity of equilibria under this approach. Only Parker and Van Alstyne (2018) have addressed these issues but in a monopolistic framework. Finally, to outline the key works regarding network effects and coordination, Table 2 highlights the essential works.

5. Control Rights and Ownership Structure

One of the three pillars that define multisided markets are the control rights. If a company takes control of the sellers' goods to resell them to buyers, that firm is a merchant. On the contrary, if the company leaves that control to sellers and simply allows buyer and seller access to a common marketplace, that may constitute a platform. Although this differentiation between these two schemes is (more or less) clear, it gives rise to other questions: When is optimal to be a merchant or a platform? Is there something between these two schemes?

A priori, it is not clear whether a company has to provide only the platform, or it has to control the intermediation too. Nonetheless, companies are living entities that can change their organization/ownership over time. Hagiu and Wright (2015) use as an example the case of Amazon and Zappos. Amazon started off as a one-sided retailer platform but, it has moved to a two-sided platform scheme. On the other hand,

Zappos has gone in the opposite direction. Therefore, those structures are not immutable, and if the market conditions change, the ownership structure may change as well.

In this regard, Hagiu (2007) states that *the merchant mode is strictly preferred to the two-sided platform mode whenever there is a positive probability that seller expectations are unfavorable [about the platform adoption]. It is easier (cheaper) to convince sellers to sell their products outright than to affiliate to a platform and sell the products to consumers themselves, because the first option eliminates coordination issues […] there is a trade-off between the merchant mode and the two-sided platform mode […] between higher costs of managing more products and higher costs of convincing sellers to affiliate. This suggests that intermediaries, especially for new goods, will generally start under a merchant format and, as sufficient sellers become affiliated, move towards a more "open," platform mode, which is cheaper per seller and thus allows intermediaries to offer a broader variety of products*, see Hagiu (2007).

On the other hand, from the workers' point of view, Hagiu and Wright (2015) compare the incentives of some workers to be employed by a platform as freelancers or as regular employees. They find that there is no a first-best solution. There is not a better structure than the other. There is always a trade-off between the incentives (and the risk) that people have when their salary depends only on their performance and the safety of a fixed salary. And this trade-off also impacts on the performance of the platform because the incentives to work when you have a fixed salary are different from those based on the day-to-day performance. In other words, there is no an "always better" ownership structure, either from the workers' point of view or the platforms' point of view. Recently, Hagiu and Wright (2019) consider this issue from the regulators' point of view. They address the consequences of misclassificating workers as employees when they are independent contractors, and vice versa. They find that any misclassification leads to a loss of welfare. Therefore, a nonrigorous regulator may inflict a welfare loss because of a wrong misclassification. On top of that, an additional complication is that between pure merchants and two-sided markets, there is a continuum of ownership structures that depend on the allocation of control rights over the decision variables.

As well as there are profits and non–for-profits merchants, there is a similar distinction for platforms too. In this sense, Rochet and Tirole (2003) find that non–for-profits platforms need not generate an efficient outcome because the non–for-profits platforms do not internalize the end-users' surpluses. In a similar vein, Hagiu (2004) analyzes the case of open source and proprietary platforms, and his results suggest there is a welfare trade-off between open source and proprietary platforms. A proprietary platform creates a dead-weight loss as a consequence of monopoly pricing, but an open-source platform does not internalize indirect network effects, so there is no obvious way to determine which ownership structure creates a higher level of product variety, adoption, or welfare. The preference for one or another is not justified economically in his model. In other words, there is no unambiguously superior ownership structure. There are economic trade-offs that need to be taken into account. On the contrary, Choi and Zennyo (2019) find that profit-maximizing platforms may yield a higher social surplus than open platforms with free access because proprietary platforms can use price mechanisms to incentivize consumers to change sides. Nonetheless, they argue that such a result relies heavily on their Hotelling specification.[34] Economides and Katsamakas (2006) argue that, when proprietary and open-source platforms compete, the proprietary ones tend to dominate in terms of market share and profitability, a point that is also shared by Cabral (2019), but who argues that depends on the assumed homogeneity. This is a consequence of the fact that an open-source platform cannot adopt two-sided strategies because this ownership structure imposes a null price on at least one side and a nonprofit behavior, which could always be replicated by a proprietary platform.

Additionally, proprietary platforms can be organized in different ways depending on how the value created is allocated, in other words, it depends on who owns the platform. Bakos and Katsamakas (2008) study the optimal ownership structure of multisided platforms, and find that *the optimal ownership is always ownership by the side that enjoys the strongest network effect from the participation of the other side*. In a similar vein, Ambrus and Argenziano (2009) highlight that, sometimes, it is optimal to split

monopolies into two platforms but under common ownership. The idea is to adopt second-degree price discrimination because, in that way, users coordinate by themselves (higher and lower quality lovers). However, a monopoly network without price discrimination is the most profitable strategy when there is no differentiation among agents.

Finally, it is common to assume that providers and clients are the two sides that the platform is linked to. However, sometimes the platform does not interact with one of those sides directly, and in other cases, one of those sides could be integrated in the platform totally or partially. The first case implies a disconnection with the network effects on one side, which raises a new concern, the interfirm price coordination. Kind *et al*. (2016) address this issue and find that platforms face two conflicting needs: the need for intrafirm coordination (internalization of network effects) and the need for interfirm price coordination (internalization of the competitive pressure). When products become more homogeneous, competition raises because the interfirm price coordination dominates intrafirm coordination. Thus, platforms prefer letting an independent firm set prices on one side to reduce competition between platforms on that side. Although this situation could lead to a cartel-like outcome in one-sided markets, it may not be the case in two-sided ones because the interfirm coordination prevents intrafirm price coordination. However, their model is rather specific, and it focuses on the TV distribution schema. It is still unknown whether or not those results hold in more general settings.

The second case represents an example of vertical integration, which is quite common in digital markets. For example, Netflix offers both own films and series along with a platform for third-party films and series. Vertical integration eliminates the double marginalization problem, as it happens in one-sided markets, and it may also lead to a better internalization of externalities, see Jullien and Sand-Zantman (2019). However, integration may lead to own content bias, but the internalization of consumers' decisions on the other side generates a countervailing effect that promotes a larger variety. For instance, Nocke *et al*. (2007) find that if the platform integrates some agents on one side and later excludes some potential entrants on that side, that is detrimental to welfare when network effects are weak, but welfare-enhancing if network effects are strong. Therefore, the effect of vertical integration is ambiguous in two-sided markets, see De Corniere and Taylor (2014). In the end, platforms face a trade-off between maximizing its long-run value and short-run profits through the integration, see Jullien and Sand-Zantman (2019).

As a summary, there is a continuum of ownership structures between platforms and merchants that are underexplored. The literature has focused on extreme cases, and it has shown that there is a lot of ambiguity. Nonetheless, there is a lot of work to be done in this area, especially, on the allocation of IP, and the different integrated/disintegrated structures that may be plausible. Finally, to outline the key works regarding property rights, Table 2 highlights the essential works.

6. Market Structure and Competition Policy

Do platforms tend to become natural monopolies over time? Should platforms be left under current regulation and ex post antitrust scrutiny, or they require new regulations and procedures? Currently, these two questions have attracted the attention of both scholars and practitioners alike. This open debate has given rise to a rich body of literature but an exhaustive analysis of the whole literature around these two topics deserves a specific literature review. However, in the following sections, we provide a general view of the current debate on these issues. In the first section, we address the incumbent-entrant relationship and the practices that have raised the concern of public authorities, such as exclusive contracts. In the second section, we make a quick review of the common and specific areas of literature in multisided markets regarding competition policy, and we illustrate the current debate on the application of competition policy in multisided markets.

6.1 *Entry the Market and Tipping. The Winner Takes All?*

A common myth about multisided platforms is that markets tend to become monopolies as a consequence of the network effects. Nowadays, this thought has become popular because of the rise of social networks, such as Facebook, Twitter, or LinkedIn. However, there is no clear evidence supporting this line of thought. In fact, there are examples in the opposite direction, such as Uber versus Lyft, Uber Eats versus Just Eat, or Deliveroo versus Glovo. A general perception is that, because of network effects, incumbency advantage creates some barriers to entry that make monopolies more likely. Jullien and Sand-Zantman (2019) point out that three elements prevent a market with network effects from being a natural monopoly: the existence of stand-alone value, the possibility of multihoming, and the existence of compatibility. On top of that, they highlight that dynamic competition considerations may contribute to weakening incumbency advantage. The prospective benefits of gaining future incumbency advantage for a superior quality entrant are larger than the prospective benefits of the lower quality incumbent. Hence, a forward-looking entrant may be willing to sacrifice more in the current competition, thus, forcing the incumbent to sacrifice all their profits to keep its position, see Caillaud and Jullien (2003).

In this sense, White and Weyl (2016) state that the owner of a better technology must have two preconditions to replace an incumbent and to avoid a failure in the launching. First, the platform must be sufficiently well capitalized to finance subsidies to consumers. Second, it must be sophisticated enough to manage consumers' coordination. In that sense, three elements that create incentives to enter and isolate the influence of competitors are differentiation, compatibility, and segmentation, see Jullien (2005) and Belleflamme and Toulemonde (2004). Additionally, Jullien (2011) highlights that market typology also matters. In pure intermediation markets, barriers to entry are more likely than when platforms offer some value beyond the connectivity to a network. In this respect, Caillaud and Jullien (2003) raise an interesting question: *To what extent will established firms use exclusivity to deter entry?*

Exclusive dealing has long been a controversial practice under the antitrust law, and multisided literature is not an exception. Intuitively, exclusive contracts may be used to protect monopoly power and exclude potential competitors, see Doganoglu and Wright (2006). For example, it may be used to mitigate multihoming by forcing customers to choose one platform, which may lead to monopolization, see Armstrong and Wright (2007). Jullien and Sand-Zantman (2019) conclude that, although exclusivity could be exclusionary, it raises less concern in the case of platforms. Even without efficiency gains, exclusivity may not be motivated by the exclusion of competitors but rather by the maximization of profits. But exclusive contracts also have implications for consumers on all sides. Belleflamme *et al*. (2020) review recent works on exclusivity, and they highlight that when platforms find profitable to impose exclusivity, it damages at least one side.

In a similar vein, Carroni *et al*. (2019) study whether the presence of an agent that generates large externalities on the other side (a superstar) may also convince agents on the same side to stop multihoming and join the platform exclusively. Because more agents singlehome on the superstar side, that attracts more demand, which attracts more agents on the superstar side, and so on. But gaining exclusivity with the superstar is costly, and they find that platforms only consider exclusivity when the competition is strong on the opposite side of the superstar. Surprisingly, this exclusivity may benefit agents despite that it may lead to a monopoly market. Although superstar exclusivity increases welfare relative to its absence, some agents are worse-off, for example, singlehoming consumers on the platform without the superstar. Nonetheless, the overall effect is an increase in welfare because the superstar induces some agents to enter the market.

But, under which circumstances can we expect exclusive contracts? Caillaud and Jullien (2003) provide the first answer by pointing out that such contracts depend on the quality of the matching technology of the incumbent w.r.t. the entrant. Hogendorn and Ka Yat Yuen (2009) use a Cournot model and highlight that the must-have component providers will prefer to sign an exclusivity contract when

compatibility is low, and the size assymetry in terms of market share between platforms is high, and Carroni *et al*. (2019) expect such exclusivity when differentiation is low.

More generally, platforms can make strategic investments to deter entry, exclusive dealing could be a specific case in which platforms invest in creating lock-in, but there may other potential deterring investments. Farhi and Hagiu (2008) adapt Fudenberg and Tirole's typology of strategic interactions to multisided markets to study how those interactions may influence the market structure. We can have four strategies based on the effects of investment on the strategic variable (prices or quantities) and the relationship among these strategic variables (whether they are strategic complements or substitutes). Intuitively, an investment that reduces an incumbent's marginal cost can only hurt the entrant and benefit the incumbent. But what the authors prove is that, in a multisided market, *a cost-reducing investment by one firm can both increase the profits of its rivals and be desirable for the firm undertaking the investment […]. The set of strategic configurations in a two-sided market is strictly larger than in a one-sided market*, Farhi and Hagiu (2008). Therefore, other strategies that deter entry in one-sided markets may not have the same effects on multisided markets, which opens the door to the careful application of traditional insights.

Nonetheless, most of the analysis so far comes from the difficulty for a newcomer to overcome the incumbent position in "traditional cases." But there are other factors to take into account, for example, backward compatibility or data usage. Many digital platforms are built on top of other previous platforms or technologies. In this sense, a critical question is to what extent backward compatibility may influence the market equilibrium. To the best of our knowledge, there is only one work that addresses this topic despite its relevance. Tremblay (2017) finds that when an entrant and the incumbent with backward compatibility have the same technology, the incumbent will drive the entrant out of the market. However, if the entrant has a technology advantage, three scenarios are possible. Either the incumbent sets low prices to deter entry, or the entrant has superior technology and sets prices with mark-up, or the incumbent is expelled from the market. Concerning data usage, past consumption may allow platforms to reduce search costs for consumers, creating a new incumbency advantage.[35] Therefore, policies aiming at data portability may influence incumbency advantage and competition, but so far, the impact of data portability on platform competition is an open question that is starting to be addressed. To the best of our knowledge, the closest work in addressing this issue is Lam (2017). She finds that the strategy of lowering prices on one side is not only due to network externalities or consumer's characteristics but also due to switching costs and the dynamic nature of the model. She argues that switching costs could be procompetitive in some circumstances. Therefore, policies aimed at facilitating switching, such as data portability, may end up limiting competition.

6.2 *Competition Policy and Antitrust Literature of Multisided Markets*

A fundamental issue for competition policy nowadays comes from the lack of proper competitive benchmark for activities involving large demand externalities, such as network effects. Without demand externalities, the perfect competition provides the normative benchmark, but with demand externalities, prices may not reflect costs, and costs may not internalize the effect on other consumers' decisions. For instance, Kind *et al*. (2008) show that platforms might over- or underinternalize indirect network effects, which depends on the relation between the average indirect network effect and the marginal indirect network effect, and the platform only accounts for the latter in its pricing decision. This does not mean that traditional analysis never applies to platforms, but that we should be cautious, see Jullien and Sand-Zantman (2019).

There is a growing interest in how competition authorities have to address multisided platforms because, in some cases, it is possible to find optimal prices below marginal costs, socially optimal monopolies, competitive tying/bundling, etc, see Filistrucchi *et al*. (2013). In this section, we do not try to make an exhaustive analysis of the development of the antitrust policies regarding multisided markets,

but to present another field that is attracting the attention of researchers. More exhaustive analyses can be found in some of the cited papers.[36]

Evans (2002) points out that it is essential to consider network effects in the antitrust analysis because they create externalities that make the one-sided analysis no longer suitable. This is a broadly shared opinion among scholars who consider that relying on one-sided logic may lead to mistakes, see Filistrucchi *et al*. (2013), Goos *et al*. (2011), or Lam (2017). For example, the identification of market power may not be related to the markup over cost. *In the traditional analysis of oligopoly, market power is identified by a large markup over cost. But […] platforms may exhibit strong price skewness with some sides being charged low or zero prices and others being charged relatively high prices. That implies that observing a high markup on one side […] need not reflect strong market power*, see Jullien and Sand-Zantman (2019). Additionally, market power is a capacity and not a behavior. Platforms have multiple sources of revenue and may choose not to exploit their market power on one side. Thus, authorities have to choose between defining a common market for both sides, or separate markets for each side. Depending on the choice made, the consequences for antitrust enforcement may differ significantly, as we explain later in this section.

Following those ideas, the first contributions in the literature developed extensions of traditional one-sided tests to address the multisided nature of platforms. One of the first is Filistrucchi (2008), who proposes a modification of the SSNIP test to identify the relevant market in two-sided markets. Filistrucchi highlights the complexity of adapting this one-sided tool to two-sided markets. *In a two-sided market, the profits of the hypothetical monopolist are determined by both, the price level and the price structure. It is not a priori clear whether the hypothetical monopolist should be thought of as raising*:

(1) *the price level while optimally adjusting the price structure*.
(2) *both prices together keeping fixed the price structure*.
(3) *each of the two prices separately allowing the other price to be adjusted optimally*.
(4) *each of the two prices while keeping the other price fixed*.

Answering these questions requires using Filistrucchi's taxonomy of two-sided markets (see Section 2.1). In a "payment card" market, the hypothetical monopolist would increase the price level and optimally adjust the price structure. In a "media" market, that is not true, and the hypothetical monopolist would increase each one of the two prices separately while optimally adjusting the price structure. However, Evans and Noel (2008) also distinguish between short- and long-term effects of the price increase, but Filistrucchi does not think in that way, who states: *the distinction is probably useless from a practical point of view in the case of SSNIP test*, see Filistrucchi (2008).

Filistrucchi also highlights that nontransaction markets tend to be more complicated than transaction markets. Nontransaction markets require a more extensive analysis of which feedbacks we should take into account. On the other hand, the profits in transaction markets come from the transactions, in which all the externalities are included. Following this idea, Filistrucchi and Klein (2013) point out that, if we study a nontransaction market, it has to be considered as two interrelated markets. Whereas in payment card markets, we have to define only one market because in these markets there is a basic service (the transaction) that is linking both markets.[37] Contemporaneously to Filistrucchi's work, Evans and Noel (2008) propose a two-sided framework for the Critical Loss Analysis and SSNIP test, and they find that:

(1) the bigger the network effects, the larger the biases.
(2) one-sided approaches underestimate merger effects.[38]

Other interesting works that have contributed to extending traditional one-sided tests are Weyl (2010), that proposes an extension of his model to measure the market power and to evaluate predation; Behringer and Filistrucchi (2015) that extend the Areeda-Turner rule to two-sided markets; and White and Weyl (2016),

who make recommendations about estimating discrete choice models and upward pricing pressure (UPP) tests.

Apart from modifying one-sided tests to address the multisided nature of platforms, another two topics that have attracted the attention of scholars are market collusion and bundling/tying.[39] With regard to market collusion, only a few works have explicitly addressed it, such as Ruhmer (2010). Collusion in two-sided markets is more complex and harder to detect because collusion may occur on all prices, but sometimes only on prices on one side, and the characteristic price skewness may favor colluding on one side only. However, network effects make collusion harder to sustain too. For example, Ruhmer (2010) finds that the higher the network effect, the harder to collude in repeated games with a grim trigger strategy. But when collusion is possible, its consequences vary depending on whether or not some consumers multihome. With singlehoming, all consumers are hurt, but when multihoming on one side leads to monopoly prices on that side, collusion has no effect on them; or if collusion occurs on only one side, prices on both sides react in opposite directions, which imply that some consumers may benefit from collusion, see also Correia-da Silva *et al*. (2019). Another interesting related work is Boffa and Filistrucchi (2014). They argue that there is a similarity between collusion in two-sided markets and collusion in one-sided markets with complementarities. They find that in some cases, it may be profitable for the cartel to set quantity levels lower than monopoly levels. When platforms cannot coordinate on the monopoly outcome, the cartel can coordinate on pseudo-competitive outcomes, thus, raising the cost of deviation from the equilibrium. More recently, Lefouili and Pinho (2020) have shown that collusion in two-sided markets may harm some consumers but benefit others.

Concerning bundling/tying, the motivations for bundling/tying in multisided markets differ from the usual ones in classical markets, and also the consequences. For example, in classical markets, these strategies have been used as a tool to price discriminate and hence extract consumer surplus more efficiently; or to deter entry in both the tied and the tying good's market, see Affeldt (2011). In contrast, Farhi and Hagiu (2008) and Affeldt (2011) find that tying is unlikely a barrier to entry because tying platforms in multisided markets have an incentive to compete *softly*. After all, it could be profitable for both incumbent and entrant. In multisided markets, tying allows platforms to perform a better balancing between sides, which may increase social welfare, Rochet and Tirole (2008). In this regard, Choi (2010) studies the tying strategy and finds that the effect on welfare depends on the relative strength of externalities and the level of differentiation. This ambiguous result in terms of welfare is also found by Amelio and Jullien (2012). In general, in welfare terms, tying has ambiguous effects, and it depends on parameter values and whether or not some customers multihome. Lastly, another common intuition from classical markets is that bundling/tying can serve as price discrimination tools and thus help firms to extract more consumer surplus. The welfare effects of bundling and tying in classical markets as a price discrimination tool are ambiguous. They increase producer surplus as they are adopted as a profit-maximizing strategy, but the effects on consumers are not a priori clear though. Chao and Derdenger (2013) find that, in multisided markets, the motivation to price discriminate is consistent in both market structures, but the consequences are different. For instance, it is also true that bundling provides the platform an additional instrument to extract consumer surplus, but the overall welfare increases because prices on both sides of the market are lower.

Jullien and Sand-Zantman (2019) point out that we should also pay attention to new concerns that are specific to platforms, for example, the net neutrality debate.[40] The evidence is unclear, and different authors have found a rationale for both regimes. For example, Njoroge *et al*. (2013) argue that the nonneutral regime is the best option for consumers and content providers, and it also leads to higher social welfare. On the other hand, Economides and Tåg (2012) find that indirect network effects provide a rationale for network neutrality regulation, but only for some parameter values. In the duopoly case, they find that platforms prefer the neutrality regime, but the opposite is true in the monopoly case. From a theoretical point of view, it is not clear whether or not the neutral regime is better than the nonneutral regime. Therefore, there is room for further research. Additionally, given the FCC's decision of revoking

net neutrality in the United States, there is an opportunity to empirically address the consequences of such a decision.

Nonetheless, the use of multisided literature in antitrust cases and public policy is not exempt from critics. There are two open issues already: the definition of multisided platforms and the role of nonprice competition. As we have pointed out in Section 2, there is no consensus on how to define a multisided platform. Therefore, there is no consensus on how to address the relevant market or how to evaluate competitive harm. Although our proposal of Section 2 may be a first step in identifying multisidedness and addressing these issues, it relies on relevant implicit assumptions that limit its use. In this regard, it is important to realize that "multi-sidedness," as described in this work, is a static, demand-side view of platform competition, which fulfills a specific need in competition policy but that falls short if we want to define platforms for other purposes, such as for innovation policy. In this case, it would be relevant to take into account the governance of the ecosystem. For example, the governance influences the effective competition within the sides, which, if excessive, may lead to further contractualizing the relationship moving away from the canonical platform market to a supply-chain one.[41] Concerning nonprice competition, a common feature of multisided markets is gratuity, which generates difficulty for antitrust analysis. Gratuity raises the level of complexity because of the locus of competition shifts from prices to the nonprice competition, an area in which no well-established measure of quality is available, which implies a need to go case-by-case. On top of that, such a gratuity tends to raise privacy concerns, which adds a further complexity because, in some instances, privacy may be a strategic variable that public authorities must take into account, see Casadesus-Masanell and Hervas-Drane (2015).

Another interesting question that has attracted attention recently is the interrelationship between the sides. Could it be that the interrelationship is not different than the importance of complementarities in a simple single-sided market? As Wright and Yun (2019) point out, these concerns lead to a competition between two schools of thought. The first school claims that platforms should be addressed in a similar way as traditional single-sided markets. The core justification is that the two sides are not interchangeable, and they do not include the same participants sometimes. Therefore, each side of the market should be considered as a separate market but interrelated with the other markets or sides by complementarities. The other school of thought claims that platforms cannot be considered without taking into account all sides. This school argues that "the relevant market must be sufficiently broad that, if it were monopolized, the monopolist would be able to exercise market power profitably." They use Google as an example. It would be an error to consider the online search tool in isolation because Google is not profit maximizing with respect to the online search tool only.

The recent decision on the Ohio versus American Express case in the United States has pointed out how vivid this debate is because of the divergences between the criteria of the district court and the Second Circuit. Two essential works to understand this conflict are Wright and Yun (2019) and Katz (2019b). The first work supports a more flexible use of multisided theory, and the second one supports a more limited use.

Wright and Yun (2019) argue that we cannot justify paying attention to the prices on one side of the transaction only. However, Katz (2019b) argues that we cannot consider the "transaction" as the unit over which competition occurs because relevant markets are defined as a collection of products that are sufficiently close substitutes. The services offered to each side are not substitutes. Nonetheless, other authors argue that the complementarities between both sides are akin to the left and right shoes. Katz (2019b) argues that this argument lacks to point out that both sides have different interests that may not be aligned.

The practical implication of this debate is that it affects the allocation of the burdens of proof between the plaintiff and the defendant. The first school that claims that the indirect network effects should not be considered out-of-market efficiencies, and therefore, any "prima facie" antitrust assessment of competitive harm must incorporate the impact on all sides. The second school does not support this view.

7. Future Directions

We acknowledge that this is a vibrating and fast-pacing field that generates new evidence each year. However, there are areas in which the multisided literature has open questions. For example, a relevant issue that deserves exploration is competition in nonprice features, as Jullien and Sand-Zantman (2019) or Foros *et al*. (2015) point out. This is a relatively unexplored area that deserves more attention given its potential impact on how we understand platform competition. One recent example is Parker and Van Alstyne (2018). They focus on studying how a monopolist platform should set its IP policies. They consider that such policies depend on two parameters: the openness degree and the length of the exclusivity period awarded to developers to exploit their innovations. This nonprice approach is promising, and the first results point out that non-price features play an essential role in how platforms set their control rights. However, the evidence is quite scarce when we consider oligopolistic settings, and it can be considered unexplored yet.[42] Privacy is another notorious nonprice dimension that is relevant in the competition analysis on the Internet. Casadesus-Masanell and Hervas-Drane (2015) analyze this case by considering the privacy policy as a quality parameter used by homogeneous platforms to compete. They find a rationale for a vertical differentiation scheme in which platforms set different levels of privacy disclosure. In general, the research on nonprice competition is currently an unexplored area that deserves more attention given that it influences from prices to coordinating issues, as Veiga *et al*. (2017) show.

Two other areas of great relevance for public authorities that are yet underexplored are acquisitions of start-up technologies by big companies and the impact of Big Data. On the one hand, these acquisitions normally do not meet the requirements to lead to traditional merger analysis, and the frequent acquisitions by the "Big Five" (Amazon, Apple, Facebook, Google, and Microsoft) have raised concerns about the persistent and increasing market power of some of those firms. To this date, there is some early theoretical evidence that calls for more intervention of antitrust authorities, but this evidence is scarce and does not take a multisided approach.

Motta and Peitz (2020) propose a simple model with two companies in which one company is the big incumbent, and the other one is a small start-up that has an innovative but risky project. They find that mergers are only procompetitive if, without the acquisition, the start-up is unable to pursue its project. As a recommendation, the authors suggest that the burden of proof that the merger is procompetitive should be placed on the merging firms in contrast with current practice. In the same spirit, Bryan and Hovenkamp (2020) show that, given the prospects of acquisition, startups incentive to innovate would be based on the leaders' agenda, which may be inefficient and leads to monopolies. They argue in favor of interventions (compulsory licensing) in situations where a highly dominant incumbent acquires a startup whose technology could plausibly influence competition if rivals are excluded from using it. Although interesting, these results rely on one-sided approaches, and it is yet unknown to what extent these results hold if, for example, the start-up operates on several platforms. In this regard, a new wave of works on multisided platforms focused on the effects of the strategic behavior of agents on the sides is needed. How will a likely-to-be-acquired start-up invest resources when multihoming? How that influences platform competition? Will start-ups compete to be acquired? How? To this date, all those questions are open.

On the other hand, a related issue is the use of data on digital platforms. Some authors have raised concerns because of the idea that the amount of data that platforms gather can create market power beyond the market they operate. Katz (2019a) reviews the literature on big data and antitrust policy and highlights five potential areas that raise concerns: the impact on rivals' costs, predatory conducts, mergers, price discrimination, and privacy. In general, Katz concludes that with the current tools, many of the potential negative effects of data cannot be detected. For example, is a platform limiting their APIs because data are key to the competitor's success, or is it because of privacy concerns? Privacy is a part of the product offering, and therefore, part of the nonprice competition dimension. A related work is Condorelli and Padilla (2020). They analyze the risks of privacy policy tying. This policy requests users to grant consent so that the platform can combine the data users generate when using multiple services.

They identify both procompetitive and anticompetitive effects, but it is not clear which one dominates and when, and it is a topic that is currently open in the multisided literature.

Lastly, an interesting area that is yet to explore is the interrelation between IP and competition laws. Antitrust law aims to promote competition and static welfare. In contrast, IP law permits static welfare losses in exchange for dynamic welfare gains, see Blair *et al*. (2020). Thus, there is an apparent trade-off between both approaches that is of key relevance for public authorities. In recent years, the European Commission has devoted significant resources to The European Digital Strategy,[43] which aims for fostering *a trusting, lawful, and innovation-driven online platforms' environment in the EU*. Thus, there is an urgent need to take into account both approaches because innovation policies influence competition, which is also influenced by competition policy. To avoid unnecessary conflicts between policy objectives, it is necessary an integrative framework.

8. Conclusions

In the last decade, multisided platforms have become a popular topic as a consequence of the emergence of platforms, such as Facebook or Google. However, since the early 2000s, this business model has attracted the attention of many scholars because it seems to defy some of the cornerstone intuitions about markets, such as price below marginal costs denoting predation. In this work, we provide an introduction to the theoretical literature to new readers and an overall view of the current state of this literature to experienced researchers. In that sense, the first question we address is what characteristics these multisided platforms have. We discuss the most relevant contributions in defining a multisided platform, and we identify three essential elements: multiproduct nature, presence of network effects, a specific allocation of control rights. We review how the literature has evolved in considering each one of these features, and how the vast majority of the definitions lacks some essential element, which has led to the current situation in which there is no standard definition. Their identification can be tricky because there is no industry of platforms that allow us to group them all. In this regard, several taxonomies have been proposed depending on specific interests (managerial, competition policy, etc.) but it is a relatively underxplored area. Once we characterized platforms and their typologies, we address why platforms are relevant by pointing out differences with respect to traditional market models.

One of the most recurrent differences is the price structure of multisided platforms, which have attracted the vast majority of the attention. In Section 3, we address the source of those differences. We start by describing the most robust result on comparative statics in the literature, the "Seesaw principle." In other words, *factors leading the platform to choose higher participation on side "i" lead it to choose lower participation on side "j,"* see Weyl (2010). This principle is the source of many divergences with respect to traditional price structure. Nonetheless, the Lerner principles also hold, which leads us to study which other factors that influence price elasticities have been considered in the literature, such as multihoming, information management, taxation, or beliefs. With respect to multihoming, we first address the incentive to do it, and we show recent evidence that highlights that prices on both sides move in opposite directions.

Another essential factor that influences price structure is the available information for both, platforms and customers. On the one hand, platforms set different prices depending on how customers form their beliefs. The larger the market power, the more likely platforms prefer facing informed agents. On the other hand, sometimes is the platform, which is uncertain about the externalities that each side exerts on the other. In this case, current literature provides a rationale for introductory prices. There are two external factors that have been widely studied that also influence price structure: taxation and customers' behavior. Taxation in multisided markets creates quite surprising effects, such as increasing the number of affiliates on both sides, or inverting the asymmetric price structure, or even changing the political views of newspapers. Lastly, customer's behavior is quite an increasing research branch that little by

little is gaining the attention of economists because provides different explanations for the asymmetric price structure.

In Section 4, we address one of the main concerns in the literature: the coordination problem of attracting two or more different types of users that need each other in some way, also known as "the chicken & egg problem." This coordination issue derives from the presence of indirect network effects, which create a feedback loop. Consumers' decisions about whether or not joining a platform are not isolated from other consumers' decisions. This situation leads to the possibility of multiple equilibria, which implies uncertainty about the market outcome. There is no universal way to deal with the chicken and egg problem in the multisided literature, and there have been proposed different approaches. One of the earliest and most popular is based on expectations or beliefs. If the participation of one group depends on the participation of another group, an intuitive and direct way to solve the problem is by paying attention to how those groups believe the other group will behave. However, it is a risky bet to focus on consumers' ability to coordinate among themselves only. Different timings have been proposed as a way of mitigating those coordination problems, but it only mitigates the problem partially. A more satisfactory way of dealing with this problem is the "insulating tariff" proposed by Weyl (2010). The intuitive idea is that coordination emerges not because of consumers having some intrinsic ability to coordinate themselves, but because platforms give them a dominant strategy to do so. These tariffs "insulate" consumers from participation on the other side by providing them a "fixed" utility level. Another way of dealing with the coordination problem is the idea that platforms can influence consumers' beliefs by creating "focal platforms." Focality broadly refers to an incumbency advantage based on consumers' expectations. This advantage implies that when several equilibria are possible, platforms have some kind of advantage that signals consumers that those platforms will attract other consumers, which reduces the potential set of equilibria. Although promising, this approach still does not explain how or why such an advantage emerges.

However, many of the current multisided platforms that we know today were born as one-sided platforms, and they evolved toward multisided platforms over time. This may be another way of dealing with the chicken and egg problem, but it relates to a fundamental point to describe multisided platforms: the allocation of control rights. In Section 5, we analyze the branch of the literature that has focused on comparing different allocations of control rights in multisided platforms, for example, between merchants and platforms, or between open source and proprietary platforms. In the first case, the literature agrees that the merchant mode is strictly preferred to the two-sided platform mode whenever there is a positive probability that seller expectations are unfavorable about the platform adoption. It is easier to convince sellers to sell their products outright than to affiliate with a platform. However, a key conclusion is that there is no an "always better" ownership structure. With regard to open or proprietary platforms, the current evidence shows that a proprietary platform creates a dead-weight loss as a consequence of monopoly pricing, but an open-source platform does not internalize indirect network effects, which implies that there is always a trade-off between the ownership structures. Lastly, the literature has also addressed whether or not one of the sides should control the platform, or whether or not the platform should directly interact with one of the sides. Nowadays, the evidence supports the idea that platforms have to be created by those who benefit the most from attracting the other side, but the evidence in this area is scarce. Similarly, the current and scarce evidence highlights that vertical integration has ambiguous effects in multisided markets, but also that there is a trade-off between the need for intrafirm coordination (internalization of network effects) and interfirm price coordination (internalization of the competitive pressure).

In Section 6, we address two topics: the possibility of monopolization or tipping by platforms, and the main lines of the research in competition policy and antitrust in multisided markets. In the first case, the idea that multisided platforms tend to monopolization is more a myth than a reality. In general, three elements prevent a market with network effects from being a natural monopoly: the existence of stand-alone value, the possibility of multihoming, and the existence of compatibility. Another common myth

is related to exclusive dealing, which has long been a controversial practice under the antitrust law, and multisided literature is not an exception. Intuitively, exclusive contracts may be used to protect monopoly power, but the current evidence highlights that, in multisided markets, it raises fewer concerns. In the second case, we address the current issues of addressing antitrust policies from a multisided perspective. We continue highlighting some areas in which the evidence is scarce, such as collusion or mergers, and we conclude by presenting the current debate on how to address the relevant market or how to evaluate competitive harm. Finally, we conclude in Section 7 by describing some of the most promising areas of research, such as nonprice competition or the new challenges of competition policy in the digital economy. These areas represent the forefront of the multisided platforms literature, and the results so far show that this literature has yet a lot to offer, and many questions remain open.

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Notes

1. In this work, we refer to two-sided platforms, two-sided markets, multisided markets, and multisided platforms as synonyms. We know that this is not true. However, for simplicity's sake, we keep the same language from the original authors.
2. This term was first used in Rochet and Tirole (2003). However, these models had been studied before by Parker and Van Alstyne (2000), Caillaud and Jullien (2001), and Caillaud and Jullien (2003). In the last two works, they refer to the platforms as "cibermediaries." For some authors, the literature was born when the term "two-sided market" is coined. To others, it is when the first paper with interdependent demands between two markets was published. In this regard, the birth is attributed to Parker and Van Alstyne.
3. It depends on the relation between the average indirect network effect and the marginal indirect network effect, see Kind *et al*. (2008).
4. Other examples of these definitions are those of Kumar *et al*. (2010) and Amelio and Jullien (2012).
5. Other similar cases are Wright (2004), Cabral (2019), or Affeldt (2011).
6. What is even more interesting is the link between their definition and the Coase Theorem. In the previous example, couples can negotiate how to divide the price of the tickets. A nightclub in which only couples go would be a one-sided platform. In the credit card market, sellers and buyers cannot coordinate themselves to reallocate their prices, so the Coase Theorem fails. Therefore, the failure of the Coase Theorem is a necessary condition.
7. This literal interpretation has sparked a fruitful discussion about the difference among multisided markets that we address in Section 2.1.
8. Weyl (2010) argues similarly to Rochet and Tirole (2006). He highlights three conditions that must be met to consider adopting a two-sided approach. The failure of any of these conditions makes simpler and better understood other models: There is a multiproduct firm, there are network effects, and there is bilateral market power. However, as it has been previously stated, these conditions miss the one regarding the control of essential terms of the interaction by the end-users.
9. Other authors have considered similar definitions, such as Song (2013) or Filistrucchi *et al*. (2013). The latter also makes an interesting comparison between the Rochet and Tirole's (2006) and Evans's (2003a) definitions.
10. In Filistrucchi *et al*. (2010), we find an example of ambiguity between Evans' and Rochet and Tirole's definitions.

11. See Rochet and Tirole (2006) or Weyl (2010) for other specific cases that break the multisidedness.
12. The current debate about public intervention in this context is symptomatic of this. As Jullien and Sand-Zantman (2019) point out, the mere presence of network effects does not call for specific interventions, but it is its relative strength, which calls for different approaches. In the same spirit, Hagiu and Wright (2015) highlight that between multisided platforms and resellers, there is a continuum of potential business models, which further emphasizes that, in reality, we could observe several degrees of multisidedness that may require different interventions. Thus, an open question is to determine which degree of multisidedness is necessary to call for specific public intervention.
13. In Section 6.2, we address the relevance and current discussion around this topic.
14. Even a monopoly may set prices under marginal costs, see Caillaud and Jullien (2001), Caillaud and Jullien (2003), or Schiff (2003).
15. *Optimality will call for subsidies, […] and one should subsidize more the less profitable side of the market*, Jullien (2005).
16. A wider and more general view of platform differentiation from an empirical point of view can be found in Cennamo and Santalo (2013).
17. Later, Weyl (2010) states that the Seesaw principle was the most robust result on comparative statics of two-sided markets, but he argues that the notion of "price" is unclear, and he reformulates it as follows. *Factors leading the platform to choose higher participation on side "i" lead it to choose lower participation on side "j."*
18. That does not imply that other areas have not been addressed or their insights are not trustful, but that there have not attracted the same level of attention. Many other factors influence price structure, as Wright (2004) pointed out, intuitions derived from classical models may not apply to multisided markets, which implies that those factors that influence pricing on classical models should be reviewed under a multisided perspective. In this sense, the multisided market literature progresses steadily, and an exhaustive analysis of all those works is as unattainable as an exhaustive review of all the industrial organization literature.
19. Evans (2011) considers that it is common to find singlehoming consumers and multihoming advertisers.
20. In this case, Jullien (2005) warns that multihoming drives competition toward transaction fees. With multihoming, agents try to concentrate their activity on the low transaction fee platforms.
21. Although we focus on pricing in this section, multihoming also influences other variables. Ambrus *et al*. (2016) show that advertising levels do not depend on whether the market is a monopoly or a duopoly when viewers multihome.
22. This market failure is unambiguous only if there are no intragroup externalities on the multihoming side.
23. Lastly, another possible strategy to deal with the supposed monopoly prices of multihoming is to commit a certain level of prices in advance. That is the case addressed by Hagiu (2006). He analyzes four market structures with combinations of multihoming and price commitments, and he finds that price commitment is always a dominant strategy for platforms.
24. Belleflamme *et al*. (forthcoming) review recent works on price transparency, and they highlight that competing platforms prefer opaqueness. In fact, tipping becomes more likely when competing platforms disclose information.
25. See Belleflamme and Toulemonde (2018) for a short review of this topic.
26. Other interesting works in this area are Bourreau *et al*. (2018), Kind *et al*. (2010), and Tremblay (2018).
27. The Spence distortion arises because the platform internalizes network effects to marginal rather than average participating agents. This distortion was pointed out for the first time by Wright (2004), and it was also analyzed by Kind *et al*. (2008), but it is Weyl (2010) who coined the term.

28. This same idea can be found in Kind *et al*. (2008). Although the models are different, the basic feature of that the incomplete internalization of indirect network effects (Spence distortion) may counteract the market power distortion (possibly even leading to too high quantities in equilibrium) is already part of their work.
29. When there are two dimensions of heterogeneity, even fixing the size on the other side and the price on the side considered, many types of users could be just on the margin between participating and not. Some may have high interaction benefits but large membership costs, and others may have low interaction benefits and no membership cost.
30. Other examples of models in which we find that platforms set allocations of users are Kind *et al*. (2008), Kind *et al*. (2009), or Kind and Koethenbuerger (2018).
31. The notion of focality is equivalent to "favorable beliefs" as Caillaud and Jullien (2001) and Caillaud and Jullien (2003) coined. See Halaburda and Yehezkel (2019) for an introduction to several degrees of focality.
32. We would like to thank one of the anonymous reviewers for pointing out this limiting feature.
33. Or it may also lead to more efficient outcomes, see Affeldt (2011).
34. The Hotelling model assumes a perfect negative correlation between tastes. This assumption heavily influences some results, see Ambrus *et al*. (2016).
35. This idea is found in Halaburda and Yehezkel (2019), who use this example to motivate the focality advantage. See Section 4.
36. Some interesting reviews about the antitrust issues in two-sided markets are Filistrucchi *et al*. (2013), Filistrucchi *et al*. (2012), Filistrucchi and Klein (2013), and Jullien and Sand-Zantman (2019).
37. From a theoretical point of view, it is worth mentioning Alexandrov *et al*. (2011). Their model has no network effects. However, there are cross-side effects that arise from shortages, so both sides are interdependent as we expect in two-sided markets, but they are not truly two-sided platforms. What is interesting about this work is that it is necessary to take into account the relationship between both sides, even in markets beyond the canonical definition of two-sided markets/platforms. Some of their results are common to those found by Filistrucchi.
38. It is worth mentioning that this result is not found by Chandra and Collard-Wexler (2009) when analyzing the Canadian newspaper industry.
39. We acknowledge that there are other interesting topics for public authorities, such as mergers. However, the literature on those areas is still in its infancy due to the difficulty of modeling multiplatform competition. Nonetheless, some of the lessons that already emerge are: (i) increase in prices following a merge may not hold, (ii) singlehoming or multihoming behaviors may change the consequence of merging, and (iii) as merging platforms involve different populations on each side, conflicting interest may arise. See Foros *et al*. (2015) for a review of mergers in media markets, and Jullien and Sand-Zantman (2019) for a review of the current state of platform literature on competition policy.
40. In 2005 the Federal Communications Commission (FCC) changed the classification of Internet transmissions from "telecommunication services" to "information services." Internet Service Providers (ISPs) are no longer bound by the nondiscrimination policies in place for the telecommunications industry. As is pointed out by Njoroge *et al*. (2013): *there is no standard definition of what a net neutral policy is, it is widely viewed as a policy that mandates ISPs to provide open-access, preventing them from any form of discrimination against Content Providers (CPs)*.
41. In this regard, the management literature has paid more attention to this concern. See, for example, Gawer (2014) for a literature review.
42. In this regard, to the best of our knowledge, only Sanchez-Cartas (2020) addresses a duopolistic framework.
43. https://ec.europa.eu/digital-single-market/en/content/european-digital-strategy

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