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Adoption of new online services in the presence of network externalities and complementarities

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ABSTRACT

A typical online user utilizes multiple services in the same service category concurrently due to the fact that many online service markets are characterized by the coexistence of multiple services offering complementary features. Along with an inherent network externality feature, this complementary nature among competing online services complicates predictions of adoption patterns in these markets. This paper extends the adoption function model of Arthur [W.B. Arthur, *Competing technologies, increasing returns, and lock-in by historical events*, *The Economic Journal* 99 (1989) 116–131] and applies it to the online service market in an attempt to explain various cases of adoption behavior. The proposed model predicts that there exists a first-mover's advantage in this market. Specifically, when network externality is large enough, the follower is confined to a low market share, even though it provides the same level of service as that provided by the leader. However, this first-mover's advantage can be overcome in cases where perturbations are caused by the heterogeneity of consumers or by service value uncertainty. In addition, a two-step punctuated equilibrium may exist: under specific conditions, market share distribution may be stable for a while at certain levels and then move into actual equilibrium.

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1. Introduction

A peculiar feature of online services is that multiple, similar services in a single service category can be utilized simultaneously. For example, a typical online user possesses multiple e-mail accounts from different service providers. Also, many users subscribe to more than one instant messenger service or join several blog websites. Many online services in the same service category offer slightly or moderately differentiated features in order to avoid direct competition. Consequently, users can enjoy differentiated features of multiple services offered by multiple service providers. For instance, a typical Internet user utilizes multiple search engines due to the fact that each search engine possesses unique features and yields different search results. Google is famous for its huge size of web coverage and reliable popularity ranking. On the other hand, Yahoo provides shortcuts that give quick access to dictionary, synonyms, patents, and other related information. Ask.com is strengthened by its subject-specific popularity ranking which suggests broader and narrower terms than the search terms already submitted. Utilizing these slightly different features and strengths together, an Internet user can enjoy more accurate search results, with broader web coverage and access to a rich

set of related information that can enhance utility from search activity.

Many online users take advantage of this situation by utilizing multiple services depending on the context. Since utilization of these similar services with moderately differentiated features together has a potential to give a higher utility than the sum of utility of each individual service to users, these services are complementary in nature from the users' perspectives. For instance, as an online information repository, content from multiple portal services used together can endow users with a wider range of knowledge that can enhance and deepen the knowledge of users. The services of each of these categories are complementary since combined usage of these services provides more features, or more content that can provide larger utility than the mere sum of utility from each service to users.

Along with this complementary nature, many online services are provided free of charge. A typical online service thrives on indirect revenue sources such as advertisement instead of direct sources such as application software charges or usage fees from its users. In addition, a new online service typically requires a minimal level of user adoption cost in terms of downloading, installation, registration or trial efforts. This minimal adoption cost in addition to the complementary nature among services in the same online service category entails "mixed usage" behavior, in which a typical online user adopts multiple services in the same service category and utilizes them concurrently. Recognizing that mixed

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usage behavior is frequently observed in the online service market, scholars need to reflect this in a study on user adoption dynamics of an online service.

From a consumer's perspective, there are a number of factors that contribute to the adoption decisions regarding a particular online service. The quality of the online service in consideration will be important. In addition, the network size of the online service will also be important due to the inherent network externality effect in online service markets. Finally, the extent of complementarity of the online service in conjunction with other online services in the same market is expected to play an important role. In this paper, a utility model that incorporates these features of online services is utilized to explore various adoption patterns in the market. Later in this paper, this model is extended, incorporating a feature of quality improvement over time as well as inflow of new users.

The rest of this paper is organized as follows. In Section 2, the literature on the areas of network externality and complementarity as well as online services is explored. In Section 3, a mixed usage model of online services is constructed and equilibrium conditions are analyzed with simulations and introduction of adoption function. In Section 4, various characteristics of online services are explored and the basic mixed usage model is further developed in order to account for additional factors on market conditions such as cumulative network externality and growing market size. Section 5 speculates on the managerial implications of the results of Sections 3 and 4. Lastly, Section 6 provides conclusion and discusses limitations of the paper.

2. Literature review

Many online services exhibit positive network externalities. For instance, consumers consider the size of the consumer base of messenger services by firms such as AOL and Microsoft to be very important, as the size of the consumer base determines the potential number of people consumers can communicate with. In addition, an online community with a large number of members is likely to be filled with lively communications and user-contributed content, thereby yielding high value for its users. Essentially, most online services provide values based on communication and information exchanges that are normally positively correlated to the number of people using the same service. However, the possibility of mixed usage in an online service context, as described in Section 1, allows for a number of interesting features of adoption patterns of online services that differ from those observed in other markets.

The main objects of consideration from previous literature concerning network externality have been products or industrial technologies. Katz and Shapiro [9] distinguish direct and indirect network externalities. The extent of direct externality is proportional to the number of purchases of other users as exemplified by telephone or fax machine markets. In contrast, an indirect externality arises when the likelihood of a benefit for a potential consumer depends on the size of the existing consumer base through product support. For example, a PC architecture with a large consumer base has a high probability of a greater level of support from software vendors compared to that with a smaller consumer base, thereby awarding its user a higher benefit. Furthermore, the quality of post-purchase services ordinarily depends on the number of product purchases. Compatibility decision has also been regarded as an important determinant for adoption patterns in markets with externality [7–10,15]. The lock-in phenomenon and its effect have also been explored [2,19]. Regarding the entrance of a new service in the market with network externality, uncertainty and expectations about the new service are deemed important [9,12]. Katz and Shapiro [9] proposed the “ful-

filled-expectations equilibrium” concept which asserts that consumer expectations regarding a product's demand size decide the actual market size.

Additionally, the nature of products and services in the online environment is completely different from that in the physical world [4,6,14]. Many firms have failed to survive online because they did not consider the Internet to be an entirely new medium [14].

Usually, a single online service offers a mix of services from different categories [18]. From the perspective of users, different online services offer differentiated services in a single category. Accordingly, people usually find themselves using multiple services in a single service category, in contrast to cases of physical products or industrial technologies in which different uses are normally exclusive. In addition, a lack of significant adoption cost in many online service markets implies that market equilibrium based on consumer expectations (such as the fulfilled expectation equilibrium) can be perturbed more easily than in the case of physical products.

The primary adoption decision factor for a given online service is its quality [11]. In addition, due to the mixed usage characteristic of the online service market, complementarity is another important adoption decision factor. Complementarity has been regarded as an important factor in the context of brand extension [1,17], including cases of online services [18]. In this paper, the complementary nature of online services within the same service categories by different service providers is modeled through the use of bundling literature [3], because of their similarity. However, in the online service context, time resources are limited for consumers in terms of using more than two services simultaneously. Such time resource limitations have been reflected in the utility model of this paper.

The concept of “punctuated equilibrium”, which originated in biology [5] and later was adopted in the business literature [12,13,16], has been widely utilized in this paper. Specifically, Loch and Huberman [12] showed that a market characterized by a combination of positive network externality and technology uncertainty can lead to a punctuated equilibrium. In this paper, such punctuated equilibrium is observed under certain market conditions. The distinctive features of punctuated equilibrium in this paper are that the proposed model considers a mixed usage model, and that punctuated equilibrium is observed in the absence of product quality uncertainty. In addition, punctuated equilibrium is also observed in the presence of consumer heterogeneity or quality uncertainty when there are quality improvements over time.

3. The model

In this section, a basic model is constructed, and equilibrium conditions and simulation results are provided. In Section 3.1, the mixed usage model is defined. In Section 3.2, a brief user survey on the parameters is presented to assess the applicability of this model to the real world setting. Section 3.3 demonstrates equilibrium conditions of the model. In Section 3.4, adoption process with various sets of parameters is simulated and a modified form of adoption function that was introduced by Arthur [2] is utilized to characterize equilibrium from simulation analysis.

3.1. The mixed usage model

It is assumed that there are two complementary online services (Service A and Service B) in the same service category that are provided for free and that their perceived basic service qualities by the users are Q^A and Q^B , respectively. Also assumed is that Service A is the incumbent service and Service B is a potential entrant. There

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