European Journal of Operational Research 196 (2009) 661–671

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Computational Intelligence and Information Management

Short-term and long-term competition between providers of shrink-wrap software and software as a service

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ARTICLE INFO

Article history:
Received 2 May 2007
Accepted 16 April 2008
Available online 26 April 2008

Keywords:
Pricing
Economics
Quality competition
Software as a service
Differential game

ABSTRACT

Software as a service (SaaS) has moved quickly from a peripheral idea to a mainstream phenomenon. By bundling a software product with delivery and maintenance service, SaaS providers can effectively differentiate their products with traditional shrink-wrap software (SWS). This research uses a game theoretical approach to examine short- and long-term competition between SaaS and SWS providers. We analyze the factors that affect equilibrium outcomes, including user implementation costs, SaaS provider's operation efficiency, and quality improvement over time. Bundling software with service lowers software implementation cost for users, and our results suggest that it increases equilibrium prices. In providing software services, SaaS providers have to incur significant operation cost. In the long run, service operation cost may significantly affect SaaS firm's ability to improve its software quality.

1. Introduction

An outgrowth of the application service provider (ASP) model in the dot-com era, software as a service (SaaS) has moved quickly to a mainstream phenomenon. Some well-known examples of SaaS are the sales force automation and customer relationship management (CRM) applications provided by Salesforce.com and NetSuite. Companies have also unveiled SaaS applications for individual customers. Examples include Google's spreadsheets and Microsoft's OneCare service; the latter provides virus and spyware cleanup for personal computers (Richmond, 2005). It is estimated that SaaS market will grow at about 25% a year to a $90 billion market by 2009 (Pallatto, 2006).

According to industrial studies, the biggest appeal of SaaS is its lower implementation and maintenance cost (Kaplan, 2005). SaaS provider delivers software over the Internet and can potentially eliminate the need for companies and individuals to implement, and maintain complex software applications. Companies that implement business applications such as Enterprise Resource Planning (ERP) and CRM systems often have to face unexpected high implementation costs, pay big bills to consultants, and still end up with projects overruns. SaaS can empower business units and allow businesses to reduce the upfront costs of deploying business solutions. To individual customers, if software applications need to be periodically updated such as anti-virus applications, SaaS is an appealing choice. With SaaS, customers do not need to track the installed version of anti-virus software, and can manage computer security from one place and make PC care as simple as car maintenance (Richmond, 2005).

From an economics point of view, SaaS essentially bundles software products with software delivery and maintenance service. Product bundling has been an active research field in economics (e.g., McAfee et al., 1989; Whinston, 1990). A monopoly firm can use bundling to leverage its market power in one market to a second market. In competitive markets, a firm can use bundling to effectively compete with other firms by bundling a primary good with complementary goods and services. For example, credit-card issuers bundle the use of cards with variety of goods and services. By providing software together with service, a SaaS provider can effectively differentiate its product with traditional shrink-wrap software (SWS) by lowering software implementation costs. The innovative bundling of traditional software product with service is inconceivable without the rapid progress in Internet and telecommunication technologies. Those technologies are fundamentally changing how software products are developed, released, and marketed. One of the goals of this research is to apply the economic principles to investigate the business of SaaS and analyze competitions in the software market.

By bundling software with service, SaaS providers are facing a number of challenging issues. First, providing software service could be costly. In late 2005, Salesfoce.com customers experienced several service outages. Since then customers have become very

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doi:10.1016/j.ejor.2008.04.023

concerned about system availability and reliability (Herbert, 2006; Vara, 2006). To satisfy customer demands, SaaS firms have to invest heavily on capacities and processes to guarantee service quality. Second, in choosing software applications, users often have to face tradeoffs of application performance versus cost of deployment. Although SaaS is easy to use and its implementation cost is lower, there remains performance gap between the thin client interfaces of SaaS applications and the rich desktop of SWS. Some believe innovations on desktop systems and Windows Vista could even widen the performance gap between rich desktop applications and HTML-based thin clients (Zetie, 2005). Thus, software quality such as functionality and performance is an important factor affecting the competition between SaaS and SWS providers.

This research uses a game theoretical approach to examine short- and long-term competition between SaaS and SWS. Our model has the following characteristics: (i) We recognize that customers with heterogeneous sensitivity to implementation cost will react differently to SaaS, and we model customer choice based on price and implementation cost. (ii) We examine the benefits as well as the costs related to SaaS. In providing software service, SaaS companies have to incur significant operation cost. We consider queueing delays in providing software service over the Internet and examine the effects of service cost on SaaS provider's strategy and the equilibrium outcome. (iii) We analyze price competition in a static game as well as dynamic quality competition using a differential game approach.

Bundling software with service lowers software implementation cost, and our results suggest that it increases equilibrium prices. In the long run, software quality plays an important role in firms' competitiveness, and service cost significantly affect whether the SaaS firm can compete effectively. Our results provide important managerial implications on competitive strategies and operation policies for software companies.

The rest of the paper is organized as follows: Section 2 reviews related literature. We set up the model in Section 3, and analyze a one-period price competition model with service guarantee from SaaS providers in Section 4. Section 5 examines the quality competition in a finite horizon differential game, and Section 6 provides solutions in an infinite horizon. Section 7 discusses the results, and we provide the conclusions in Section 8.

2. Related work

This research is related to economics literature on competition between firms with heterogeneous products (Shaked and Sutton, 1983). Many of the competition models have been inspired by the work of Hotelling (1929), who assumes that consumers have heterogeneous tastes that lie on a continuum. In contrast to Hotelling's horizontal differentiation models, vertical differentiation suggests that products have different features, which reduces price competition (Shaked and Sutton, 1983). If two companies have very similar products with little differentiation, the companies are often engaged in a Bertrand competition and do not make positive profits (Tirole, 1992). Bundling complementary products can serve as a product differentiation device in a competitive market and help firms avoid direct price competition (Chen, 1997).

To bundle software product with service, companies have to incur capacity cost. In modeling the cost of providing software service, we follow prior studies in IS on pricing computing services and modeling of queueing delays (e.g., Gupta et al., 1997; Tan and Mookerjee, 2005). Tan and Mookerjee (2005) model the cost of queuing delay as a nonlinear loss function.

Another stream of research related to our study is product quality competition. Fine (1986) refers product quality as features, styling, and other product attributes that enhance fitness for use. In manufacturing applications, quality is often described as conformance to specifications or as meeting standards on the performance of the product (Karmarkar and Pitbalddo, 1997). Software quality has been studied in software engineering economics (e.g., Boehm, 1981). The quality of software usually includes functionality, reliability, and usability (Khoshgoftaar and Allen, 2001).

Early game theoretic models in product competition emphasized static models. A dynamic model can add the important dimension of time and recognize the competitive decisions that do not necessarily remain fixed (Fudenberg and Tirole, 1991). Models involving competition in continuous time are typically treated as differential games, in which critical state variables, e.g. demand or market share, are assumed to change with respect to time according to specified differential equations (Dockner et al., 2000). Differential games have been widely applied in analyzing competition in dynamic advertising, pricing, and quality innovation (Sethi, 1977; Erickson, 1995; Jørgensen et al., 2003; Nair and Narasimhan, 2006). For example, Piga (1998) analyzes dynamic advertising and pricing strategies in duopolistic rivalry. Mukhopadhyay and Kouvelis (1997) examine design quality decision over the product life cycle for two competing companies with a similar product. Bass et al. (2005) study generic and brand advertising strategies in a dynamic duopoly. In this research, we study the dynamic quality strategies of SWS and SaaS providers in a differential game.

3. The model

We consider a competition model with two players: Firm 1 is an SWS provider and firm 2 offers SaaS over the Internet. Customers, either corporate users or individuals, choose software products based on their values or utilities. We assume that the two software products have little difference and customers have homogenous valuation of v for both products. Let the implementation cost be c_1 for SWS and c_2 for SaaS. By bundling software with service, SaaS company can lower the implementation cost of its product, and we have $c_2 < c_1$. This assumption is supported by a study of over 600 companies that SaaS indeed significantly reduced implementation cost and time (PR Newswire, 2006). With different knowledge levels, users will have heterogeneous sensitivity to the implementation cost. We denote the cost sensitivity as θ, which is randomly drawn from a uniform distribution with support on $[0,1]$. The price of SWS is p_1 while the price of SaaS is p_2.

Customers choose the two software products based on price, implementation cost, and their own sensitivity to implementation costs. A customer's utility is $u_1 = v - p_1 - \theta c_1$ for using SWS, and $u_2 = v - p_2 - \theta c_2$ for using SaaS. A customer is indifferent between the two products if $u_1 = u_2$, or $v - p_1 - \theta c_1 = v - p_2 - \theta c_2$; solving this equation leads to $\theta^* = (p_2 - p_1)/(c_1 - c_2)$, which is the indifferent point for customers (see Fig. 1). When $\theta > \theta^*$, the customer will choose SaaS because $u_2 > u_1$. When $\theta < \theta^*$, the customer will choose SWS because $u_2 < u_1$.

In this study, we are interested in a more general case when there are demands for both SWS and SaaS. Here, we want to find that condition. As shown in Fig. 1, when $v = v^*$ and $\theta = \theta^*$, $u_1 = v^* - p_1 - \theta^* c_1 = 0$ and $u_2 = v^* - p_2 - \theta^* c_2 = 0$. When $v \leqslant v^*$, (i) $u_2 \leqslant 0$ if $\theta \geqslant \theta^*$, and (ii) $u_2 < u_1$ if $\theta < \theta^*$. Thus, the demand for SaaS will be zero under the condition $v \leqslant v^*$. Therefore, we need the condition $v > v^*$ in order to have demands for both SWS and SaaS, and we can easily find out the value for v^* as $v^* = p_1 + \theta^* c_1 = p_2 + \theta^* c_2$. Thus, $v^* = (c_1 p_2 - c_2 p_1)/(c_1 - c_2)$.

In addition, we consider the case that the demands for both SWS and SaaS do not cover the whole market. This requires $v < p_2 + c_2$; otherwise, when $v \geqslant p_2 + c_2$, the whole market will be