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MULTI-SIDED PLATFORMS

Multi-sided platforms reduce transactions costs and thereby facilitate value-creating interactions between two or more different types of economic agents.

Abstract: This essay provides an overview of the basic economics literature on multi-sided platforms, focusing on ways in which they businesses differ from ordinary single-sided businesses. Distinctive aspects of startup, pricing, welfare analysis, and competition are discussed.

Keywords: platform, multi-sided, two-sided, network, externality, network effects, critical mass

Multi-sided platforms (or *MSPs*), which we also call *matchmakers* (Evans and Schmalensee, 2016) reduce a transaction cost or economic friction that makes it difficult or impossible for agents in different groups to get together for productive interactions. (We resist calling MSPs two-sided markets because being an MSP is a property of a business, not of a market.) In some cases by eliminating potential frictions, platforms create opportunities for the emergence of new types of economic agents – app developers for smartphones, for instance. MSPs play critical roles in many economically important industries including payments, communications,, financial exchanges, advertising-supported media, operating systems, and various Internet-based industries such as online marketplaces and ride-sharing apps. In many 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, tending to make larger platforms more attractive to potential customers. 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 worthwhile for all types.

The fundamental insight that there is a broad class of businesses of this sort that have economic features not well explained by standard textbooks was presented by Rochet and Tirole (2003) in a paper that started circulating around 2000. Other foundational papers are Caillaud and Jullien (2003), Armstrong (2006), and Rochet and Tirole (2006). Weyl (2010) generalizes and unifies the models in these papers. (In the context of information goods, Parker and Van Alstyne (2000) introduced a model that is a linear version of the model subsequently developed by Armstrong (2006).)

The main focus of Rochet and Tirole (2003) was on how the prices charged to the two sides of a 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 matchmakers set some prices below marginal cost and sometimes at zero.

Since its inception, the literature on multi-sided platforms has grown rapidly in economics, antitrust, and strategic management. In addition, in recent years many new MSPs such as Uber have grown explosively by exploiting advances in computation and communications (Evans and Schmalensee, 2016, ch. 3). The multi-sided platform literature is now regularly cited by competition authorities and courts. These businesses pose novel problems for competition policy (Evans 2003b, Evans and Schmalensee, 2015).

An Instructive Example

OpenTable is a U.S.-based company that serves restaurants and consumers across the U.S. and in other countries. (Evans and Schmalensee, 2016, esp. ch. 1). It enables consumers to make and restaurants to accept reservations over the Internet. It helped solve a transaction cost problem for consumers and restaurants. In the U.S., consumers used to have to call a restaurant and, assuming they reached someone, ask whether a particular time was available for their party. If the answer was no, 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.

OpenTable has several features that are common among multi-sided platforms. First, it facilitates valuable interactions between two distinct groups of agents: consumers and restaurants. The fact that members of each group value interacting with members of the other group underlies the indirect network externalities involved and provided an opportunity for an entrepreneur to create a profit-making platform by reducing the transactions costs members of both groups had to incur in order to interact.

Second, OpenTable has three sorts of indirect network externalities. There is a *usage externality*: both consumers and restaurants benefit when each uses the system to make a reservation. And there is a *membership externality*: the system is more valuable to consumers the more different restaurants it lets them access, and the system is more valuable to restaurants the more consumers that use it, since that increases the likelihood that there will be a coincidence between consumers looking for a restaurant and tables available at a particular time.

OpenTable also has what we have called a potential *behavioral externality* (Evans and Schmalensee, 2016, ch. 9). Like many MSPs, and unlike most single-sided businesses, OpenTable has rules against conduct that would reduce the value of its platform for other users. In particular, diners who fail to show up for four reservations in a 12-month period have their accounts cancelled.

Third, OpenTable faced a *critical mass* problem when it began, a problem that is often the most difficult one faced by new matchmakers (Evans and Schmalensee, 2010). For OpenTable's service to be viable, it needed to have significant numbers of *both* consumers and restaurants using its platform. OpenTable started by leasing table management software to restaurants—a one-sided business. It developed a web-based platform for consumers to make reservations that linked with its table management software and marketed the online reservation service to consumers for free. After some expensive experimentation, it finally obtained critical mass by working hard to sign up the leading restaurants in a single city, using their presence on the system to market to diners in that city, using that customer base to recruit more restaurants, which then got more diners. It then repeated this formula for obtaining a sufficient density of diners and restaurants that wanted to connect with each other in other cities.

Finally, like many matchmakers OpenTable's price structure involves a *money side*, the group that pays more than marginal cost, and a *subsidy side*, the group that pays than marginal cost. OpenTable offers its service to consumers for free. In fact, the price to consumers is slightly negative: consumers earn modest usage-based rewards. Restaurants, the money side of this platform, must license Open Table's table management software and pay a fee for every patron they seat who has made a reservation through OpenTable. That is, they pay a fixed *access fee* 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.

When a single-sided firm with market power sets a price below marginal cost, worries about predatory pricing naturally arise. But OpenTable's charges to restaurants more than cover all its costs. Matchmakers can, of course, engage in predatory pricing, but a correct analysis of their pricing must consider prices to all sides, not just one. (Evans, 2003b).

To see the complexity of competition policy toward matchmakers, suppose that Open Table proposed a merger with a competitor of roughly equal size and that the merged firm would likely increase prices to restaurants. The merger could still increase the welfare of restaurants, of diners, and possibly both. If restaurants used only one platform and the merged firm did not take the radical step of charging consumers to make reservations, consumers would clearly be better off: they would still face a zero price and could access more restaurants on a single platform. Restaurants might be better off too: they would likely have access to more consumers, and that might more than make up for the price increase.

Critical Mass

As noted above, the major challenge for most aspiring platforms is to get enough agents on each side to secure the critical mass necessary to ignite indirect network effects and drive growth (Evans and Schmalensee, 2010; 2016, ch. 5). Since platforms are basically selling members of each group access to members of the other group or groups, unless there are enough individuals of the right sort in each group, the platform has nothing to sell.

An interesting example of the power of network effects to ignite growth is provided by Diners Club, the first general-purpose payment card (Evans and Schmalensee, 2005; 2007). It gave cards to several hundred consumers in wealthy neighborhoods in Manhattan. It then used that fact to recruit 14 restaurants to take its card. Consumers could use the card for free; restaurants paid a per-transaction usage fee. In the ensuing months 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. Diners Club ignited. By its first anniversary in 1951, Diners Club had 42,000 individuals who carried its card and 330 merchants that that took the card. Five years later it was accepted at nine thousand merchants, with an annual transaction volume of $54 million. This is an example of what Jullien (2011) has called a "divide and conquer" strategy: subsidize agents in the most price-sensitive group, then use their participation to attract agents in the other group. Other sorts of strategies have also worked for some firms (Evans and Schmalensee, 2016, ch. 5).

In contrast, the launch of Apple Pay shows how hard it can be for even sophisticated firms to attain critical mass (Evans and Schmalensee, 2016, ch. 10). Apple Pay was launched in October 2014, with rhetoric that promised that it would replace plastic cards at physical points of sale. As of this writing, however, Apple Pay use in the U.S. is insignificant. To use Apple Pay, consumers needed an iPhone 6 or iPhone 6 Plus, and merchants needed to have new terminals that could accept contactless payments. While the new iPhones sold well, most consumers didn't have them at first. Those who did didn't find a compelling reason to use Apple Pay rather than a plastic card, which was easy and convenient. Limited demand to use Apple Pay by consumers gave merchants little reason to acquire the new terminals and promote the use of Apple Pay. Since consumers thus couldn't use Apple Pay at many merchants, even early adopters had little incentive to use it.

Pricing

Pricing in two-sided platforms is more complex than in ordinary multi-product businesses. For single-sided firms, demand depends on the prices of its products 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 of (or, more precisely, measures of the expected value of potential matches with) members of each of the other groups that the platform serves. Loosely speaking, the sides are complements in demand. (Ad-supported media typically require a different analysis because advertisers value more users, but users don't necessarily value more advertising.)

Consider a platform with sides A and B. An increase in price to A-type customers will reduce the number of A's on the platform. Since B-type customers value the platform because of their ability to access A-type customers, the demand by B's will fall, all else equal. The demand by As will then 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.

We now briefly consider pricing in the two most basic models of two-sided platforms. In the first of these, due to Rochet and Tirole (2003), 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 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:

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

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 in which men value the presence of many women and vice versa. The demand of each group for membership depends both on the fee it is charged and on the number of members of the other group. The firm's profit function in this model is given by

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

where Q_i is the number of members from group i and $Q_i = D_i(P_i, Q_j)$, i=1,2, i≠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 (positive) 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 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 connect differentiated sellers with consumers. He finds that the stronger are consumers' preferences for variety, the larger the share of a monopoly platform's profits that is optimally derived from sellers.

Welfare

An accurate analysis of the impact of any platform's decision on consumer welfare must take into account all the interdependent 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 through indirect network externalities. This point is particularly important in the antitrust context, where focusing only on the effects on one group is likely to lead to error.

There are two potential reasons why the profit-maximizing decisions by a platform might differ from the decisions that maximize social welfare. The first is the familiar market power failure. A platform with market power will set its overall *price level* higher than is socially desirable. Since most firms have some market power, the market power failure is not unique to MSPs.

The second possible market failure stems from a platform's choice of its *price structure*. In the two basic monopoly models considered just above, Weyl (2010) shows that this distortion arises because a platform considers the impact of its pricing on the marginal users in the groups it serves, 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.

Payment card interchange fees 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). They thus primarily affect the system's price structure. As a very large literature that began with Baxter (1983) makes clear, there is no general reason why the profit-maximizing interchange fee would also maximize social welfare. (See Tirole (2011) for an accessible overview of policy issues and Bedre-Defolie and Calvano (2013) for an interesting recent contribution.) However, the socially optimal interchange fee depends on detailed features of cost and demand structures.

Competition

In simple models, indirect network effects can 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 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, and multiple shopping malls in most metropolitan areas.

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.

As in one-sided firms, there is often variation among a matchmaker's consumers both in their valuation of various product attributes (horizontal differentiation) and in their willingness or ability to pay for quality (vertical differentiation). 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 side(s). Because of these interdependencies, a platform must usually make differentiation decisions (including product innovation 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.

Product differentiation is a key reason why many industries with multi-sided platforms have multiple competitors. The online portion of the job placement industry, which consists of job boards that help match job searchers with employers through online postings and search, is a highly fragmented industry of two-sided platforms. In the U.S. there are two large job boards that cover many different job categories. But there are also 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.

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 case of payments, consumers and merchants both generally use several payment platforms and therefore multi-home.

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 *competitive bottleneck*. When there is single-homing on one side and multi-homing on the other side in his model, Armstrong shows that platforms will compete more aggressively for the single-homing customers, 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. It is not clear how robust this finding is and how it interacts with other aspects of platform competition. Operating system providers, for example, typically charge users, who single home, and subsidize developers, who multi-home.

Sometimes one set of multi-homing agents can dictate the choice of platform to agents on the other side of the market. Even though most U.S. consumers use multiple payment systems and most merchants accept all of the payment alternatives, one can argue that in practice the consumer dictates which payment system is used. The consumer generally offers one particular payment alternative at checkout. The merchant then has to decide whether to reject that alternative method, with the risk of losing a sale. If the consumer effectively dictates, then, by the logic of competitive bottlenecks, payment platforms have an incentive to compete more aggressively for consumers. Bedre-Defolie and Calvano (2013) show that under this assumption, payment card systems have an incentive to subsidize card users at the expense of merchants.

Multi-sided platforms often face complex competitive environments that involve asymmetric competition (Eisenman et al, 2011). Several common examples include:

- A multi-sided platform competes with single-sided firms on one or more sides. Shopping malls compete with stand-alone single-sided merchants.
- A multi-sided platform competes on the same sides as a rival but serves an additional side as well. Microsoft Windows competed for users, developers, and computer makers while Apple's MacOS, which wasn't licensed to computer makers, competed only for users and developers.
- Two multi-sided platforms that compete on some but not all sides. This is common for ad-supported media. Facebook operates a social network to attract users to its platform (a two-sided communication network) while Google Search operates a search engine that attracts users looking at search results (from connecting users and websites). Both then connect advertisers to users.

These asymmetries can make both a platform's analysis of its possible decisions and antitrust analysis of platform behavior quite complex. One general lesson for antitrust is that the use of antitrust analytic tools developed for single-sided markets can lead to significant error when applied to MSPs, while multi-sided generalizations of those single-sided tools involve more complexity and information requirements (Evans and Schmalensee, 2015).

Bibliography

Armstrong, M. 2006. Competition in Two-Sided Markets. RAND Journal of Economics 37, 668-691.

Baxter, W. 1983. Bank Interchange of Transactional Paper: Legal and Economic Perspectives. Journal of Law and Economics 26, 541-588.

Bedre-Defolie, Ö. and Calvano, E. 2013. Pricing Payment Cards. American Economic Journal: Microeconomics 5, 206-31.

Caillaud, B. and Jullien, B. 2003. Chicken and Egg: Competition among Intermediation Service Providers. RAND Journal of Economics 34, 309-328.

Eisenmann, T.R.., Parker, G. and Van Alstyne, M. 2011. Platform Envelopment. Strategic Management Journal 32, 1270-1285.

Evans, D. S. 2003a. Some Empirical Aspects of Multi-Sided Platforms. Review of Network Economics 2, 1-19.

Evans, D. S. 2003b. The Antitrust Economics of Multi-Sided Platforms Markets. 20 Yale Journal on Regulation. 327-379.

Evans, D. S. and Schmalensee, R. 2005, Paying with Plastic: The Digital Revolution in Buying and Borrowing, 2nd Ed. Cambridge, MA: MIT Press.

Evans, D. S. and Schmalensee, R. 2007. Catalyst Code: The Strategies Behind the World's Most

Dynamic Companies. Cambridge, MA: Harvard Business School Press.

Evans, D. S. and Schmalensee, R. 2010. Failure to Launch: Critical Mass in Platform Businesses. Review of Network Economics 9, 1-26.

Evans, D. S., and Schmalensee, R. 2015. The Antitrust Analysis of Multi-Sided Platform Businesses. In *Oxford Handbook of International Antitrust Economics* (R.D. Blair and D.D. Sokol, eds.), Oxford: Oxford University Press, 404-447.

Evans, D. S., and Schmalensee, R. 2016. Matchmakers: The New Economics of Multisided Platforms. Boston: Harvard Business Review Press.

Hagiu, A. 2009. Two-Sided Platforms: Product Variety and Pricing Structures. Journal of Economics and Management Strategy 18, 1011-1043.

Jullien, B. 2011. Competition in Multi-Sided Networks: Divide and Conquer. American Economic Journal: Microeconomics 3, 1-35.

Parker, G.G. and Van Alstyne, M.W. 2000. Internetwork Externalities and Free Information Goods, in Proceedings of the 2nd ACM Conference on Electronic Commerce, New York: Association for Computing Machinery, 107-16.

Rochet, J.-C. and Tirole, J. 2003. Platform Competition in Two-Sided Markets. Journal of the European Economic Association 1, 990-1029.

Rochet, J.-C. and Tirole, J. 2006. Two-Sided Markets: A Progress Report. RAND Journal of Economics 37, 645-667.

Schmalensee, R. 2011. Why is Platform Pricing Generally Highly Skewed? Review of Network Economics 10, 1-11.

Spence, A. M. 1975. Monopoly, Quality, and Regulation. Bell Journal of Economics 6, 417-429.

Tirole, J. 2011. Payment Card Regulation and the Use of Economic Analysis in Antitrust. Competition Policy International 7, 137-158.

Weyl, E. G. 2010. A Price Theory of Multi-Sided Platforms. American Economic Review 100, 1642-1672.

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