THE ANTITRUST ANALYSIS OF

MULTI-SIDED PLATFORM BUSINESSES

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Revised: 30 January 2013

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This is a draft of a chapter that has been published by Oxford University Press in the book: *Oxford Handbook on International Antitrust Economics* edited by Roger Blair and Daniel Sokol, eds.
© Oxford University Press 2015
DOI: 10.1093/oxfordhb/9780199859191.013.0018

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ABSTRACT

This Chapter provides a survey of the economics literature on multi-sided platforms with particular focus on competition policy issues, including market definition, mergers, monopolization, and coordinated behavior. It provides a survey of the general industrial organization theory of multi-sided platforms and then considers various issues concerning the application of antitrust analysis to multi-sided platform businesses. It shows that it is not possible to know whether standard economic models, often relied on for antitrust analysis, apply to multi-sided platforms without explicitly considering the existence of multiple customer groups with interdependent demand. It summarizes many theoretical and empirical papers that demonstrate that a number of results for single-sided firms, which are the focus of much of the applied antitrust economics literature, do not apply directly to multi-sided platforms.

I. INTRODUCTION

Economists have identified an important class of businesses that are now generally referred to as "multi-sided platforms."[1] Multi-sided platforms create value by bringing two or more different types of economic agents together and facilitating interactions between them that make all agents better off. These platforms play critical roles in many economically important industries including payments, mobile phones, financial exchanges, advertising-supported media, and various Internet-based industries. In this Chapter we will focus on common aspects of platform businesses that have important implications for firm behavior and competition, but we will also note some of the novel and important ways these implications differ across firms and industries.[2]

Multi-sided platforms solve a transaction-cost problem that makes it difficult or impossible for agents in different groups to get together. In most cases, greater involvement by agents of at least one type increases the value of the platform to agents of other types. Such *indirect network effects* function something like economies of scale on the demand side and increase the value economic agents can realize from the platform. In a two-sided setting, the chance of finding a value-increasing interaction depends on how many agents of the first kind an agent of the second kind can reach and often vice versa. A multi-sided platform creates value by coordinating the multiple groups of agents and, in particular, ensuring that there are enough agents of each type to make participation

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[1] They are also sometimes referred to a "two-sided markets." We resist this terminology because multi-sidedness is an attribute of an individual business that may not always be shared by all of its competitors.

[2] Over the years, several strands of economic analysis have touched on aspects of these types of businesses. Economists have understood how intermediaries facilitate value-creating exchange at least since Smith (1776, at 213-222). The microfinance literature modeled exchange institutions such as those for equities. See Spulber (1996). The advertising economics literature has examined the role of the media in connecting advertisers and readers. See Bagwell (2007). The literature on indirect network effects has considered the coordination of demand between users and producers of complementary goods. See Katz and Shapiro (1994) for a survey. On the surface, multi-sided platforms resemble ordinary multi-product firms, but, as we discuss below, they in fact differ fundamentally.

worthwhile for all types.

The fundamental insight that there is a broad class of businesses that act as catalysts for creating value for two or more groups of customers and have economic features not well explained by the standard economics of the firm was made by Jean-Charles Rochet and Jean Tirole (2003) in a paper that started circulating around 2000.[3] Their main focus in developing an economic model of multi-sided platforms was on how the relative prices charged to the two sides of the platform coordinated demand. They showed that the optimal prices—both from the standpoint of profit-maximization and social welfare maximization—could entail pricing below the marginal cost of provision to one side and above the marginal cost of provision to the other side. Evans (2003a) showed that there were numerous industries in which firms acting as catalysts set some prices below marginal cost and sometimes at zero. These include software platforms, advertising-supported media, exchanges, and payment systems. They range from the old (the village matchmaker) to the new (mobile-based social networking).

Since the birth of the multi-sided platform literature, three noteworthy developments have taken place that are particularly relevant to this Chapter. First, there has emerged a large and rapidly expanding literature on multi-sided platforms in economics, antitrust, and strategic management. We have identified more than 200 articles on multi-sided platforms that have appeared in print or in working paper form since we last surveyed this area in 2007.[4] It is still early in the development of this corner of industrial organization, and all the important questions have by no means been answered. Second, competition authorities around the world have used the multi-sided platform framework to evaluate cases and reach decisions. See OECD (2009) for a survey of the how various authorities are approaching cases involving platforms.[5] The multi-sided platform literature is regularly cited in submissions in legal and investigative proceedings. Third, a number of large global multi-sided platforms have emerged as a result of ongoing revolutions involving the Internet, mobile devices, and information technology more broadly, as described in Evans (2008). These platforms have garnered considerable attention from antitrust authorities—for example the U.S. Federal Trade Commission's and the European Commission's investigations of Google—and private complainants—such as Qihoo 360's lawsuit against Tencent in China and the Consumer Watchdog complaint against Facebook in the U.S.[6]

Experienced antitrust practitioners know that no two businesses or markets are alike and may

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[3] Other key theoretical papers are Caillaud and Jullien (2003), Armstrong (2006), and Rochet and Tirole (2006). Weyl (2010) generalizes and unifies the models in these papers. Most of the subsequent literature builds on these papers. In the context of information goods, Parker and Van Alstyne (2000) introduced a model with interdependent demand between two groups of customers. Their model is a linear version of the model subsequently developed by Armstrong (2006).

[4] The appendix provides a bibliography of the literature on multi-sided platforms through 2012.

[5] OECD Competition Committee (2009). The first author was an advisor to the OECD and helped draft the OECD's report.

[6] Washington Post, October 14, 2012; Wall Street Journal Online, November 29, 2012; Qihoo v. Tencent.

wonder why one class of businesses, multi-sided platforms, deserves a chapter in a volume on antitrust. After all, grocery stores and copper mines also differ in fundamental ways. Indeed, early in the emergence of the economic literature on multi-sided platforms, some commentators argued that there was nothing new in the economics of multi-sided platforms and thus no reason for competition analysis to treat them differently from grocery stores or copper mines.

Few hold this view today. The economics literature that has developed since 2000 shows robustly that many results derived from models of one-sided businesses generally do not apply to multi-sided platforms that serve different interdependent customer groups. The clearest example of this involves price. When competition is imperfect, long-run equilibrium prices exceed marginal cost in traditional models but not necessarily in multi-sided platform models. Similarly, many of the analytical methods that are commonly used in antitrust matters, such as the SSNIP test or models for evaluating exclusionary abuses through tying, do not necessarily apply, without significant adaptation, to industries with multi-sided platforms.

An additional reason for a separate focus on multi-sided platforms is that there are important similarities in the business models adopted by multi-sided platforms in different industries, and the literature has already identified some important determinants of both those similarities and of differences of the sort that distinguish grocery stores from copper mines. The selective survey in this Chapter is intended to provide insights from across these industries that readers may find useful in specialized cases. In this sense, surveying multi-sided platforms is similar to considering franchises. The economics and the case law related to one kind of franchises or multi-sided platform are relevant to other kinds of franchises or multi-sided platforms, but in both cases it is important to pay attention to sources of differences between individual businesses and markets.

As we noted above, some early commentators argued that the economics of multi-sided platforms was old wine in new bottles: just a new label for industries with indirect network effects that economists had written about since the mid-1980s. Others claimed that these platforms did not raise any issues that required significant modification to traditional antitrust tools.[7] We have asserted above and will demonstrate below that the burgeoning economics literature on multi-sided platforms has shown that there are new wines here—particularly good, complex vintages in fact—and that one-sided tools often do not apply, at least not without substantial changes, to multi-sided platforms. Much of the work discussed below is making its way into the interactions among authorities, complainants, defendants, and courts. And there is more to come.

II. ECONOMICS OF MULTI-SIDED PLATFORMS

It is useful to start with an example of a two-sided platform to establish some basic concepts. OpenTable is an American-based company that provides a platform for fine-dining restaurants and

[7] See, e.g., Plaintiffs' Pretrial Brief at 17-24, United States v. First Data Corporation, No. 03-2169 (D.D.C. December 10, 2003).

consumers in various cities in the U.S. and other countries.[8] It enables consumers to make and restaurants to accept reservations for tables over the Internet. It helped solve a transaction problem for consumers and restaurants. Consumers used to have to call a restaurant and, assuming they reached someone, ask whether a particular time was available for their party. If they were unable to make a reservation, they would repeat the process for another restaurant, perhaps many times. Restaurants used to have to devote resources to taking phone calls, many of which did not result in a reservation, and keeping track of the reservations they did take. As anyone who has used both methods has observed, the web-based reservation systems enable consumers to search very quickly for restaurants with availability and make reservations at them. Figure 1 shows OpenTable's view of the transaction cost problem that it solved.

Figure 1: OpenTable and Transaction Costs

For OpenTable to provide this service it needed to have significant numbers of both consumers and restaurants using its platform. OpenTable started by providing table management software to restaurants—a one-sided business. Once it had signed up a sufficiently large number of restaurants in some cities, it developed a web-based platform for consumers to make reservations that would be automatically incorporated into its table management software. OpenTable provided this service to consumers for free. In fact, the price to consumers is slightly negative: consumers earn modest rewards that can be used to reduce their bill at participating restaurants. Restaurants have to license Open Table's table management software and pay a fee for every patron they seat who has made a reservation through OpenTable. As of 2011 OpenTable had 25 thousand restaurants in the U.S. and sat 9.0 million consumers a month. It earned $139.5 million in revenue.[9]

[8] For the company's geographic scope, see OpenTable Inc. (2011), at 3, 7-8.
[9] OpenTable Inc. (2011), at 2, 7.

OpenTable has several features that are common among multi-sided platforms.

First, it has two sorts of indirect network externalities. There is a *usage externality*: both consumers and restaurants benefit when the system is used to make a reservation.[10] And there is a *membership externality*: the system is more valuable to consumers the more different restaurants it lets them access. It is not clear that restaurants benefit from having more consumers use the system beyond the benefits related to usage; consumers value variety, but restaurants probably do not. On the other hand, it is clear that the value of the table management software is greater the more consumers use it to make reservations.

Second, Open Table clearly facilitates valuable interactions between two distinct groups of agents: consumers and restaurants. The fact that members of each groups value interacting with members of the other group underlies the indirect network externalities just discussed and provided an opportunity for an entrepreneur to create a profit-making platform that could increase value for these economic agents by reducing the transactions costs they must incur in order to interact. Consumers and restaurants were able to find each other and make reservations before OpenTable, of course. One could even argue that the telephone network was the pre-existing platform, which generally had no out-of-pocket costs for consumers. But the transactions costs of using the telephone were nonetheless much higher on both sides of the market.

Third, the price structure for the two different types of economic agents, which determines the relative incremental profit earned from the two types, is an important tool in solving the coordination problem between the two sides in order to capture value from the externalities that link them. Most likely subsidizing consumers increased the value of the platform to restaurants, which resulted in OpenTable getting more restaurants, which in turn made if more attractive to consumers. Note also that restaurants pay a fixed *membership fee* to license the software that enables them to be on the platform as well as a *usage fee* when they take a reservation. It is not uncommon for platforms to charge fees of both sorts. Consumers pay no membership fee and enjoy a small negative usage fee. This sort of dramatic asymmetry, with one group of agents paying prices below marginal cost, is also not uncommon with multi-sided platforms.

A. Definitions of a Multi-Sided Platform

Before relying on the multi-sided platform literature to analyze a business, one obviously needs to determine whether that business is in fact a multi-sided platform. Economists have proposed several definitions of a multi-sided platform; they will generally agree in specific cases. Rochet and Tirole (2006) focused on the price structure in defining two-sided platforms (which they refer to as two-sided markets):

> *A market is two-sided if the platform can affect the volume of transactions by charging more to one side of the*

[10] This distinction between usage and membership network externalities was first made by Rochet and Tirole (2006).

market and reducing the price paid by the other side by an equal amount; in other words, the price structure matters, and platforms must design it so as to bring both sides on board.

For a business to be two-sided it must reduce transactions costs for the two sides. Because of indirect network externalities there is interdependence between the demands of the two sides, and the price structure is used to balance membership and usage to maximize platform value. Rochet and Tirole emphasize that a business is not two-sided if the economic agents can easily defeat the pricing structure through side payments.[11] In practice, it is hard to know as a theoretical matter whether economic agents could defeat a platform's pricing structure. Restaurants could impose the charges they pay for reservations onto those who make them, thereby negating the Open Table subsidies. In fact, restaurants do not do this despite complaining about the charges,[12] perhaps because of transactions costs or because consumers would strongly object to such a charge, since making a reservation by phone is free – except for the time involved.

Evans and Schmalensee (2007a) proposed a less formal definition that captures the key features of platform businesses.[13] A multi-sided platform (which they call an *economic catalyst*), "has (a) two or more groups of customers; (b) who need each other in some way; (c) but who cannot capture the value from their mutual attraction on their own; and (d) rely on the catalyst to facilitate value-creating interactions between them." The focus of this definition is on the role of the platform in creating value that would not exist (or would be much smaller) in its absence. This value is created as a result of solving a coordination—and transaction cost—problem between the groups of customers. The generation and allocation of this value between the multiple sides is determined simultaneously. How much value each side gets determines whether they will participate and also how much is left over as profit for the platform. The price structure is critical in determining that allocation.

The multi-sided platform literature assumes the presence of multiple customer groups with demand that is interdependent in various ways. Perhaps the best test of whether a particular situation involves one or more multi-sided platforms is whether the multi-sided platform literature provides useful insights that do not emerge from more standard analysis. In the case of OpenTable it seems apparent both that there are significant usage and membership externalities and that it would be difficult to explain Open Table's subsidization of reservation makers without taking those externalities into account.

In the remainder of this chapter we distill insights from the multi-sided platform literature that are relevant to competition policy. Whether these insights apply to a particular entity, or to competition policy issues related to that entity, depends on the extent to which the entity is a multi-

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[11] Therefore a necessary condition for a firm to be a multi-sided platform is that the Coase (1960) Theorem, which relies on there being zero transactions costs involved in side payments, does not apply.

[12] Pastore (2010); New York Times, December 12, 2010; Pittsburgh Post-Gazette, May 1, 2011.

[13] Evans and Schmalensee (2007a). Also see Evans (2003b).

sided platform. When in doubt it is useful to consult the Rochet-Tirole or Evans-Schmalensee definitions and to make sure that the assumptions of the multi-sided platform theoretical model(s) being considered apply to that entity. It is also important to note that many of the theoretical models of multi-sided platforms are heavily dependent on assumptions that may not apply in a particular application or, for that matter, in any application.

B. EXTERNALITIES

Externalities are a key aspect of multi-sided platforms. As we noted above, Rochet and Tirole (2006) observed there are two types of indirect externalities: usage externalities and membership externalities.

A *usage externality* exists when two economic agents need to act together, to use the platform, to create value. We see that with OpenTable. There is a person who wants to dine at a restaurant at a particular time and a restaurant that would benefit from serving that individual at that time. They can enter into a value-increasing exchange only if they can get together. In practice that means the person and the restaurant finding each other and entering into a transaction. OpenTable and similar businesses help generate these usage externalities by making it easier for restaurants and diners to enter into this transaction. They also increase the value of usage externalities by increasing the quality of the matches: they make it easier for people to find the best restaurant for the particular occasion involved.

It is possible that the usage externalities are positive for one type of economic agent but negative for another type of economic agent. So long as the net value of these externalities is positive there is a benefit to facilitating interaction, some of which the platform may be able to capture. Some advertising-supported media are examples. An advertiser benefits from being able to communicate with a possible customer, but consumers may place a negative value on seeing ads. The platform enables a value-increasing interaction by subsidizing the consumer so that she is willing to see the ad. Most advertising-supported media do this by bundling subsidized content with advertising. Anderson and Gabszewicz (2006), for instance, discuss how free television stations buy consumers' attention with programming.

There is a membership externality when the value received by agents on one side increases with the number of agents—or some related measure of their aggregate value—participating on the other side. As we noted above, OpenTable is more valuable to consumers the more restaurants that participate in the service. Smart mobile phone software platforms provide another example. Developers of applications value a platform more if there are more potential users; users value a platform more if there are more applications. This phenomenon results in the well-known positive feedback loop.[14] More agents on one side attract more agents on the other side, thereby fueling growth.

Yet another example of membership externalities is provided by the entry of Diners Club, the

[14] Katz and Shapiro (1985); Farrell and Saloner (1985); Arthur (1989).

first general-purpose payment card. At its start it recruited 14 restaurants to take its card and several hundred consumers to carry its card in Manhattan. Driven by membership externalities, more restaurants and consumers joined its system in the ensuing months.[15] Diners Club ignited. More restaurants joined to get access to consumers who wanted to use the card to pay and more consumers joined to pay at more restaurants. By its first anniversary in 1951, Diners Club had 42,000 individuals who carried its card to make payment and 330 merchants that that accepted the card for payment. By 1956, it was accepted at nine thousand merchants, with an annual transaction volume of $54 million.[16]

The platform plays a key role in creating these indirect network effects. In fact, as described in Evans and Schmalensee (2010), the major challenge for aspiring platforms is to get enough agents on each side to secure enough critical mass to propel indirect network effects.[17] Platforms generate indirect network effects, and thus value for the economic agents they aspire to serve, through pricing, product design, marketing, and other efforts to attract agents on each side. Jullien (2011), for instance, has stressed the value of "divide and conquer" strategies for a startup or an entrant challenging an established platform: subsidize agents in the most price-sensitive group, then use their participation to attract agents in the other group.

The presence of these indirect network externalities has an important implication for economic analysis of multi-sided platforms. For traditional one-sided industries, economists ordinarily assume that demand depends on the price of the product as well as the prices of complements and substitutes. For multi-sided platforms, the demand by one group of economic agents also depends on the number (or other measures of the size and quality) of each of the other groups of economic agents that the platform serves. Loosely speaking, the sides are complements in demand. Failure to account for these demand interdependencies in an economic model renders the results of that model suspect if not completely unreliable when such interdependencies are important. We will return to this point when we discuss economic models commonly used in antitrust.

C. PRICING

Pricing in two-sided platforms is more complex than in ordinary multi-product businesses, and it depends on the nature of the platform. To illustrate both points, we briefly consider pricing in the two most basic models of two-sided platforms.

In the first of these models, due to Rochet and Tirole (2003),[18] a two-sided monopoly platform operates with no membership externalities, only usage externalities, and levies no membership charges, only per-transaction usage charges. The demand for transactions from group i is given by $D_i(P_i)$, for i=1,2, where P_i is the per-transaction charge to members of group i. One can think of the

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[15] Evans and Schmalensee (2007b), at 1-2.

[16] Evans and Schmalensee (2007b), Evans and Schmalensee (2005), at 54.

[17] Zhou (2012) provides an empirical study of the critical mass problem in the U.S. video game market.

[18] See also Schmalensee (2002), where this same model is applied to the analysis of payment card systems.

two groups as merchants and consumers and the platform as a payment system that levies only per-transaction fees. The number of transactions that actually occurs is proportional to the product of the groups' demands in this model, so that, as in real payment systems, there is a value to balanced participation. The platform's profit is given by

$$\Pi = \left[\left(P_1 - C_1\right) + \left(P_2 - C_2\right)\right]\left[D_1\left(P_1\right)D_2\left(P_2\right)\right],$$

where C_i is the per-transaction cost of serving a member of group i.

Let E_i be the (positive) elasticity of D_i with respect to P_i. Then Rochet and Tirole (2003) show that the profit-maximizing prices satisfy the following two optimality conditions:

$$\frac{\left(P_1 + P_2\right) - \left(C_1 + C_2\right)}{\left(C_1 + C_2\right)} = \frac{1}{E_1 + E_2}, \quad \textit{and} \quad \frac{P_1}{E_1} = \frac{P_2}{E_2}.$$

The first of these resembles the classic Lerner condition for monopoly equilibrium; the total markup over cost is lower the higher is either demand elasticity. The second condition, however, makes clear that this is not an ordinary multi-product firm. Such a firm would generally maximize profit by charging prices that are inversely related to demand elasticities, all else equal. Here, however, that condition is turned on its head: the optimal prices are *directly* proportional to demand elasticities. Intuitively, the reason is that the platform cares about balanced participation of the two groups, while balance has no value to an ordinary multi-product firm.

In the second basic model, due to Armstrong (2006), a two-sided monopoly platform operates with no usage externalities, only membership externalities, and levies no usage charges, only membership charges. One can think of a heterosexual singles bar or an academic journal. In the first example men value the presence of many women and vice versa; in the second example authors value journals with large audiences, and readers value journals in which many good authors want to publish. The demand of each group for membership depends both on the fee it is charged and on the number of members from the other group. The firm's profit function in this model is given by

$$\Pi = \left(P_1 - C_1\right)D_1\left(P_1, Q_2\right) + \left(P_2 - C_2\right)D_2\left(P_2, Q_1\right),$$

where Q_i is the number of members from group i and $Q_i = D_i(P_i, Q_j)$, $i=1,2$, $i \neq j$.

This model is formally related to the classic model of a monopoly selling complements. In the classic example of coffee and cream, lowering the price of coffee increases the demand for cream because some individuals consume coffee and cream together. Here, however, there are two distinct groups. In the singles bar example, lowering the admission charge to women will increase the demand for admission by men as a reaction to the increased number of women in the bar.

Unlike the Rochet-Tirole (2003) model, the Armstrong (2006) model does not yield simple optimality conditions that hold for all demand functions. Armstrong (2006) shows that in the special case where the D_i functions are linear, the profit-maximizing prices satisfy the following conditions:

$$\frac{P_i - (C_i - \theta_{ij})}{P_i} = \frac{1}{\varepsilon_i}, \quad i, j = 1,2, i \neq j.$$

Here ε_i is the elasticity of D_i with respect to P_i, holding Q_j constant, and θ_{ij} is a positive term that measures the impact of increases in Q_i on demand from group j, i,j=1,2, i≠j. As in the case of complements, prices are lower than they would be in the absence of cross-effects.

Schmalensee (2011) shows that in both of these models differences in demand functions can lead to highly skewed pricing of the sort that platform businesses like OpenTable often employ. Weyl (2010) explores a general model that has these two models as special cases, and he shows that they have rather different comparative static properties.

While the Rochet-Tirole (2003) and Armstrong (2006) models form the foundation of much of the multi-sided platform literature, later authors have introduced additional factors in attempts to produce more tailored models of particular platform types. Hagiu (2009), for instance, modifies the Armstrong (2006) model to capture features of platforms like video game consoles, OpenTable, Amazon, or eBay, that serve to connect differentiated sellers with consumers. He finds that the stronger consumers' preferences for variety, the larger the share of a monopoly platform's profits that is optimally derived from sellers. He argues that this explains why video game platforms derive very little of their profits from consumers of video games, who have a strong preference for variety, while most other software platforms, like Microsoft's Windows and Apple's iOS, derive most of their profits from consumers.

D. Consumer and Social Welfare

For antitrust an important and immediate implication of the multi-sided platform models is that an accurate analysis of the impact of any platform decision on consumer welfare must take into account all interdependent customer groups the platform serves. Search engines, for example, provide value to three distinct groups of economic agents: (1) websites that are indexed and made available to people through search queries; (2) people making search queries; and (3) advertisers who are seeking to reach the people who are looking at the search-results page from the query. There are usage and membership externalities across all three groups. The search-engine platform has to balance the interests of these three groups to provide value to them and maximize its own profit. Business decisions that affect the welfare of one group of users are likely to affect the other groups of users through indirect network externalities.

Another welfare issue concerns the relationship between the profit-maximizing decisions by a platform and the social welfare maximizing decisions. There are two potential market failures

resulting from multi-sided platforms.

The first one is the traditional market power failure. In the absence of perfect competition, which is an implausible market structure for platform-based industries, the platform will set its overall *price level* higher than is socially desirable. It will earn at least short-term profits that exceed the competitive level. Since most firms have market power, and many must have some market power to compensate for fixed costs and risk taking, the market power failure is not remarkable for multi-sided platforms. The market power-related market failure is similar to that for a one-sided firm. The fact that platform-based industries deviate from perfect competition should not raise competition policy concerns any more than the fact that almost all real-world single-sided markets also deviate from perfect competition.

The second possible market failure can result from the platform choosing a *price structure* that does not maximize social welfare. In the two basic models considered just above, Weyl (2010) shows that this distortion arises because the platform considers the impact of its pricing on the marginal users in the groups it serves in order to balance participation, while the impact on the average users is what determines the effect on social welfare. This sort of distortion was first pointed out by Spence (1975) in a model of quality choice by a monopoly. It arises, in principle, whenever a firm with any market power has more than one decision variable and faces buyers who are affected differently by the levels of those variables – that is, almost universally. And, unlike the price level distortion, even its direction depends fundamentally on details of the demand structure: Spence (1975) shows that market-determined quality may be either too high or too low under plausible conditions. Perhaps because of this complexity, this sort of distortion has not received much attention from antitrust authorities or others concerned with public policy.

Possible distortions created by payment card interchange fees are a notable exception to this generalization. These fees, which primarily affect the price structure, rather than the overall price level, are paid by merchant acquirers (and passed on at least in part to merchants) to bank issuers (and passed on at least in part to consumers) and thereby affect the relative prices paid by merchants and cardholders. There is no general reason why the profit-maximizing interchange fee would also maximize social welfare. Bedre-Defolie and Calvano (2012), for example, show that under certain assumptions payment networks will set the interchange higher than would be socially optimal.[19] However, determining the socially optimal interchange fee depends on detailed features of cost and demand structures and is empirically demanding. Moreover, even when there is a theoretical reason to believe that the socially and privately optimal pricing structures are different, there is no a priori reason to believe that they are *very* different – as observed by Calvano (2011).

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[19] There is an immense literature on the economics of interchange fees, begun by Baxter (1983). In addition to Bedre-Defolie and Calvano (2012), other recent contributions include Prager et al (2009), Rochet and Wright (2010), and Wang (2010).

III. COMPETITION AMONG MULTI-SIDED PLATFORMS

The typical U.S. consumer has many different types of payment methods: cash, checks from at least one depository institution, at least one debit card, and several credit cards.[20] Most retail stores accept cash, checks, debit, and credit cards. Each of these payment methods is provided by a two-sided platform serving consumers and merchants. In the U.S., debit cards are provided through platforms operated by MasterCard and Visa, credit cards through platforms operated by American Express, Discover, MasterCard, and Visa; cash through a platform operated by the U.S. Department of the Treasury and the Federal Reserve System; and checks through a platform operated by the Federal Reserve System. Some large retail stores also offer store credit or charge cards, which many consumers also use. These store cards are traditional single-sided products. One can debate which of these payment methods compete so closely with each other they should be included in the same relevant market for a merger or antitrust claim—a topic we consider in the next section. But it is clear consumers and retailers use all of these methods, they all compete with each other to some degree, and this competition has been going on for decades.

Diners Club was able to break into the mature payments industry in the U.S. in 1950 through product differentiation. There were two established payment platforms—cash and checks. Some retailers also had store cards. Diners Club introduced a charge-card platform that, like cash and checks, many consumers and merchants could use for payments. Unlike checks, Diners Club guaranteed payment to the merchant. Unlike store cards, consumers could use the card at many merchants. And unlike cash and checks, the consumer did not have to pay for the transaction until her monthly charge card bill came due. Despite the advantage that cash and checks had from indirect network effects, Diners Club and subsequent payment card entrants were able to introduce a new payment platform. More than fifty years later, although shares of payments have shifted dramatically among them, all of these platforms coexist.

This competition and its evolution are hard to reconcile with the simplest models of network effects. In these models, a platform is more attractive the more participants it has, and these demand-side scale economies propel markets to monopoly. In the early literature on direct network effects, there was emphasis on the impact of certain events—including anticompetitive behavior—on tipping markets to monopoly.[21]

One of the major contributions the multi-sided platform literature has made to industrial organization has been to demonstrate that indirect network effects are important across a wide range of industries—from low-tech industries such as shopping malls to high-tech ones such as mobile phone operating systems. In simple models, indirect network effects can also produce demand-side economies of scale that lead to monopoly: increased participation on one side of the platform makes it more attractive to the other side, leading to increased participation there, making participation by

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[20] Federal Reserve Board of Governors (2010); Federal Reserve Bank of Boston (2009).

[21] Useful overviews of this literature are provided by Katz and Shapiro (1994) and Farrell and Klemperer (2006).

the first side more attractive, and so on.

But many of the industries in which indirect network effects are important do not have a single monopoly provider and do not seem to be tending toward monopoly. For example, in the U.S., in addition to several payment systems, there are several competing financial exchanges, numerous magazines even in narrow categories such women's fashion, multiple shopping malls that people in metropolitan areas can patronize, several mobile phone operating systems used by consumers and developers, numerous dating venues, and three general purpose search engines.

Two features missing from simple models help explain this apparent discrepancy. First, competing platforms typically offer differentiated products. Second, in some settings customers on one or more sides of the business can patronize more than one platform – a phenomenon that has come to be called "multi-homing."

Nevertheless, indirect network effects, like ordinary supply-side scale economies, do tend to limit the number of viable multi-sided platforms in any market. Most multi-sided platforms thus face a relatively small number of competitors as they seek to gain customers on all sides of their businesses. Often, both static and dynamic competition are important in industries with multi-sided platforms.

A. Product Differentiation

The traditional concepts of product differentiation (see Tirole 1988, Chapter 7) for one-sided firms apply to multi-sided platforms. There is variation across consumers both in the valuation of various product attributes (horizontal differentiation) and in the willingness or ability to pay for quality (vertical differentiation).[22] Firms can select product attributes to appeal to particular groups of consumers and to differentiate themselves from competitors.

For one-sided firms, horizontal and vertical differentiation locates the firm near a pool of potential customers and helps determine pricing. For multi-sided platforms, by determining the customers on one side, horizontal and vertical differentiation affect demand on the other sides. Because of these interdependencies, a platform must usually make differentiation decisions jointly for all of the sides it serves. Moreover, the selection of customers on one side is one possible way to differentiate the platform horizontally or vertically.

A shopping mall developer, for example, must decide on a number of different product attributes such as location, size, parking, and quality of construction. But it also needs to decide what kind of stores and customers it wants to attract. Those are obviously interdependent. It could be an upscale mall and only rent space to merchants with an upscale clientele. If it succeeds in attracting enough such merchants it will tend to attract an upscale clientele. In order to do this, of course, it is likely to make other decisions—such as locating close to wealthy towns and using better finishes—

[22] Ambrus and Argenziano (2009) consider two-sided platforms serving customers who differ in their valuation of an important dimension of quality: the number of customers on the other side of the platform. They show that multiple asymmetric platforms can exist in equilibrium.

that help attract wealthy customers and merchants they tend to patronize.[23]

Product differentiation, as this example suggests, is a tactic that firms can use to create value by making it easier for agents to find counterparties for value-increasing exchange. The upscale mall, for example, makes it easier for shoppers to find stores that serve their tastes and easier for stores to find customers. In some cases, platforms differentiate themselves by using what Evans (2012a), following Strahilovetz (2006), has called the exclusionary vibe.[24] The dating site, JDate, does not prevent Gentiles from using it but engages in various actions that signal that it is primarily for Jewish singles looking for other Jewish singles. Platforms can also create value for agents on one side by limiting how much competition they face for a match, as observed by Halaburda and Piskorski (2011).

Product differentiation is a key reason why many industries with multi-sided platforms have multiple competitors even though indirect network effects and sometimes economies of scale would seem to propel them to monopolies. Job placement provides an interesting example. The online portion of this industry consists of job boards that help match job searchers with employers through online postings and search. In the U.S. there are two large job boards that cover many different job categories. But then there are hundreds of other job boards that specialize in different job segments such as professionals (LinkedIn.com) and media jobs (mediabistro.com). By specializing, these job boards presumably increase matching efficiency. Beyond the job boards there are recruiting services that work for employers or employees. The result is a highly fragmented industry of two-sided platforms.

B. MULTI-HOMING

The competitive dynamics of multi-sided platforms depend in theory and in practice on the number of platforms that individual economic agents on each side use, on differences between the two sides in the number of platforms used, and on the ability of an agent on one side to dictate the choice of platform for the other side.

Rochet and Tirole (2003) observed that one of the key competitive aspects of multi-sided platforms was the extent to which economic agents engaged in what they called "single-homing" or "multi-homing." An economic agent single-homes if she uses only one platform in a particular industry and multi-homes if she uses several. In the cases of payments, consumers and merchants both generally use several payment platforms and therefore multi-home in this sense.

Armstrong (2006) showed the importance of "multi-homing" for competition. Suppose platforms in some market create value by having agents of Type A and Type B as members. If Type A agents only join one platform, then Type B agents can only gain access to Type A agents by joining that same platform. That makes the Type A side of a platform what Armstrong called a

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[23] Galeotti and Moraga-Gonzalez (2009) provide a model of a shopping mall that attracts horizontally differentiated retailers as well as consumers. The analysis of Hagiu (2009) is also relevant.

[24] For a discussion of the exclusionary vibe in the context of multi-sided platforms see Evans (2012a).

"competitive bottleneck."[25] When there is single homing on one side and multi-homing on the other side in his model, Armstrong shows that platforms will compete aggressively for the single-homing customer who will therefore pay low prices. With these customers on board, the platform will then earn its profits from the customers who multi-home on the other side. Armstrong and Wright (2007) show that if competing two-sided platforms are viewed as homogeneous by members of one group but are viewed as differentiated by members of the other, the latter will single-home, the former will multi-home, and "competitive bottlenecks" will arise endogenously.

Sometimes one set of multi-homing agents can dictate the choice of platform to agents on the other side of the market. As we have noted, most consumers use multiple payment methods and even use multiple payment cards, and most merchants accept all of the payment alternatives. One can argue, however, that in practice the consumer dictates which payment system is used. The consumer generally offers one particular payment method at checkout. The merchant then has to decide whether to reject that payment method. If they do they might lose a sale. In addition, there may be other reasons why the merchant cannot steer the consumer away from their chosen method—laws against surcharging payment methods, restrictions imposed by the platform involved, customs relating to payment acceptance, or transaction costs. If the consumer decides then, by the logic of competitive bottlenecks, the payment platforms have an incentive to compete aggressively for the consumer to use their payment method. That is a possible explanation for providing "rewards" for people to use cards. Bedre-Defolie and Calvano (2012) rely on this assumption in showing that payment card systems have an incentive to subsidize card users at the expense of merchants more than is socially optimal.

It is not clear how robust the "competitive bottleneck" argument is, however. In software platforms, for instance, the price structure appears to be the opposite of what the competitive bottlenecks theory would predict. Most personal computer users rely on a single software platform, while most developers write for multiple platforms.[26] Yet personal computer software providers generally make their platforms available for free, or at low cost, to applications developers and earn profits from the single-homing user side.

C. Asymmetric Competition

The theoretical economics literature on multi-sided platforms has focused on two major cases: monopoly platforms and competition among (possibly differentiated) multi-sided platforms that serve the same customer groups. Many platforms, in fact, face more complicated competitive environments as observed by Evans and Noel (2005) and Eisenman et al. (2011). An n-sided platform can face competition from:

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[25] This term seems to have first been used in connection with mobile telephony, where networks may compete for subscribers but be in a monopoly position for providing access to those subscribers; see Armstrong (2002).

[26] Evans et al (2006).

- A single-sided firm on any side. We saw that 2-sided payment platforms face competition from 1-sided store cards. The three-sided personal computer software platforms competed at least initially with one-sided platforms such as the IBM mainframe (the mainframe integrated an operating system and hardware and did not encourage the development of general complementary applications.)
- A multi-sided platform that competes on some but not all sides. The Android operating system, for example, serves as a platform for handset manufacturers, users, mobile operators, and software developers. The Apple iPhone operating system serves as a platform for all of these except handset manufacturers, since Apple does not license its operating system to other handset manufacturers.
- A multi-sided platform that has the same sides plus additional ones. That is true for Apple relative to Android. It is also true to a large degree for search platforms versus social networking platforms. Both earn revenue from advertising, but social networking platforms earn revenue from application developers—especially game developers.

Online advertising is an example of many platforms serving one side—advertisers—but providing very different products to secure the attention of consumers. In China, for example, the following platforms all sell online advertising to users but provide very different services to them: Tencent (instant messaging), Baidu (search engine), Sina (integrated portal), Qihoo (antivirus), Netease (integrated portal), Taobao (online shopping), Sohu (integrated portal), Youku (online video), Tudou (Online Video), Google (search engine), Tianya (community), Home of Websites (site map), Ku6 (online video), Thunder Video (online video), and Phoenix (integrated portal). The platforms intersect on the advertising side but deviate, at least in terms of the services offered, on the user side.[27] Of course they are all seeking attention from consumers which is what they are providing to advertisers.

IV. MARKET DEFINITION AND MARKET POWER

The fundamental service provided by multisided platforms is the ability of economic agents on each side to interact in a valuable way with economic agents on other sides. The OpenTable platform, for instance, makes it easier for consumers and restaurants to schedule a time to dine. A platform may provide economic agents with various products and services to persuade them to use the platform and help facilitate the process of searching, matching, and interacting. OpenTable provides restaurants with table management and reservation software. It provide consumers with a website that enables them to search for restaurants, see ratings, determine availability for particular times and numbers of guests, and to make a reservation. But ultimately the platform is generating value from bringing members of these two groups of customers together. The goods and services provided to each side are usually the means to that end. OpenTable provided restaurants with a suite of software services in part to get them to join its network and it provided consumers with a

[27] Evans (forthcoming-a) provides a general discussion of platform businesses that both seek and provide attention.

suite of tools to get them to use its network. (It would be easy for consumers to multi-home; less easy for restaurants.) These linkages across the multiple groups of customers and the products and services being offered to each group have to be accounted for in the analysis of the relevant antitrust market and the assessment of market power.[28]

Market definition and market power analysis are primarily methods for summarizing succinctly the extent to which competitive constraints limit the ability of a firm to engage in various kinds of behavior that may raise antitrust concerns. Market definition identifies the sources of demand-side and supply-side constraints that matter in assessing market power. Market power analysis assesses whether these constraints prevent a firm from charging prices that are noticeably higher than under competition or otherwise engaging in undesirable behavior that a competitive firm could not do profitably. We therefore begin by considering differences between competitive constraints for multi-sided firms and those for single-sided firms.

A. Competitive Constraints

Indirect network effects result in three major considerations for the analysis of competitive constraints.

First, the positive feedbacks between the sides that indirect network effects produce need to be considered when analyzing the profitability of increasing price. Consider a platform with sides A and B. An increase in price, or a reduction in quality, to A-type customers will reduce the number of A's that belong to the platform and the extent to which they participate in it. Since B-type customers value the platform because of their ability to access and interact with A-type customers, the demand by B's will fall even if the prices they face have remained the same. The result is that the demand by As will fall more since the platform is less valuable to them now that it has fewer B's. As noted by Armstrong (2006), the demand on each side of the platform is more elastic, and the profitability of a price increase is lower, when these positive feedback effects are considered than when they are not considered. In a study of magazines, Song (2011) found that these effects doubled estimated price elasticities. Of course, it is possible that these feedback effects are small and could be ignored in any particular setting. But if the subject of an antitrust inquiry is a multi-sided platform, one would at least need to inquire into the strength of these feedback effects in assessing the profitability of raising prices on any side.

Second, the competitive constraints on raising price to one side, or engaging in any other strategy, can come directly or indirectly from any and all sides of competing platforms. A platform that considers raising its price to one side, for example, has to consider the extent to which customers leave that side; how that affects customer losses on other sides; the extent to which other platforms pick up those customers; and how the addition of customers on each side of a competing platform increases the value of that platform to the other sides through positive feedback effects.

[28] For our general views on the proper analysis of market definition and market power in antitrust matters see Chang et al (2011a, 2011b) and Evans (2012b).

More generally, platforms engaging in any competitive move affecting one group it serves would need to consider counterstrategies aimed at that group or any other it serves. For example, if a platform attempts to engage in an exclusionary strategy on one side it is possible that a rival could counter with strategies that involve that, the other, or both sides. It is, of course, an empirical matter as to whether customers can turn to other platforms, as is the extent to which indirect network effects require looking beyond competition between the similar sides of alternative platforms.

Third, the existence of indirect network effects can also limit supply-side substitutability and increase entry barriers for multi-sided platforms. Successful incumbent firms have, by definition, obtained a critical mass of users on their several sides and benefit from the positive feedback effects between these customer groups. Entrants have to obtain critical mass as well and that often takes time. Moreover, in a mature market the entrant has the challenge of persuading users who may benefit from these positive feedback effects to switch to a platform that has a smaller and therefore possibly less valuable group of customers on the other side.[29] In practice product differentiation and the possibilities of multi-homing are critical determinants of the degree of difficulty faced by entrants.

B. MARKET POWER

Market power is commonly defined as the ability of a firm (or group of firms) to raise prices significantly above the competitive level, although there is no consensus on exactly how much above the competitive level constitutes *significant* market power. The competitive level is generally taken to be the price that would prevail under perfect competition, so that price is set at marginal cost.[30] There are difficulties and nuances in analyzing market power in single-sided markets that we do not address here.[31] Instead we focus on how the existence of demand interdependencies affects commonly used approaches to assessing market power.

Some models of multi-sided platforms, notably the Rochet-Tirole (2003) model discussed

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[29] In *U.S. v. Microsoft* the government argued that Microsoft had monopoly power in software operating systems because among other things it was protected by an insurmountable "applications barrier to entry." In the language of multi-sided platforms, which had not yet emerged when that case was tried, Windows was a multi-sided platform serving end users, developers who write applications, and hardware makers. All three are linked by indirect network externalities. Windows had a critical mass of customers on all three sides, and each group had made investments in the platform. The market power question is whether an entrant could have overcome these advantages and secured critical mass for the ignition, and generation of positive feedback effects, for an alternative platform. See United States vs. Microsoft Corp., 253 F.3d 34 (D.C. Cir. 2001); Evans et al (2000). The answers to questions of this sort are likely to be market-specific: Apple's iPhone had an enormous stock of applications (or apps) before the first Android smartphone was marketed, for instance, yet as this is written Android phones are substantially outselling iPhones.

[30] Areeda and Hovenkamp (2002), Volume IIA, at ¶501; Motta (2004), at 115; Elhauge and Geradin (2007), at 238. In the EU, dominance has also been defined as holding "a position of economic strength enjoyed by an undertaking which enables it to prevent effective competition being maintained on the relevant market by affording it the power to behave to an appreciable extent independently of its competitors, customers and ultimately of its consumers". See Case 27/76, United Brands Company and United Brands Continental BV v. European Commission, 1978 E.C.R. (1978).

[31] Chang et al (2011b).

above, may provide a theoretical rationale for comparing price and marginal cost by computing a multi-sided version of the familiar Lerner Index. Similar measures can be computed even when they lack a theoretical rationale, of course, but their interpretation in unclear in such cases. In general, multi-sided price-cost margins face the same difficulties in interpretation as do the single-sided price cost margins. Because competitive firms need to recover fixed costs, unless marginal cost is rising and exceeds average variable coat, prices cannot be equal to marginal cost in competitive equilibrium. Marginal cost is clearly not the right benchmark for software or internet-based products for which marginal cost is typically negligible. And, as Chamberlin (1933) noted long ago, competitive equilibrium in the presence of product differentiation necessarily involves prices above marginal cost.

Market share is often used to assess market power for single-sided firms. The theoretical justification for inferring market power from market share is weak for single-sided firms. It is no stronger for multi-sided ones. In addition, it is not always clear how to compute "share" for multi-sided firms. Consider a software platform. One of the main "products" that software developers get from the platform is access to users; one of the main "products" that users get is the access to software developers. One could compare shares for each of these sides across platforms and then make a judgment about market power based on looking at the shares for both sides, but there is no reason to expect those shares to be equal.

In addition, multi-sided platforms often provide one of their products for free or at a subsidized price. In these cases it is not possible to calculate a value-based market share, which is what is ordinarily recommended, since the price does not in fact reflect the value received by the user. In some cases there is a common metric for the multiple sides that provides a natural way to compute share. For example, buyers and sellers both use payment systems to execute transactions, and one could calculate shares based on the number or value of these transactions

Several authors have warned against basing judgments about market power on analysis of only a single side of a multi-sided platform.[32] As noted above, it is theoretically possible and empirically common for platforms to have prices that are significantly above marginal cost on one side and at or below marginal cost on the other side. A platform could have a monopoly in which it earns significantly more than the competitive rate of return yet price at or below marginal cost on one side. Therefore examining price on that side would result in a false negative test result for market power. A platform could also earn a competitive rate of return yet price significantly above marginal cost on one side. Therefore examining price on that side would result in a false positive test result for market power. In principle an analyst could adjust these prices by assessing the marginal cost of securing access to a customer on the other side, thereby lowering the effective margin for the high-price side and raising the effective margin for the low-price side. But this would not be a simple exercise and would still face the same difficulties as single-sided price-cost margin analyses.

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[32] Argentesi and Filistrucchi (2007); Evans (2003b); Song (2011); Weyl (2010); Wright (2004).

Profitability is also sometimes used to assess market power for single-sided firms. For multi-sided platforms the economic rate of return is an appealing measure of market power because it assesses the extent to which the platform has been able, through setting prices for its multiple sides, to earn more than a competitive return. Rates of return vary over time, however, and it is well known that measuring the economic rate of return and comparing it to the competitive rate of return is challenging at best.[33] The manner in which accounting data are collected and reported makes accurate measurements and comparisons difficult, as does the problem of accounting for risk and its compensation.

There is no single reliable method for assessing market power for traditional firms and it is usually recommended that analysts consider multiple sources of evidence to reduce the chances of false positives or false negatives. Exclusive reliance on mechanical measures such as market share or price-cost margins in determining market power is not advisable. The same issues apply to multi-sided platforms but, as we have discussed, there are further problems. A thorough review of competitive constraints is normally needed, and analysts need to make judgments based on multiple sources of evidence on these constraints. In evaluating these constraints, it is important that the analyst consider the role of interdependent demand as discussed above.

C. MARKET DEFINITION

The purpose of market definition is to identify the competitive constraints on the supplier of the product under consideration – the market forces that reduce the profitability of raising prices above competitive levels or lowering quality.[34] As noted above, these constraints may be imposed by single-sided firms on any side of the platform under consideration, by other platforms that serve the same customer groups, by other platforms that serve some but not all of the same groups, or by other platforms that serve the same groups plus others. Although some of these may be unimportant in particular instances, it is impossible to rule any of them out without investigation.[35]

The literature on multi-sided platforms has examined three issues related to market definition.[36] The first concerns the consequences of applying analytical tools that were developed for single-sided firms to defining markets for a product offered on one side of a multi-sided platform. Evans and Noel (2005, 2008) show that the failure to consider positive feedback effects in demand can result in significantly overstating or understating the breadth of the market, depending on the analytical approach. Consider the simple hypothetical monopolist test.[37] Suppose a small but significant, non-

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[33] Fisher and McGowan (1983); Fisher (1987); Feenstra and Wang (2000).

[34] European Commission (1997), at 5; UK Office of Fair Trading (2004), at 3; U.S. Department of Justice and Federal Trade Commission (2010), at 9-10.

[35] Rysman (2009).

[36] See Evans (2012c) for an overview.

[37] It starts with a hypothetical monopolist, which often consists of two firms that seek to merge. It then asks whether this hypothetical monopolist could profitably increase price by a small but significant and non-transitory amount above the current level. If the evidence implies that it could not, then there must be additional substitutes that constrain its pricing. The test proceeds in principle by including substitutes in the hypothetical monopolist until one

transitory price increase is profitable on one side under the assumption that nothing changes on the other side of the platforms included in the hypothetical monopoly. Therefore one could conclude that the products considered constitute a relevant antitrust market. However, as we have noted, a price increase on one side results in a reduction of demand by customers for that side and, through positive feedback effects, a reduction in the demand for the other side; the decline in demand on the other side further reduces the demand on the first side. Consequently, one might conclude after considering the positive feedback effects that the price increase is unprofitable. In that case the market is defined too narrowly. One can identify other techniques, such as those involving critical loss analysis, which when applied to a single side of a multi-sided platform would result in defining markets too broadly. The key point is that it is wrong as a matter of economics to ignore significant demand interdependencies among the multiple platform sides.[38]

The second issue concerns determining cases in which it is possible to easily adapt existing tools for market definition to multi-sided platforms. A special case is when the two sides are tied together in a fixed proportion, as in the Rochet-Tirole (2003) model. It is then possible to define a composite price that is equal to the sum of the prices that each customer side pays. The analyst can, in principle, conduct the SSNIP, critical loss, and Lerner-type market power analysis using this composite price. In the case of a critical loss analysis the Lerner-based elasticity of demand would be based on the composite price and the composite marginal cost of providing the service to the two sides, though the same concerns about these approaches in one-sided analyses would generally apply. Emch and Thompson (2006) propose applying this approach to payment cards. The composite price includes the fees charged to merchant acquirers for each transaction (a network fee plus an interchange fee) and the fees charged to issuers for each transaction (a network fee minus the interchange fee which they are paid). The U.S. Department of Justice adopted this approach in a case involving payment cards.[39] Many multi-sided platforms do not, however, provide services that are consumed in fixed proportions by the multiple sides. For example, in the case of mobile software platforms software developers are provided access to users while users are provided access to applications.

The third area involves developing general tools that can be used for assessing market definition for multi-sided platforms. These generally involve econometric models that explicitly account for

obtains an aggregate that, if acting as a single firm, could profitably increase price, and that aggregate defines the relevant market. See Kaplow (2013) in this volume.

[38] More generally, Evans and Noel (2008) show that there are two biases. It is possible to predict whether these biases lead to too narrow or too broad a market in the cases where the platforms are symmetric in the sense that they serve the same groups, face the same elasticities of demand, and have the same degree of positive feedback effects. There is an estimation bias that results from estimating a demand system for the potential group of products that ignores positive feedback effects. This bias leads to markets that are too narrow in the symmetric case. There is the Lerner bias that results from using the single-sided price-cost margin to estimate demand elasticity and then using this in a critical loss formula. This would result in defining markets too broadly in the symmetric case. It is not generally possible to predict the directions of the biases in the empirically more common case of asymmetric platforms.

[39] Hesse and Soven (2006); U.S. vs. First Data Corp., No. 03-CV-02169 (D.D.C. May 25, 2004), Final Judgment.

interdependencies in demand between the various platform sides. To date, these models have been developed and deployed entirely in the context of mergers and primarily for newspapers. We discuss them in the next section.

D. MULTI-SIDED PLATFORM MARKETS

As the discussion above demonstrates, multi-sided platforms do not fit neatly into the standard approaches for assessing market definition and market power. Moreover, extending these approaches to deal with multi-sided platforms rigorously is technically and empirically challenging. There is therefore a temptation on the part of analysts to do the best they can with standard tools, particularly when a case is presented as dealing with only one side of a platform's business—magazine advertising rates, for instance. While ideal tools for dealing with many situations do not yet exist, two basic limitations of standard tools must be dealt with to avoid serious errors.

First, the analysis needs to consider how positive feedback effects between demands on the multiple sides affect competition on the side under examination. It is a fundamental mistake to ignore these positive feedback effects, without at least first evaluating their significance, and therefore conduct a market definition analysis that focuses on one side and in effect assumes the other sides away. These features of the market could be considered in the market power prong of the analysis, but they must be considered somewhere.

Second, the analysis needs consider the welfare of all customer groups. When there are material demand interdependencies the welfare of the customers on the multiple sides are inextricably intertwined, and may move in opposite directions as price structures change. In an empirically-based simulation of hypothetical magazine mergers, for instance, Song (2011) found that mergers would sometimes benefit subscribers and harm advertisers and sometimes would have the opposite effects. Similarly, Jeziorski (2012) finds that the 1996-2006 merger wave in U.S. radio harmed advertisers but benefitted listeners. In these cases and in general, there is no compelling public policy rationale for ignoring the welfare of any group of customers as an artifice of market definition that focuses only on one side. Song's (2011) analysis indicates that even if advertisers oppose a particular magazine merger that would harm them and present a compelling analysis of a "magazine advertising market," it does not follow that the merger is socially undesirable.

V. MERGERS

The basic question in a merger inquiry concerns whether the proposed combination is likely to decrease consumer or social welfare significantly after accounting for unilateral and coordinated effects and efficiency.[40] We first discuss some significant general issues that arise in the unilateral effects analysis of mergers between multi-sided platforms in addition to those discussed above concerning the analysis of market definition and market power.[41] (We treat coordinated effects

[40] See Willig and Keating (2013) and Ordover (2013).

[41] An early and important contribution to the literature on multi-sided platforms is Rysman (2004) which developed

generally in Section VII, below.) While the bulk of the economic literature on multi-sided platforms has been theoretical, actual and potential mergers involving advertiser-supported media have been subjected to a good deal of empirical analysis. The second part of this section provides a brief overview of some recent empirical work on mergers of media businesses.

A. PREDICTING UNILATERAL EFFECTS OF MULTI-SIDED PLATFORM MERGERS

There are four general points to be made here:

First, the "off-the-shelf" analytical tools for assessing unilateral effects from mergers between one-sided firms may yield incorrect assessments insofar as they fail to account for interdependencies in demand among the multiple sides. Unfortunately, the multi-sided extensions of the single-sided tools used for back-of-the-envelope calculations of unilateral effects result in complex formulae that require estimates that are not likely to be readily available to the analyst. For example, Affeldt et al (2012) and White and Weyl (2012) explore how the UPP analysis introduced by Farrell and Shapiro (2010), and subsequently included in the 2011 Horizontal Merger Guidelines in the U.S., must be modified to account for indirect network effects in analyzing mergers of two-sided platforms. The formulas become a good deal more complex because a change in any one price affects all four quantities. To do a complete UPP analysis of a merger between two two-sided platforms, six diversion ratios must be estimated. These necessarily include estimates of indirect network effects. Similarly, Filistrucchi et al (2012) show how to perform a two-sided SSNIP test: they estimate the profitability of a small but significant and non-transitory post-merger increase in either or both of a two-sided platform's prices. This analysis requires a complete structural model of the firms' demands, including both cross-price effects and indirect network effects, a good deal more information than is necessary in the case of ordinary single-sided firms.

Second, in some cases it is at least theoretically possible for a merger of two-sided firms to result in price reductions to both sides even in the absence of efficiency gains. In the Chandra and Collard-Wexler (2009) model of a two-newspaper market, the main initial effect of a merger is that if a price increase of one paper causes a reader so switch papers, she is not lost to the merged firm. The way the model is set up, the first reader to switch away in response to a paper's price increase is always the least profitable for that paper. In fact, both newspapers, which are assumed unable to price discriminate, could well be losing money on their marginal readers at their optimal pre-merger prices. At those prices, by definition, a tiny increase in either paper's per-copy price would leave its profits unchanged. (That is, the derivative of each paper's profits with respect the per-copy price is zero.) Suppose at its optimal pre-merger price paper A is losing money on its marginal reader. Post-merger, a tiny increase in its price would lower the profits of the merged firm, since the unprofitable marginal reader would switch to the firm's other paper, thus lowering its profits. (That is, the

and estimated a structural model of Yellow Pages. Subsequent papers that have used a similar framework to analyze mergers of multi-sided platforms have included Affeldt et al (2012); Chandra and Collard-Wexler (2009); Filistrucchi et al (2012); Jeziorski (2012); and Song (2011).

derivative of the merged firm's profit with respect to the per-copy price of paper A is negative at the optimal pre-merger prices.) If a small increase in either paper's price would reduce the merged firm's profit, it follows that a small decrease in subscription prices at both papers would increase profits. Because consumers' propensity to subscribe to either paper is assumed to be correlated with their attractiveness to advertisers at that paper, these price cuts bring in subscribers who lower the average attractiveness to advertisers, thus also making a lower per-subscriber advertising rate optimal.

As this discussion indicates, the possibility of this particular result depends on a number of special assumptions, and even then whether prices go up or down depends on the values of particular parameters in the model. This model is certainly not generally applicable. But it remains to be seen whether the possibility to which it points—a platform merger lowering profit-maximizing prices to both sides even without efficiency gains—is also present in other models that are descriptive of other market settings. In the absence of further study, one must conclude that it appears possible that some mergers of multi-sided firms can lead to price cuts on all sides of the market even in the absence of efficiency gains—something that is simply impossible for mergers of single-sided firms. Although this possibility may turn out to be a very rare occurrence, its existence emphasizes once more that analysts need to consider the multi-sided aspects of mergers carefully and avoid mechanical analysis of multi-sided mergers with traditional one-sided tools.

Third, all else equal a merger of multi-sided platforms would ordinarily increase indirect network externalities by increasing the size of all customer groups and thereby provide efficiency benefits.[42] There is no similar presumption in the case of mergers of single-sided firms. To evaluate the impact of the merger on consumer (or social) welfare, analysts need to assess the value of these externalities. It is particularly important to do so since prices could increase to consumers on one or more side, while the value consumers are receiving on that side has increased even more as a result of positive externalities.

Fourth, to evaluate the impact of a merger of multi-sided platforms on consumer (or social) welfare it is necessary to consider the impact of all sides. A merger could benefit consumers on one side but harm those on the other side and the net effect of the merger across all customer groups could therefore be positive or negative. Suppose, for instance, that Open Table proposed a merger with a competitor and that it is determined that the merged firm would likely increase prices to restaurants. It does not follow that the merger is undesirable, however. Restaurants would likely have access to more consumers, and that might more than make up for the price increase. And if restaurants single-home and the merged firm does not take the radical step of charging consumers to make reservation, consumers would clearly be better off: they would still face a zero price and could access more restaurants on a single platform.

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[42] We want to emphasize that we are not advocating a lighter standard of review for multi-sided platform mergers or any presumption that such mergers are procompetitive.

B. ADVERTISING-SUPPORTED MEDIA MERGERS

Newspapers, magazines, and radio stations are two-sided platforms. Newspapers and magazines provide news and entertainment to readers and sell space on their pages to advertisers who want to reach those readers. Radio stations also provide news and entertainment, and they sell airtime to advertisers who want to reach their listeners. All these media solve a usage externality by providing a mechanism to bring a possible buyer and seller together. They pay the reader or listener to come by providing content, often at a subscription price below marginal cost for print media and at a price of zero for over-the-air radio, and they give the advertiser access to that reader or listener. They also generate positive externalities for advertisers; advertisers value media with more readers or listeners.[43] Consumers could like or dislike advertising. The evidence from studies so far indicates that overall advertising does not generate positive or negative externalities for newspaper readers.[44]

Chandra and Collard-Wexler (2009) conduct a reduced-form examination of the effects of the consolidation of the Canadian newspaper industry in the late 1990s on prices charged to consumers and to advertisers. They find no evidence that mergers led to increases in either price, contrary to expectations derived from one-sided models, and they interpret this as consistent with their theoretical model discussed above.

Several authors have evaluated the effect of newspaper and magazine mergers on prices and welfare by developing and estimating structural models of these platforms that account for the possible demand interdependencies between the two sides. Both Affeldt et al (2012) and Filistrucchi et al (2012) use detailed econometric models of the Dutch newspaper market, and they study how taking account of two-sidedness affects the evaluation of hypothetical mergers. Affeldt et al (2012) find that when two-sidedness is ignored, the estimate of upward pricing pressure on advertising is essentially zero, while they find substantial upward pressure on advertising rates when account is taken of two-sidedness. Filistrucchi et al (2012) find similar results with a SSNIP test and a full

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[43] Economists have recently developed formal models of advertising-supported media that explicitly recognize that they are multi-sided platforms. Most of the models to date are based on the assumption that consumers rely on a single platform and that the only way for advertisers to reach a consumer is to advertise on the platform that has a monopoly on that person. That assumption departs significantly from reality. Consumers obtain content from multiple advertising platforms. Advertisers consider these alternatives partly as substitutes in deciding how to allocate their advertising budgets; they also consider these alternatives as complements when they want to reinforce messages in different ways through different media. Unfortunately, many key results of most models depend on that assumption. For example, many papers conclude that platforms charge a monopoly price for advertising (since they each have a monopoly over access to some consumers) and that competition among platforms tends to increase advertising prices (because platforms that have less advertising can attract more consumers). See Anderson and Coate (2005); Calvano and Jullien (2012); and Reisinger (2012). Athey, Calvano, and Gans (2012) develop a model that assumes that some people use one platform while others stochastically search the web. They show that under this more realistic assumption the results of the earlier models are reversed

[44] See Argentesi and Filistruchhi (2007), Chandra and Collard-Wexler (2009), Fan (forthcoming), and Song (2011). Note that these results average across different types of advertising in newspapers. We suspect that consumers generally value classified listings—a service that consumers often seek out offline and online—while they may not value display advertising mixed with news and entertainment content.

simulation of the post-merger equilibrium: taking into account two-sidedness reveals potential unilateral effects on the advertising side that do not show up in analysis that ignores indirect network effects.

Fan (forthcoming) develops a structural model of newspapers that considers the value of characteristics to readers and advertisers and the possibility that the owners could change these characteristics following a merger. She estimates the model for newspapers in Minneapolis and finds that a hypothetical merger increases subscription prices, lowers the quality of content from the readers' perspectives, reduces circulation, and lowers the value that advertisers receive. Given that multisided platform businesses typically offer a variety of services to attract economic agents to the platform, analyses such as Fan's that consider the impact of mergers on non-price dimensions are likely to prove important in practice.

Song (2011) estimates a structural model of German TV magazines that ignores two-sidedness and one that takes it into account. He simulates a merger to monopoly in this market and concludes that this drastic merger would be much less harmful than an analysis that ignores two-sidedness would conclude. For many magazines he estimates that the merged firm would lower the per-copy price, making consumers better off. While advertising rates would generally increase, the greater circulation induced by lower per-copy prices would generally make advertisers better off as well on balance.

Finally, Jeziorski (2012) estimates a structural supply-and-demand model using data from the 1996-2006 merger wave in U.S. radio and taking account of indirect network effects. As noted above, he finds that this merger wave harmed advertisers but benefitted listeners. Like Fan (forthcoming), Jeziorski (2012) considers an important non-price dimension of performance. Consistent with other studies, he also finds that these mergers increased market-specific product variety, which contributed importantly to consumer benefits.

C. Some Practical Guidance

Analysts face a quandary in examining mergers of multi-sided platforms. The literature discussed above indicates that standard back-of-the envelope calculations may give highly misleading results for the merger of platforms that have significant interdependencies in demand between customer groups. At least at this point the analogous formulas for multi-sided platforms require more information than an analyst could easily obtain for an initial screening exercise. They essentially require the estimation of a structural econometric model. But if such a model can be estimated, the analyst should just use that model to estimate the unilateral effects of the merger. Of course, in practice, the data necessary for estimating structural models are rarely available, the estimated models may not be robust, and it may take too much time to collect the data and estimate structural models even when this is feasible.

Nevertheless, the best has never been the enemy of the good in sound merger analysis, and it need not be just because multi-sided platforms are involved. The important point is to recognize the economic structure of these platforms, especially the role of competitive constraints and

demand-side efficiencies, and factor that into the overall judgment concerning the merger. In some cases, it may be possible to analyze unilateral effects on each side using traditional tools but factoring in biases that have been identified in the literature. What analysts should not do is commit the classic drunk's mistake—looking under the streetlight for his lost keys just because the light is better there—by conducting a standard one-sided analysis just because it is easier.

VI. EXCLUSIONARY CONDUCT

Economists have developed a variety of models that help analyze whether particular business practices are likely to harm consumers as a result of excluding competitors from the market or benefit consumers by reducing prices or increasing quality. These models are typically based on a variety of assumptions that may or may not apply in any specific market. It is well known that many of these models are sensitive to these assumptions. Results change when assumptions change.[45] Vertical restraints, in particular, can be procompetitive under some conditions and anticompetitive under others.

Most of the theoretical models on which antitrust analysis relies assume, explicitly or implicitly, that the businesses considered are single-sided. They therefore are not obviously applicable to situations in which firms serve multiple customer groups with interdependent demands. Moreover, given the sensitivity of many of these models to the specific assumptions on which they rest, there is no basis for assuming that the results of models built for competition among single-sided businesses would apply to competition among multi-sided businesses. The only way to know for sure is to do the math.

A relatively small number of authors have extended models originally developed to study business practices by one-sided firms to consider the effects of those practices or similar ones when engaged in by multi-sided platforms. We provide an overview of some of this work in this section. It is important to note at the outset that the papers we discuss are more likely to be the first words on the issues they address than the last words. Much more work remains to be done.

Overall, the results of these multi-sided models are also sensitive to assumptions, and it remains true as a general matter that vertical restraints may be pro- or anticompetitive.[46] The work to date shows, however, that one-sided results generally do not apply to multi-sided firms. The point is not that multi-sided firms cannot or do not engage in anticompetitive practices. They could, in fact, engage in the same anticompetitive practices as single-sided firms or in very different anticompetitive practices, not even known or understood yet. Unfortunately, the work economists have done on single-sided firms does not provide much guidance for evaluating the conduct of multi-sided firms.

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[45] Evans and Padilla (2005).

[46] See Evans (forthcoming-b) for a general discussion including the possible procompetitive benefits of vertical restraints for multi-sided platforms.

A. CRITICAL MASS AND PLATFORM VIABILITY

Multi-sided platforms may attempt to use exclusionary practices to deter platform entry. To see why, we introduce the concept of critical mass and its role in launching a platform business as developed in Evans (2010) and Evans and Schmalensee (2010). Consider a new B2B exchange for a particular group of heterogeneous commodities. To provide value to buyers it must have sellers and to provide value to sellers it must have buyers. And it must have enough of both to be viable, since the likelihood of any buyer or seller finding a mutually advantageous trade increases with the number of potential trading partners.

This leads to the well-known issue of liquidity in trading environments.[47] A trading venue is only viable if there is a sufficient volume of bids and asks for trading to occur and therefore for both liquidity providers and liquidity takers to incur the expense of coming to the trading platform. If there is too little liquidity, buyers and sellers will not come to the platform. It there is enough liquidity, more buyers and sellers will come and the platform will in fact grow and the platform will be attractive to market specialists and other liquidity providers. But if there are not enough buyers and sellers, the market will not be attractive to liquidity providers. Critical mass refers to the minimal level of demand that platforms must have on their various sides. Platforms that reach that level are viable and positioned to grow more through positive feedback effects. Platforms that fall short of that level are not viable. In some industries, the level of critical mass may be small portion of the overall market. For example, Discover appears to be a viable U.S. payment card system even though it has only about a 3.2 percent share of transaction volume.[48]

When platforms are conceived they, of course, do not have any customers on any side. The challenge for a new platform is to reach critical mass. In some cases, this involves a sequential process of building up demand on one side and then attracting the other side, perhaps a la the "divide and conquer" pricing strategies discussed by Jullien (2011). For example, a media property can invest in building up an audience and then when it gets enough people making that audience available to advertisers. In other cases the platform must have both sides on board at the beginning to have any value. That, for example, is clearly the case for matchmaking platforms such as exchanges and dating venues. In this case, startups encourage early adopters and other people on both sides that are willing to join the platform in the anticipation that it will achieve critical mass.

Strategies that prevent platform entrants from gaining critical mass or that push platforms below critical mass can therefore exclude competitors and preserve the market for the predator. The usual array of exclusionary tactics may be employed, including exclusive dealing, tying and bundling, and predatory pricing. For such practices to be successful, they would need to be effective against the divide and conquer and other entry strategies available to competing platforms.

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[47] Harris (2003); O'Hara (1995); Pagano (1989).

[48] Nilson Report No. 988, February 2012, at 8. Note, however, that the Discover Card is accepted a most merchants that accept cards in the U.S. See "Discover Striving to Raise U.S. Merchants' Awareness of Card-Acceptance Abilities," *PaymentsSource,* April 21, 2010. http://www. paymentssource.com/news/-3001446-1.html.

The existence of interdependent demands, however, also provides rationales for why these strategies could increase consumer welfare even though they discourage entry. Putting congestion effects aside, when there are positive feedback effects between the multiple platform sides, increases in the demand on each side increases the value that the platform can deliver overall. Therefore, tactics such as requiring customers on one side to consolidate their demand on the platform—e.g. exclusive dealing—can benefit not only those customers but also the customers on the other side. These tactics can therefore increase consumer surplus.[49] Not surprisingly, as the remainder of this section demonstrates, depending on the assumptions made, the theoretical models of exclusionary strategies show that these strategies can increase consumer welfare, decrease consumer welfare, or have an uncertain effect on consumer welfare.

B. EXCLUSIVE DEALING

The *Dallas Morning News* and the *Dallas Times Herald* were competing newspapers in Dallas, Texas. They both obtained content such as columns and comic strips from the Universal Press Syndicate. In August 1989 the *Morning News* signed an exclusive contract with Universal. The *Times Herald* subsequently lost readership. It filed an antitrust case, and lost.[50] In 1991, the parent company of the *Morning News* bought the *Times Herald* and shut it down. Chowdury and Martin (2010) use this example to motivate their analysis of exclusionary contracts that deny platform rivals access to a key complementary input. They show that if consumers do not have strong preferences for one paper over the other and if fixed costs are substantial, social welfare may be higher in the post-contract, monopoly equilibrium, though consumers are always worse off. Similarly, in the Armstrong-Wright (2007) model of competition between platforms viewed as differentiated by one customer group and homogeneous by the other, exclusive dealing can be used to prevent multi-homing by the latter group and to exclude competitors, and the monopoly equilibrium may nonetheless be efficient

In the presence of economies of scale, Segal and Whinston (2000) have demonstrated that an incumbent monopoly can profitably deter the entry of a more efficient rival by persuading sufficient customers to sign exclusive dealing contracts before the entrant appears. Doganoglu and Wright (2010) investigate the effectiveness of this strategy when there are no economies of scale but network effects are present. In the two-sided case, they find that it is profitable for the incumbent to exclude a more efficient entrant by offering attractive exclusive dealing contracts to one side of the market before the entrant appears and then charging high prices to those on the other side. As in the single-sided case with scale economies, entry is deterred by making it impossible for the potential entrant to obtain sufficient customers to be viable. With indirect network effects, locking up either side of the market will make it impossible for an entrant to obtain customers on the other

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[49] Prices could go up as a result of the value being provided by the platform increasing. Consumer welfare would nonetheless increase so long as the value increases by more than the price.

[50] Times Herald Printing Co. vs. A.H. Belo Corp, No. A14-90-00856-CV (Texas App. – Houston [14th Dist.] November 27, 1991).

side.

In an empirical study of the video game industry, Lee (2012) finds that exclusive contracts can facilitate entry rather than deter it. Video game console platforms serve as intermediaries between people who play games and developers that create games. The platform consists of hardware and software that developers can use for writing games and that people then use for playing those games. Developers have a greater incentive to write games for consoles that have more users who are likely to license those games and users are more interested in buying consoles that have games they want to play. Video game console makers have a timing issue as discussed by Haigu (2006). It takes time to develop games. Therefore when a new console maker enters (such as Xbox did in 2001) or Sony creates a new version of its console (as it did with the PlayStation 2 and 3 in 2000 and 2006) it has to persuade developers to write games for that console without knowing the demand for it.

Video console providers sometimes write their own games, which become exclusive to them, and sometimes enter into contracts with game providers to develop games exclusively for their console. These practices reduce the availability of games to consumers who have purchased other consoles. However, Lee (2012) finds that in the case of sixth-generation video consoles, exclusive dealing facilitated entry. In the absence of exclusivity, game developers would write games first for the incumbent platform because of its larger user base. Only later, if at all, would they port those games to entrants. Thus the entrants would be unable to match the incumbent's array of games and would find it difficult to differentiate themselves in a positive way. With exclusivity, however, as long as there are uncommitted game developers, entrants can offer games that the incumbent cannot, thus enabling them to differentiate themselves. Lee's result is not inconsistent with the theoretical analysis of Doganoglu and Wright (2010), since exclusive contracts by the incumbent that prevented entrants from getting access to popular games could exclude entrants and harm consumer welfare. Nor is it inconsistent with the empirical work of Corts and Lederman (2009), who find that the increasing prevalence of non-exclusive video games in recent years has led to a cross-hardware-platform network effect in which game developers react to the installed base of all platforms. This effect, in turn, is consistent with the persistence of multiple competing hardware platforms.[51]

This literature does not necessarily lead to the conclusion that exclusive dealing is procompetitive for entrants and anticompetitive for incumbents. The entrant could be a significant multi-sided platform business as Microsoft was when it used exclusive contracts to enter the browser business in competition with the dominant incumbent Netscape and the video-game console business in competition with the dominant incumbent Sony PlayStation. In evaluating

[51] The analysis of Hagiu and Lee (2011) is also relevant here. They focus on whether content providers (game developers here) sell to one or more platforms or simply "affiliate" (be compatible with) one or more platforms and sell directly to consumers. In their model if content providers are able to extract significant rents from consumers, perhaps because their wares are highly differentiated, they will choose to affiliate and multi-home, while if their rent-extraction ability is low, they will sell exclusively to a single platform.

exclusive dealing contracts used by multi-sided platform entrants and incumbents, analysts would need to consider the context in which those contracts are being entered into—in particular whether they are part of a plausible anticompetitive strategy by either the entrant or the incumbent—and their procompetitive effects in achieving or maintaining critical mass.

C. TYING AND BUNDLING

In a classic paper, Whinston (1990) showed that in the presence of scale economies in the market for good B, a monopoly seller of good A would under some conditions find it profitable to employ tying contracts to become a monopolist in the B market. In his model, tying is not profitable unless it excludes other sellers of B. Whinston showed that whether or not this reduces social welfare depends on the details of the situation. Does this one-sided analysis apply to multi-sided firms? As usual, adding sides also adds a layer of complexity. For instance, Li (2009) analyzes a version of the Whinston (1990) model in which a two-sided platform facing competition considers whether or not to tie an unrelated good. She finds that if network externalities are strong enough, tying may be profitable (and may also be efficient) even if it does not exclude.

Amelio and Julien (2012) consider a two-sided case in which tying is both profitable and welfare-increasing. Suppose the profit-maximizing price on one side of the business is negative, but it is not feasible actually to charge a negative price. (One could argue that OpenTable must have faced this problem, since, as noted above, it effectively charges a negative price to consumers by providing rewards for usage.) By bundling another good or service, however, it is possible to make the effective price on that side negative. They show that this practice increases consumer welfare in the monopoly case but that it may not do so if there is competition.

Rochet and Tirole (2008) also model a situation in which tying increases social welfare. They consider two competing platforms: A, which offers both credit and debit cards, and B, which offers only a debit card. In their simplest model, allowing A to tie its two cards on the merchant side of the business, so they must accept either both cards or neither card (the so-called "honor-all-cards" rule), increases social welfare. Tying allows A to rebalance its pricing by raising the interchange fee on debit above the competitive level and lowering the interchange fee on credit. While this is always welfare-enhancing in their simplest model, in more complex models the net effect of tying on welfare is ambiguous.

Choi (2010) presents a model designed to shed light on the effects of including Microsoft's Windows Media Player with Windows, which was the subject of an antitrust case in Europe.[52] This involves tying two platforms together—an operating system (which connects computer users and application providers) and a streaming media software application (which connects computer users and content providers), though Choi does not model the multi-sided aspects of Windows. In this

[52] European Commission, Decision of 24 May 2004 Relating to a Proceeding Pursuant to Article 82 of the EC Treaty and Article 54 of the EEA Agreement Against Microsoft Corporation (Case COM/C-3/37.792 – Microsoft), Official Journal L 032, 06/02.2007 P. 0023-0028; Ahlborn and Evans (2009).

model, two platforms, A and B, link content providers to consumers, and A also produces a product M, which must be purchased in order to use either A or B. He assumes that content providers multi-home. If consumers single-home, tying A to M will exclude B but may increase welfare if network effects are strong (so there is a large efficiency gain from having more customers on both sides of A) and consumers do not consider A and B to be very different (so the reduction in variety from eliminating B is small). If consumers multi-home, however, tying A to M does not exclude B (there are no economies of scale), and social welfare is unambiguously increased. This analysis makes clear the importance of understanding where multi-homing occurs and, if it is not observed, why it does not occur.

When products are consumed in fixed proportions, as in the Choi (2010) model, tying is equivalent to pure bundling – selling only bundles of the two products involved. Chao and Derdenger (forthcoming) investigate mixed bundling – selling the products individually and (at a discount) in a bundle. Consider a monopoly video game platform that is considering a mixed bundling strategy: offering a bundle consisting of a console and some games as well as selling the console alone and allowing video game developers to sell games by themselves. Ignoring indirect network effects, one would expect that the optimal mixed bundling strategy would have higher prices for both the console and games when sold separately than would be optimal if the bundle were not offered, since the bundle enables the firm to segment the market according to the number of games buyers prefer to consume. Chao and Derdenger (forthcoming) present a theoretical model in which network effects make it is optimal to reduce both console and game prices if a bundle is offered. In that model, mixed bundling acts as a price discrimination device, as in one-sided models, and the presence of the bundle reduces the cost of cutting console and game prices in order to encourage participation by both consumers and developers. Chao and Derdenger (forthcoming) present an empirical analysis of video game pricing that reaches conclusions consistent with their theoretical model.

D. PREDATORY PRICING

The general concerns about predatory pricing are as applicable for multi-sided platforms as they are for single-sided firms. A platform could try to drive rivals out of business by lowering price to one or several of the groups it serves. That could involve increasing subsidies on one side by providing more or better free products and services. After driving a rival out of business the platform, like a single-sided firm, could raise prices and reduce subsidies thereby recouping its losses. As with the traditional story, one benefit of engaging in this strategy could be developing a reputation for being a ruthless competitor thereby discouraging entry or competition in multi-market settings.[53] One should recognize, however, that successful predation may be extremely difficult and unlikely, as it is in single-sided markets, given that it would entail certain up front losses from pricing below cost in pursuit of uncertain future gains from driving and keeping competitors out of the

[53] Kreps and Wilson (1982); Milgrom and Roberts (1982).

market.

The difference is that standard cost-based tests for detecting predatory pricing generally make no economic sense for a multi-sided business. Those tests are motivated by the standard theoretical result that profit-maximizing prices are never below marginal cost. But for multi-sided platforms, as a matter of theory, the profit-maximizing price to one or more sides (though not, of course, to all) could be lower than marginal cost—or any other measure of per-unit cost. Indeed, as we have noted, many multi-sided platforms normally charge prices that are less than marginal cost and often zero or even negative on at least one side.[54]

The flip side of this problem is that a platform could engage in predatory pricing by maintaining a low price on the "subsidy" side (readers for newspapers) and lower the price on the "money" side (advertisers for newspapers) so much that the platform overall loses money. Of course, in theory it would be possible to determine whether the platform has adopted an unprofitable set of prices, but in practice that would be a more complex analysis than comparing prices and some measure of per-unit cost as is standard for single-sided firms.

The important point is that the fact a multi-sided platform is providing goods or services to one of the groups it serves at prices that do not recover costs provides no meaningful evidence that the platform is engaging in predatory pricing. On the other hand, a change in pricing policy by a multi-sided platform that results in an overall lowering of prices to loss-inducing levels and that is not explained by other changes in the market could provide an indication of a possible abuse. As for single-sided businesses, one must go beyond analysis of pricing before concluding that predation has actually occurred.[55]

It is also important to note that there may be procompetitive explanations for a change in pricing policies for multi-sided platforms that result from interdependent demands and that would not ordinarily be considered for one-sided firms. For example, in examining allegations that *The Times* of London engaged in predatory pricing Behringer and Filistrucchi (2011) argue that there is evidence that *The Times* lowered subscription prices sharply because it recognized that advertising prices, and therefore the value of readers, were increasing. It was then profitable to reduce subscription prices to increase readership so as to be more valuable to advertisers. These authors suggest that perhaps *The Times* recognized this before its rivals and therefore lowered its prices earlier than they did.[56]

Predatory pricing strategies could also exploit the role of interdependent demands and critical mass for platforms. By charging unprofitably low prices (including providing subsidies in kind) a platform could make it difficult for a rival that cannot match these low prices (or subsidies in kind)

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[54] Motta and Vasconcelos (2012) present a model of platform competition in which below-cost pricing never occurs except to deter entry, so that cost-based tests can be employed, but the model seems unlikely to be widely applicable.

[55] See the chapter on predatory pricing in this volume, Elzinga and Mills (2013).

[56] Motta and Vasconcelos (2012) agree that this episode was probably not an instance of predation, but they point to other cases involving platform businesses that they believe did engage in predatory pricing.

to obtain a critical mass of customers. For example, suppose an incumbent platform faces competition from a venture-backed startup. To prevent the startup from getting enough critical mass to ignite its platform the incumbent could increase the content offering it is giving customers for free on one side of its platform. Assuming the startup is liquidity constrained, that could prevent the launch of its platform.[57]

E. EFFICIENCIES

When it comes to considering efficiencies the main novelty for multi-sided platforms arises from the fact that platforms serve multiple groups of customers with interdependent demands. Business practices can increase the overall value of the platform both to its owners and to society in a variety of ways. By increasing demand on one side, a platform can increase its value to agents on other sides through indirect network externalities. This is a real social benefit, and the platform is unlikely to be able to capture it all. In addition, Evans (2012a) shows how platforms develop governance systems to reduce bad behavior by platform participants that could reduce the platform's value. The ability to exclude customers is central to the rules platforms use for this purpose. More generally, Boudreau and Hagiu (2009) discuss the use of platform regulations to increase positive externalities and decrease negative ones. In other cases, business process innovations might increase the efficiency of a platform by providing better and cheaper matches between members of the various sides.

As a general matter, a platform could increase consumer welfare overall if it increased the value it delivered by more than it increased the prices it charged. It is possible, however, that change in platform prices and products benefit customers on some sides while making customers on other sides worse off. In evaluating such changes, there is no economic reason why one would focus on losses to one group of consumers and ignore gains by another group. Economists are normally interested in overall consumer welfare. A court or competition authority could erroneously conclude, however, that a business practices harms consumers by analyzing competitive effects in a narrow market that excludes one or more sides of a platform.[58] That is a fundamental mistake; correct analysis of multi-sided platforms always considers all groups served by the platform.

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[57] Of course, it is well known that predatory pricing strategies generally face a number of challenges, and these challenges also apply to multi-sided firms. Easterbrook (1981); Carlton and Perloff (2005), at 352-360.

[58] Payment card networks have rules that merchants that have agreed to accept a card brand cannot surcharge consumers for using that brand or selectively refuse to accept cards with that brand. Competition authorities and private litigants have challenged these rules under various theories including tying. In these cases, the competition authorities and courts have focused primarily on the merchant side of the payment platforms and ignored the benefits on the consumer side. Our point is not that these practices are necessarily pro-competitive but that the correct analysis needs to consider the welfare of customers on both sides of the platforms. See In Re Payment Card Interchange Fee and Merchant-Discount Antitrust Litigation, No. 05-MD-1720-JG-JO (E.D.N.Y. February 20, 2009), First Amended Supplemental Class Action Complaint; U.S. vs. American Express Co., No. 10-CV-04496-NG-CLP (E.D.N.Y. October 4, 2010), Complaint.

VII. COORDINATED BEHAVIOR

Two major issues arise in the analysis of coordinated behavior for multisided platforms:

First, the welfare analysis of price fixing becomes more complex. When competing single-sided firms collude on prices, economic theory predicts that they will generally raise prices, reduce output, and reduce consumer and total welfare.[59] The theory of multi-sided platforms yields much less clear predictions. It is possible that competing platforms have adopted prices that are too low on one side and too high on another. That is, there is no guarantee that competition will result in platforms adopting the pricing structure that maximizes consumer welfare. It is therefore possible that a coalition of platforms could fix prices—raising them on one side and lowering them on another—that increases consumer welfare.

Several papers have reached this conclusion directly or indirectly. The analysis of payment card systems' "honor-all-cards" rule by Rochet and Tirole (2008) points in this direction. In their model that rule has the effect of reducing competition between debit cards, permitting a rebalancing of interchange fees that is socially beneficial under some conditions. Chandra and Collard-Wexler (2009), discussed above in the context of mergers, finds that a merger of two newspapers or, presumably, an agreement to fix subscriber and advertiser prices could result in an increase of consumer welfare as a matter of theory and finds support for this possibility based on Canadian newspaper data. But, as we noted above, the structural model developed by Fan (forthcoming) implies that a merger of two Minneapolis newspapers would make both readers and advertisers worse off.

Two recent studies have considered coordinated behavior by newspapers that stops short of fixing all prices. In a model that considers differentiation of newspapers along political lines, Antonielli and Fillistruchi (2012) find that competition on pricing and political positioning creates greater consumer welfare than collusion. But they also find that Joint Operating agreements, a device used in the U.S. that allows newspapers to collaborate on pricing and production but compete on the editorial side, result in lower consumer welfare than allowing newspapers to collaborate on all aspects of their business. Gentzkow et al (2012) develop another structural model that allows newspapers to choose their political positions and estimate it using U.S. data from early in the 20th century, when it was common for newspapers to declare their political affiliation, and many more cities had multiple papers. They find that the main effect of allowing collusion on circulation prices is to reduce consumer and advertiser surplus, while allowing collusion on advertising prices reduces advertiser surplus but increases consumer, newspaper, and total surplus. It also induces substantial new entry and increased ideological diversity. Because advertisers value readers, collusion on advertising rates makes it profitable to lower circulation prices to increase readership, making consumers better off, and then to extract the increased value to advertisers

[59] The rare case of firms with substantial market power selling complements provides an exception; see Rey and Verge (2008).

through higher advertising rates.

The second issue is that the existence of inter-linked prices raises the question of whether collusion is harder or easier for platforms than for single-sided firms. Clearly the need to agree on multiple prices makes platform-wide collusion harder, all else equal. Moreover, even ignoring this issue, Ruhmer (2011) presents a two-platform model with single-homing in which stronger indirect network effects increase the gains from price-cutting and thereby make collusion harder to sustain. This result suggests that in analyzing proposed mergers of multi-sided firms, enforcement agencies might be less concerned about collusion than in mergers of single-sided firms, but it is not clear that a significant difference can be rationalized unless indirect network effects are very strong indeed.

Ruhmer (2011) also addresses the question of whether multi-sided platforms can increase profits by colluding on only some of the prices they charge. Evans and Schmalensee (2007a) argued that intense competition on one side between two-sided platforms could eliminate the profitability of collusion on the price charged on the other side. In Ruhmer's (2011) model, where the two platforms are imperfect substitutes for consumers and competition is not particularly intense, it is possible for firms to profitably collude on prices on only one side. The profitability of such incomplete collusion thus depends on the intensity of competition on the non-collusive side.

VIII. CONCLUSION

As economists, we find the rapidly expanding literature on multi-sided markets interesting and exciting. It is interesting both because of its technical complexity and because of the growing economic importance of multi-sided platforms. It is exciting because it reveals patterns of behavior and market outcomes that cannot arise with ordinary single-sided firms. As students of antitrust policy, however, we look as this expanding literature with some trepidation.

As this chapter has indicated, correct economic analyses of multi-sided platforms are more complicated than correct analyses of single-sided firms. Moreover, the relevant theory, at least in its current stage of development, yields fewer clear predictions, and there is relatively little empirical work from which one can draw general lessons. Thus it does not now seem possible to come up with many guidelines that can be used to structure rule of reason inquiries, let alone sharp lines that would justify per se rules.

But the world and the economic literature are what they are, to paraphrase a successful professional (American) football coach. Multi-sided platforms are more complicated than single-sided firms. Analyses or policy rules that ignore this complexity are prone to commit serious errors. Just because the economic literature on multi-sided platforms does not have simple extensions of existing single-sided tools does not provide a license to apply the wrong, single-sided tools to multi-sided platform issues.

In the meantime, we can provide some bits of general guidance. Perhaps the most important is to consider all sides served by a platform carefully and to understand the indirect network effects that link them. Understanding that newspapers are two-sided platforms does not make analysis of them simple. But it does serve to structure the analysis in sound and sensible ways. Understanding

that OpenTable is a two-sided platform leads the way to understanding how giving away services to consumers could be profit maximizing, not predatory. Recognizing that there are multiple customer groups with interlinked demand may help competition policy analysis identify anticompetitive strategies and identify possible efficiencies that would not be apparent from applying a traditional analysis. Finally, recognizing these multiple customer groups is critical for ensuring that antitrust enforcement does not have the unintended consequence of reducing consumer welfare by causing more harm on one or more sides of a platform than it provides benefit on another side.

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Appendix
The Literature on Multi-Sided Platforms Through 2012

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