Two-Sided Market Pricing in Operations Management: Review of Current Literature and Research Directions

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Abstract

With the rapid evolution of Internet technologies and the popularization of smart technologies, various two-sided markets have sprung up in different fields. Due to its special network externalities and the huge impact on traditional markets, two-sided markets have aroused great concern of academics to the two-sided market theory. In recent years, many scholars in the field of operations management also turn their attention to two-sided platforms. The research on operations management strategies for two-sided platforms needs to incorporate multidisciplinary theories rather than relying solely on research in a single discipline such as economics. As one of the main strategies of operations management, pricing in two-sided market becomes a mainstream research issue. Based on the development of two-sided market theory, this article reviews the studies on two-sided market in operations management in recent years, from the perspective of whether the two sides enter the market simultaneously.

Key words: Two-sided market; Pricing; Operations management; Review

INTRODUCTION

The classic two-sided markets are comprised of video games market, search engine, operating systems, portals, newspapers and magazines, television networks, credit card networks, shopping malls, home agencies, social media, etc. These markets provide a wealth of case support for early theoretical research on two-sided market. After more than a decade of development of the Internet and smart technologies, the Internet-based service industry continues to emerge. In the communications industry, Apple Inc., in conjunction with the release of first-generation smartphones, first set up an application store, which connects application developers and customers, to further develop a platform-centric two-sided market. Since then, Samsung, Huawei and other communications industry giants have followed the example of Apple to build their own application platform. In the e-commerce industry, Amazon gradually transformed itself from an initial retailer model to a hybrid model consisting of a retailer model and a platform model, which include two typical models of this industry. In tourism, Airbnb matches the supply of private space to the demand of travelers, creating a two-sided market for online rental deals. In the field of transportation, the intelligent travel platforms such as Uber and DiDi founded a few years ago and the bike sharing platforms represented by Mobike and OFO founded recently are constantly changing our traveling mode. In catering industry, the takeaway booking platforms offer great convenience to lives. In addition, the new online market formats such as crowdfunding platforms, online auction platforms and lending platforms have also provided abundant soil for the study of two-sided market theory. In this paper, we mainly review the application of two-sided market theory in the field of operations management from the perspective of two-sided market pricing strategy.

1. THE BASIC CHARACTERISTICS OF TWO-SIDED MARKETS

What is the two-sided market? Two-sided market related studies began to emerge around 2003, and early scholars gave the definition of a two-sided market from different perspectives. From a transactional perspective, Rochet and Tirole (2004) roughly defines it as a market where transactions between end users can be traded on one or more platforms; from the price allocation perspective, it is defined as a market where the number of users "on board" is not only related to the price level of the platform (i.e., the sum of the prices charged to two sides users), but also to the to the price structure (i.e., the two sides allocation of price levels); from the perspective of transactional externalities, in a two-sided market, the trading volume on the platform would be affected by charging more fees on one side and simultaneously charging the same amount less on the other side. In other words, the platform "brings both sides on board" by coordinating the price structure. However, the concept of these definitions is questioned by Hagiu (2007). Rochet and Tirole (2004) indicate whether a market is two-sided or not depends on whether the market satisfies certain conditions. In short, this definition is a 0-1 choice. Hagiu (2007) argues that the two-sidedness relies on the division of control between sellers and intermediaries, including the control over pricing, advertising, distribution and bundling decisions, rather than on the effects of the pricing structure chosen by the intermediary, as is the case with the definition proposed by Rochet and Tirole (2004). In short, there is a continuum of intermediary types between a pure merchant and a pure two-sided platform, which is not a 0-1 choice. Rochet and Tirole (2003) also gives a rough definition from the perspective of externality, they believe that two-sided market needs to meet two conditions: firstly, two sides interact through the platform or intermediary; secondly, the decision of one side will affect the number of the other side, typically by exerting influence through externalities.

Two-sided market theory is closely related to network externalities theory and multi-product pricing theory. The origin of this theory is to solve the problem that one side user's welfare will be affected by the network externalities brought by the other side users on the platform when transacting on the platform, but this externality has not been internalized. Indeed, the research on two-sided market could be seen as a subset of the research on network effects in a technical sense. However, two-sided market study concentrates on the intermediary's or platform's actions, particularly pricing strategies, while papers on network effects focus on user adoption and optimal network size (Rysman, 2009). In two-sided market, generally, buyers and sellers trade through the platform. In a monopoly market, for a certain transaction,

from the platform's perspective, in order to maximize its own profit, it is necessary to set a reasonable charging mechanism, in most cases, including membership fee (i.e., access fee or lump-sum fee) and transaction cost fee (i.e., usage fee or per-transaction fee), or a combination of the two. From the seller's perspective, when pursuing high returns, in addition to considering the costs, it is necessary to consider the network externalities brought by buyers (inter-group externalities) and the externalities caused by sellers' competition (intra-group externalities). From the buyer's perspective, in pursuit of utility maximization, they not only have to consider the transaction costs, but also need to consider the network externalities brought by sellers and buyers interaction. Finally, the interactions of the three jointly determine the market equilibrium. In a competitive market, buyers and sellers face the choice between single-homing and multi-homing to multiple competing platforms. The former means that users can only use a single platform, the latter means that users are free to choose affiliation.

2. TWO SIDES ENTER THE MARKET SIMULTANEOUSLY

The classic literature of two-sided market theory has conducted a wealth of research on the pricing mechanism and tactics of two market structures, including monopoly and oligopoly. The basic assumptions include that the market structure is monopoly or oligopoly, the users are single-homing or multi-homing, the platform charges two-stage fees or only one type of fee, and the inter-group externality or the intro-group externality is considered, etc. These studies make different combinations of these basic assumptions to form different sets of basic assumptions under specific market conditions. Rochet and Tirole (2003) consider the platform's pricing strategy for two sides in monopoly and oligopoly market, respectively. They assume that the platform only charges transaction fees for users. In competitive markets, the sellers are single-homing while the buyers are multi-homing. Without considering intro-group externality, they establish classic two-sided market pricing model, which shows that the price level is determined by the price elasticity of demand. Combined with the research of Rochet et al., Armstrong's study focuses on the pricing of duopoly competition in two-sided market. Armstrong and Wright (2004) assume that the platform charges transaction fee for users, and construct a "competitive bottlenecks" transaction structure by restricting the seller's multi-homing affiliation and the buyer's single-homing affiliation. In this paper, they introduce the classic Hoteling model (Hotelling, 1990) to characterize the heterogeneity among buyer (i.e., the transaction cost per buyer), which has been extensively used in the research of competition platforms in two-sided market. They indicate that in market equilibrium,

the platforms mainly compete for buyers by offering them a price that is below cost aiming to increase network externalities and attract more seller users. Although platforms make a loss on buyers, they recover from sellers who want to reach buyers. After a preliminary study of the structure, aiming to maximize the profits of the platform, Armstrong (2006) analyzed the pricing strategies and market equilibriums under three market structures, including monopoly platform, competing platforms where each user must choose to join a single platform and "competitive bottlenecks" where one group wishes to join all platforms, more comprehensively, from three aspects: the relative sizes of externalities, charge forms, and affiliations. This research draws the following several important conclusions: (i) Positive cross-group network externalities act to intensify competition and reduce platform profits, they create a downward pressure on the prices on both sides compared to the case without cross-group network externalities. The platforms can increase their profits by charging per-transaction fee. (ii) The main difference between two charge forms is that cross-group network externalities are weaker with transaction fee. However, the distinction between two forms matters only in competing market instead of monopoly platform. (iii) The platforms have monopoly power over providing access to single-homing users for the multi-homing side, which leads to high prices being charged to the multi-homing side. In fact, in order to increase the possibility of successful transactions, there are incentives to use different platforms for multi-homing side, but due to the high price, most users on this side can not afford multi-homing choice, resulting too few users on this side. In addition, in these models, Armstrong (2006) assumes that users are homogeneous, profit in equilibrium corresponds to a series of different combinations of membership fees and transaction fees. That is to say, the same profit may correspond to different price structures which are related to different scales of the platform. Therefore, it is a rational decision to choose the combination of price structure which can expand the scale. Reisinger (2014) expands the above research by assuming that users on two sides are heterogeneous and indicates that profit in equilibrium corresponds to the only combination of membership fees and transaction fees. It is worth noting that the above studies do not take into account the interaction within the group, i.e., intra-group externality. Li et al. (2010) study the pricing of duopoly competition in two-sided market, considering both inter-group and intra-group externalities. Under the assumptions that users are single-homing, the membership fees are charged to the sellers and the buyers are not charged, they show that when the buyer's homogeneity is high, the relative profits of one platform will increase when the inter-group and intra-group externalities increase, this unfavorable situation can be reversed by increasing the differentiation between platforms.

Hagiu carried out a large number of outstanding expansion studies based on the earlier studies in the two-sided market. He conducted cross-cutting studies on two-sided market theory and multidisciplinary theory and made great achievements. Hagiu (2006b) characterize a welfare tradeoff between two-sided open platforms and two-sided closed platforms connecting consumers and producers. He shows that the closed platforms create deadweight losses while partially internalizing positive network effects. Hagiu (2004) further supports this conclusion. When considering information asymmetry, for example, the seller knows the buyer's price, but the buyer does not know the seller's price, Hagiu and Halaburda (2014) show that monopoly platforms prefer facing more informed users, who have more demand when facing more price information. In contrast, competing platforms derive more profits when users are less informed, because more information intensifies price competition, which amplifies price reducing effect. Hagiu (2009) uses externality as an endogenous variable to study pricing. Hagiu (2014) considers not only the number of users but also their quality.

3. TWO SIDES ENTER THE MARKET SEQUENTIALLY

The above research has a common premise that users on both sides enter the market at the same time, or a certain number of users already exist in the market. These studies are focused on the market equilibrium, which is led by specific pricing mechanism. However, in the initial phase of the two-sided market, the biggest problem faced by the platform is the lack of users. The platform is attractive to the sellers only if there are already a certain number of buyers on it, and vice versa. Therefore, if the platform wants to attract the seller, it needs to attract the buyer to join first. On the contrary, if the platform wants to attract the buyer to join, it needs to attract the seller to join first. As a result, the classic "chicken & egg problem" arises. A "divide-and-conquer" strategy is proposed by Caillaud and Jullien (2003) to solve this problem, that is, to subsidize users on side 1 first, users on side 2 will be attracted to the platform after users on side 1 reaches a certain number. At this point, the platform has the ability to charge users on side 2 transaction fees or membership fees to recover the cost of subsidies. The biggest problem with this approach is that a big up-front investment in the previous period is needed, which is accompanied by a great risk. Most start-up companies adopting such strategies draw support from market financing to obtain funding sources. However, companies have great uncertainty about access to finance. Hagiu and Eisenmann (2007) study the way Google launches and propose a two-stage approach to reduce investment risk. In the first stage, a company tries to sell products to customers on just on side of a potential

two-sided platform, these products' value to the side does not depend on the other side, platform plays the role of supplier in this stage. Once building a big base of users on the first side, it can target the second side, by bringing new functionality to existing products, which introduces externalities at the same time. They also suggest that acquiring a company that offers similar services or products is another way to accumulate users, but adequate funding is the premise of this approach. However, not all two-sided platforms need big up-front investment to accumulate users. In the video game industry, game console manufacturers contract with game developers before launching the game consoles. In order to reduce developer's concerns, game console manufacturers may make price commitments to share the risk of game development. Therefore, price commitments can increase the likelihood of the sellers joining the platform. Hagiu (2006a) studied the pricing problem in two-sided market with the existence of price commitments. He assumes that the platform charges two-stage fees and sellers enter the market earlier than buyers. In addition, the sellers are multi-homing while the buyers are single-homing. He shows that a monopoly platform prefers not to make price commitments for sellers when facing unfavorable seller expectations, which mean that each individual seller expects no seller will support the platform. With competing platforms, price commitment makes the choice of single-homing affiliation less likely for sellers, while it has no impact on multi-homing choice.

Based on this stream of literature on the platform launch mechanism, Hagiu studies a series of micro-factors that influence the pricing. Hagiu and Jullien (2011) study the incentives for an information platform who enables buyers to search affiliated sellers. They assume that buyers enter the market after sellers. They show that the incentives for diverting search include: (i) buyers do not internalize all the externalities that their search activities generate before trading; (ii) divert search will help the platform to strategically charge sellers. The divert search can be replaced by charging buyers access fees and making price commitments for them. Hagiu and Jullien (2014) further study the relationship between divert the search and the degree of platform competition. They show that the equilibrium levels of search diversion are lower in competitive market than in monopoly market when the intensity of competition is high. Competing platforms induce more search diversion than a monopolist when competition is mild. In addition to this relatively new means of operation, the relationship between pricing strategies and the first-party content, which is closely related to the establishment of the platform, has not been studied. Hagiu and Spulber (2013) fills this gap. They study platform's pricing strategies under the conditions that first-hand content is complementary to seller-provided content or they can replace each other, considering

favorable/unfavorable expectations. Hagiu and Lee (2011) show that single-homing affiliation will be a dominant decision for content providers if they sell their content outright and relinquish control to the platforms. On the other hand, if content providers maintain control, multihoming is sustainable in equilibrium.

There is no doubt that there are huge network externalities in two-sided markets. Two-sided markets in many industries are moving toward the winner-take-all situation. However, in some two-sided markets, several platforms coexist in market equilibriums. There are two reasons for this situation: the platforms offer differentiated services by themselves, or sellers help differentiate platforms by providing complementary products (Rysman, 2009). In addition, some platforms such as Amazon sell some products as distributors, while other products are traded directly with the buyers through the sellers on the platforms. Naturally we will ask when the platform should adopt the intermediary mode and when the platform should adopt the dealer mode? Yoo et al. (2002) study the decision-making problem between trading through the traditional channel and through two-sided platforms. They roughly conclude that the optimal prices charged by the platform to users on both sides are related to the intensity of network externalities and switching cost, and the choice of two channels depends on actual situations. Hagiu (2007) studies some main factors affecting the platform's choice of merchant mode or two-sided platform mode and shows that platform in merchant mode gets higher profits when there are intensive network externalities and products offered by sellers are highly complementary. On the other hand, platform in two-sided platform mode gets higher profits when the seller's investment in quality is more important and there is product quality information asymmetry. Based on this research, Hagiu and Wright (2015) further explore the issue of how to position the platform between the reseller mode and the marketplace mode. They show that in monopoly market, if platform in the reseller mode has cost advantages, the marketplace mode should be adopted for long-tail products; on the contrary, if platform in the reseller mode has cost disadvantages, the marketplace mode should be adopted for short-tail products. This result happens to explain that Amazon adopts reseller mode for hot products and adopts two-sided platform mode for niche products.

4. FUTURE RESEARCH DIRECTIONS IN TWO-SIDED MARKET

The continuous improvement of the theoretical framework of two-sided market theory has made it possible to serve as a basic tool to help researchers study various problems in more and more subdivision areas. Bae and Kwon (2008) investigate the interaction between athletes and fans in professional sports leagues. Gans (2011) studies

the mobile application stores' pricing mechanisms for apps. Ehrlich and Greiner (2013) studies the media's pricing strategy for online and offline multi-dimensional sales of content and advertising. Yu et al. (2015) study the investment strategy in the Promotion of Electric Vehicles. There are also a large number of pricing research on two-sided platform in the credit card industry (Bedre-Defolie and Calvano, 2013; Chakravorti and Roson, 2006; Wang, 2016). Wang et al. (2016) focus on online taxi pricing issues. Kind et al. (2016) study TV distributor pricing issues. Kim (2016) studies the legal to restrict the abuse of power by monopoly media platforms.

Future research on two-sided market may have the following directions: (i) The related research on pricing in two-sided market will gradually expand to specific industries, and explore the law more closely linked with the real market in different areas. (ii) From the above review, we can also find that theoretical research on two-sided platform in set-up stage is scarce, and most of the models are based on the assumption that both sides enter the market simultaneously. In practice, the time points for two sides to enter are often inconsistent. The characterization of the unsynchronized and random entry process is more difficult but more practical. (iii) In the case of asymmetric information or in the presence of fraud, for example, some sellers in Amazon create false ratings and fake logistics information, buyers can not accurately estimate the benefits of network externalities. The impact of information asymmetry on platform pricing and platform competition will become a new research issue. (iv) Most studies assume that the utility function is a linear function of the number of users, some utility function variables come from parameter estimation. In real markets, the relationship is likely to be non-linear, and the overlapping of various estimated variables may mask some of the counterintuitive facts. (v) The general assumption in most studies is that users on one side of the platform may trade with each user on the other side. However, trading process on the platform is essentially a dynamic matching process, which will bring trading friction, instead of perfect matches. When the matching friction strength is large, there may be different conclusions after solving the problem.

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