Cost Efficiency Strategy in the Software-as-a-Service Market: Modeling Results and Related Implementation Issues

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Abstract. We model competition between *software-as-a-service* (SaaS) vendors by focusing on several key features of SaaS. These include: differences in vendor offerings; incomplete information for the clients side about the vendor's capability to offer well-fitting services, and the clients' learning costs and options to switch. Our findings suggest pricing strategies that will be effective for the SaaS vendor. High cost efficiency in the operations of the SaaS business model is key for the vendor to gain leverage to retain the client by making its switching costs too high, and to achieve high profitability in the process by implementing the appropriate strategies in the appropriate customer segments. We also extend the analysis by considering a broader set of implementation issues related to mechanism design choices in the SaaS market that arise around our modeling approach.

Keywords: Competition, Economic Analysis, IT-Enabled Services, Pricing Strategy, Service Science, Software-as-a-Service, Strategy.

1 Introduction

Software-as-a-service (SaaS) is a business model that has been transforming the software industry's foundations. In 2012, Gartner [10] reported that global spending for SaaS would rise to US$14.5 billion and growth will remain strong through 2015 when total spending is expected to reach US$22.1 billion. Though there were all kinds of uncertainties, concerns, and doubts in the initial years of SaaS, today SaaS has developed into a significant marketplace and attracted a lot of attention from practitioners and researchers. Existing research has investigated a variety of economic and business issues of the SaaS and cloud computing market, including workload scheduling [11], vendor pricing strategies and schemes [19, 22], *service level agreements* (SLAs) [20], contract design [3, 16, 25], and impacts on the traditional software market [9]. Firm-to-firm competition in the SaaS market is not well understood though. In this research, we try to address this gap. We propose a model of competition to explore how SaaS vendors can implement strategies for success based on game theory [17, 19].

Competition in the SaaS market deserves a close investigation because it exhibits unique characteristics. First, SaaS offerings consist of two parts: software application and related IT services. Software applications are *horizontally-differentiated*: different

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clients may prefer different software functionalities. IT services, contrast, are *vertically-differentiated*: vendors can choose to deliver higher or lower service quality. Second, the *multi-tenancy structure* of SaaS makes customization difficult [14]. The client has to use standardized software applications offered by the vendor, and as a result, the client will incur disutility from not using ideal services. Third, the *experience good* feature of software applications makes a client's choice even more complicated. We only learn about the quality of an experience good after we use it. The client faces uncertainty about how the SaaS offering will fit its specific business requirements, and also how well the application can be integrated into its existing legacy systems. Such information only can be learned after trying the SaaS offering. Finally, the client faces non-negligible switching costs because typically the vendor will be in charge of its data management, maintenance and back-up. To switch from one vendor to another will be costly for the client. The model we explore will capture all the above features, and is able to deliver new results that have not been observed in other types of competition.

We also aim to deliver practical findings for the SaaS industry. To do this, we include a rich discussion of implementation and mechanism design issues that arise as a result of our modeling choices. Figuring out how to identify the appropriate pricing strategy in a competitive IT services marketplace is a *mechanism design problem*. So vendors need to consider multiple issues that will influence their capacity to successfully implement SaaS in the marketplace:

- viewing IT services client decision-making as occurring in continuous time rather than at discrete times;
- identifying the willingness-to-pay, pricing and services contract valuation implications that arise when there is flexibility for the client to opt out of an IT services contract;
- understanding how to leverage cost efficiency to achieve different kinds of leverage to retain the firm's clients; and finally,
- managing clients that have different levels of switching cost, and pinpointing when it is necessary to co-invest to achieve retention through the implement beneficial approaches that enabled them to be locked into the relationship.

Section 2 presents our model of SaaS vendor competition. Section 3 analyzes the competition game and suggests pricing strategies for SaaS vendors. Section 4 discusses issues that relate to our modeling assumptions and choices, as well as to other issues that arise around the mechanism design that we have investigated. It is intended to enrich our understanding of competition in the SaaS market. Section 5 summarizes and concludes.

2 Model

Consider two SaaS vendors, *H* and *L*, competing in the market. Each delivers a bundle of software applications and IT services to clients. Their offerings differ in two ways. First, the software applications have different attributes and functionalities, and are *horizontally-differentiated*. We adopt the Salop [23] circle model to capture horizontal differentiation. The *service space* is a unit-length circle, and the two vendors' software applications are located on opposite sides of the circle with a distance of 0.5 between them. This set-up follows the *principle of maximum product differentiation* [6] in duopolistic spatial competition.[1] Second, the two vendors offer IT services at different quality levels: they are *vertically-differentiated*. Vendor H is the *high-quality vendor* that offers services of higher quality q_H, while Vendor L is a *low-quality vendor* that offers services of lower quality q_L, and $q_H > q_L$. In this study, we will assume that vendors can eliminate service quality uncertainty through the use of SLAs, in which all quality-related issues, including productivity, service quality metrics, problem resolution procedures, and provisions for system and data security, are defined in detail. As a result, q_H and q_L are public information for clients.

A vendor bears both the initial setup cost I and the service cost c for delivering services. Setup cost I is a one-time cost incurred when the vendor acquires a new client. It includes the vendor's efforts to build the relationship with the new client, move the client's data to a centralized location, and understand the technical architecture and business needs of the new client. Service cost c is a recurring cost. It includes the vendor's efforts to maintain client data and application code, provide supporting services, and manage data security. Delivering higher service quality requires the SaaS vendor to bear a higher service cost. We assume the quality of the vendor's IT service, q, is a function of c: $q = f(c)$. This function $f(\cdot)$ has no specific functional form. In addition, both vendors charge their clients a fixed subscription price in each period, p_H and p_L. These are the decision variables in our model.

The Salop circle model represents clients with heterogeneous tastes toward software features. All clients are evenly distributed on the circle, and a client's location represents its ideal service.[2] Each vendor only offers one standard version of the software, however; this is due to the multi-tenancy structure of the SaaS business model. A client will incur a utility loss of td for not using its ideal service. Here, d measures the distance between the client's ideal service and the vendor's offering in the circle, and t is the parameter for a client's unit *fit costs*. In addition, we assume that the two SaaS vendors' positions on the circle initially are unknown to their potential clients: they learn about their fit as they use them. So a client will not know its distance to a vendor's offering in the circle in advance: it has to figure this out by using the vendor's software. On the other hand, although all clients always prefer higher quality services, their willingness-to-pay is likely to be different. Our model considers two types of clients with this in mind: a *higher willingness-to-pay client* θ_h is willing to pay more for a higher level of service quality than a *lower willingness-to-pay client* θ_l, with $\theta_h > \theta_l$.

The utility function of Client j, when it uses services from Vendor i, is:

$$U(\theta_j, q_i, d_i) = \theta_j \cdot q_i - p_i - t \cdot d_i \quad (1)$$

where $i \in \{H, L\}$ indicates Vendor H or L, and $j \in \{h, l\}$ indicates the client's type, θ_h or θ_l. Here, q_i is the level of service quality, p_i is the price per period offered by

[1] Under the *principle of maximum product differentiation*, competing SaaS vendors differentiate themselves as much as possible in the service space to avoid head-to-head price competition.

[2] An *ideal service* would be an individually customized application. It will fit a client's technical and business requirements perfectly, and can be integrated with its legacy systems seamlessly.

Vendor i, and d_i measures the distance between the client's ideal software and Vendor i's offering on the circle. The last term, $t \cdot d_i$, is the client's utility loss due to not using an ideal application. We call it the client's *fit costs*.

3 Analysis

The competition proceeds in two stages. Prior to time 0, the vendors will post their prices p_H and p_L simultaneously. Their service quality levels, q_H and q_L, will be known publicly. The *fit costs* experienced by each client for using a specific vendor will not be known though. At time 0, facing incomplete information, the client will decide which vendor's services to use. The first stage, between time 0 and 1, is called the client's *FitCost Sampling Stage,* during which the client learns information about the fit costs. As a result, at time 1, the client will have updated information about the vendor's offering and will decide whether to remain with the same vendor or switch to another. Switching is costly though. The client will face a switching cost S, which includes the cost of discovering the other vendor, recovering data from the current vendor, and making new service arrangements. The second stage, represented by the period after time 1, is called the *Long-Term Partnership Stage*. It reflects the firming up of the service relationship between clients and vendors. By then, the market will have stabilized.

Throughout the analysis, we will assume that both SaaS vendors and their clients maximize long-run profits. Following the literature in two-stage competition games with switching costs [4, 8], we focus on the analysis of competition between two SaaS vendors competing for the marginal customer.

3.1 Analysis of the SaaS Client's Decision

We first analyze the client's decisions at times 0 and 1, taking the SaaS vendors' prices p_H and p_L as given. We use backward induction to solve the problem.

Consider a client's switching decision at time 1. If a client j, $j \in \{h, l\}$ indicating this client's type, θ_h or θ_l, has chosen the Vendor H at time 0, after the FitCost Sampling Stage, this client will have learned the true fit costs of using Vendor H: $t \cdot d_{Hj}$, where t is the unit fit cost parameter and d_{Hj} is the distance from this Client j to the Vendor H in the circle. When making a decision on whether to switch at time 1, the client will compare its utility of staying with the current Vendor H, which is $\theta_j \cdot q_H - t \cdot d_{Hj} - p_H$, with its utility of switching to the other Vendor L, which is $\theta_j \cdot q_L - 0.25 \cdot t - p_L - S$.[3] The latter case will incur a switching cost S. By equating the two utilities, we can find the *marginal switcher* for Vendor H, who is indifferent between switching to L or staying with H at time 1, given that the client has chosen to sample

[3] The number 0.25 was not chosen as a parameter; instead it is a logical outline of the factor that the vendors position their services offerings 180° away from each other on the Salop circle. The distance between these points, then, will be one-half of the unit length of the circle or 0.50. By the same logic a client will never be farther away in terms of its ideal services preferences than one-half of the distance between the locations of the two vendors' services locations. This is one-half of the half-circumference of the Salop circle or 0.25.

Vendor H at time 0. We denote the marginal switcher's distance to Vendor H by d_{Hj}^*, and d_{Hj}^* is given by

$$d_{Hj}^* = 0.25 + \frac{\theta_j \cdot \Delta q - \Delta p}{t} + \frac{S}{t}\ . \qquad (2)$$

Similarly, we can define the marginal switcher for Vendor L and solve for the relevant value as:

$$d_{Lj}^* = 0.25 - \frac{\theta_j \cdot \Delta q - \Delta p}{t} + \frac{S}{t}\ . \qquad (3)$$

Next, we return to time 0 to solve client j's decision of which vendor to try out. The client is forward-looking and has rational expectations with respect to vendor's actions. At time 0, the client will be able to correctly estimate the probability of switching to Vendor L, if it chooses to sample Vendor H, is $2d_{Hj}^*$, and the probability of switching to Vendor H, if it chooses to sample Vendor L, is $2d_{Lj}^*$. Thus, the client will compare its expected utility from sampling Vendor H, as Equation 4, and the expected utility of sampling Vendor L, as Equation 5, to make the decision.

$$\mathrm{E}[U_H](\theta_j) = 2\cdot d_{Hj}^* \cdot (\theta_j \cdot q_H - p_H - 0.5\cdot d_{Hj}^* \cdot t) + (1 - 2\cdot d_{Hj}^*) \cdot [(\theta_j \cdot q_L - p_L - 0.25\cdot t) - S] \quad (4)$$

$$\mathrm{E}[U_L](\theta_j) = 2\cdot d_{Lj}^* \cdot (\theta_j \cdot q_L - p_L - 0.5\cdot d_{Lj}^* \cdot t) + (1 - 2\cdot d_{Lj}^*) \cdot [(\theta_j \cdot q_H - p_H - 0.25\cdot t) - S] \quad (5)$$

In Equation 4, the first term is the client's expected utility from staying with Vendor H with a probability of $2d_{Hj}^*$.[4] In this case, the expected distance between this client and Vendor H will be $0.5\cdot d_{Hj}^*$ since d_{Hj}^* is the marginal switcher's distance. The second term is the client's expected utility from using Vendor L that will happen with a probability of $(1 - 2\cdot d_{Hj}^*)$. Here, the expected distance between this client and Vendor L will be 0.25 since the client has not tried Vendor L at the first stage, so it will not get updated information about Vendor L's offering. The role of Equation 5 is similar.

Thus, there are three outcomes after time 0:

- all clients will choose to sample Vendor H, if and only if $\mathrm{E}[U_H](\theta_j) > \mathrm{E}[U_L](\theta_j)$ for $j = h$ and l;
- all clients will choose to sample Vendor L if and only if $\mathrm{E}[U_H](\theta_j) < \mathrm{E}[U_L](\theta_j)$ *for* $j = h$ and l;
- θ_h-type clients will choose to sample Vendor H and θ_l-type clients will choose to sample Vendor L if and only if $\mathrm{E}[U_H](\theta_h) \geq \mathrm{E}[U_L](\theta_h)$ and $\mathrm{E}[U_H](\theta_l) \leq \mathrm{E}[U_L](\theta_l)$.

3.2 Analysis of the Vendors' Pricing Strategy

Vendors also are forward-looking with rational expectations. This means that they will expect clients to respond strategically to their prices. Vendors will set their prices, prior to time 0, to optimize their own profits. To begin our analysis, we assert:

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[4] The analysis of a marginal switcher shows that, for all clients who are in the range of $(-d_{Hj}^*, d_{Hj}^*)$ around the Vendor H in the Salop circle, the marginal switcher will stay with H at time 1, while the other clients will switch. Since the product circle is of unit length, the *ex ante* switching probability for any client at time 0 is $2d_{Hj}^*$.

- **Proposition 1 (Threshold Value for Switching Costs).** *When $S \geq 0.25 \cdot t$, no clients will not switch from their current vendor.*

Proofs for propositions are omitted, but are available upon request.

Proposition 1 identifies a threshold value for switching costs. When a client faces high switching costs exceeding this threshold value, it will always choose to stay with its current vendor. In this case, a SaaS vendor will have absolute leverage to retain its existing clients. This is called *lock-in power*. Finding the related threshold is straightforward: it equals a client's *ex ante* expected fit costs, $0.25 \cdot t$. This makes sense because the client's decision to switch is driven by the fact that the vendor's software does not fit the client's needs very well. As a result, the client must balance its switching costs, if it does indeed switch, and its fit costs, if it does not.

The strategies for vendors will be different for $S \geq 0.25 \cdot t$ and $S < 0.25 \cdot t$. We will analyze them separately as Cases A and B.

Case A: $S \geq 0.25 \cdot t$. A vendor knows that its clients eventually will not be able to switch to the competing vendor once its clients try its services and build a business relationship. In this case, a vendor will have a strong incentive to attract new clients in the first stage and then lock in them at a later stage. Meanwhile, clients will be aware of the risk of being locked in by a vendor and will be conservative when making their initial vendor choice at time 0. Keeping these considerations in mind, we expect that the market competition will become intense. Both vendors will compete head-to-head on price to make sure they are attractive enough so clients will try them out at the first stage. This has the potential to trigger a price war between them.

This conjecture, however, may not be entirely correct though. We instead find that the outcome actually depends on the two vendors' *relative cost efficiencies*, measured by the ratio $\Delta c / \Delta q$. Here, Δc is the service cost difference and Δq is the service quality difference for SaaS vendors. The ratio $\Delta c / \Delta q$ provides a measure for cost efficiency in the SaaS business model. Our next proposition suggests that a price war may occur when the cost efficiency for offering SaaS is very high or very low. It may cause one vendor to fail due to severe price competition:

- **Proposition 2 (Conditions for a Price War).** *A price war will occur under two different circumstances:*
    - *when cost efficiency is high ($\Delta c / \Delta q < \theta_l$), Vendor H will be able to compete aggressively, and at $p_H = c_L + \Delta q \cdot \theta_l$, Vendor H will be able to drive Vendor L out of the market and serve all clients itself; and*
    - *when the cost efficiency of the SaaS model is low ($\Delta c / \Delta q > \theta_h$), Vendor L will be able to compete aggressively, and at $p_L = c_H - \Delta q \cdot \theta_h$, Vendor L will drive Vendor H out of the market and serve all of the clients.*

When cost efficiency is at a medium level $\theta_l < \Delta c / \Delta q < \theta_h$, however, no vendor will be able to undercut its competitor's price. So the two vendors will coexist in the market. More importantly, there will be no direct competition between vendors. To wit:

- **Proposition 3 (Conditions for a Monopolistic Outcome).** *When the SaaS business model has mid-range cost efficiency, $\theta_l \leq \Delta c / \Delta q \leq \theta_h$, both vendors will co-exist. The equilibrium prices will be $p_L = \theta_l \cdot q_L - 0.25 \cdot t$ and $p_H = \theta_l \cdot q_L + \theta_h \cdot$*

Δq - 0.25 · *t. Vendor H will serve* θ_h *type clients and Vendor L will serve* θ_l *type clients, and they will not compete with each other directly.*

The equilibrium prices will ensure there is no direct competition. The price p_L serves to extract all expected consumer surplus from θ_l type clients. On the other hand, the price p_H will be set at a level to ensure that θ_h type clients will not be attracted to try Vendor *L*. This segments the market with no direct competition between the two vendors. Instead, each vendor will only target and serve one client group, behaving like a monopolist in its market segment.

Case B: $S < 0.25 \cdot t$. As long as the switching cost is not so high that it gives vendors full lock-in power over clients, the two vendors will always coexist in the market. One vendor will not become dominant, even when its SaaS cost efficiency is very high or very low. In this case, three different types of equilibria may come about, depending on the values of switching cost *S* and cost efficiency Δc / Δq. However, when the cost efficiency of the SaaS model is at different levels, somewhat paradoxically, the vendors will benefit from switching costs in different ways. For example, in certain situations with high cost efficiency, Vendor *H* will be the only beneficiary of switching cost: with increases in switching cost, Vendor *H* will be able to raise its price to achieve higher profitability, and meanwhile, Vendor *L* will be forced to reduce its price but still will experience lower profit. The opposite will happen when cost efficiency is low: in this case, Vendor *L* will be the only beneficiary.[5]

Previous research has never documented this finding. Instead, switching cost always has been reported to affect the two competing vendors in the same way – either positively or negatively, but not with elements of both. We are observing a unique aspect of SaaS competition: there is *asymmetric influence of clients' switching cost* on the vendors. So switching cost may benefit one vendor but hurt the other, depending on their relative cost efficiencies.

4 Discussion: Recommendations on Modeling and Implementation

The real world of competition in the IT services market is more complicated than our game-theoretical model suggests. Nevertheless, our model captures a number of interesting and important features, including the vertical and horizontal differentiation of vendors, and the sampling of fit costs and switching costs. The model also has the added benefit of enabling us to draw insightful conclusions about the pricing strategies of service vendors. The most deeply insightful finding is our observation of the asymmetric influence of clients' switching cost. This will inspire others to think more

[5] The three types of equilibria are: (1) all clients will try out Vendor *H* in the Fit Cost Sampling Stage and some will switch to Vendor *L* at time 1; (2) all clients will try out Vendor *L* in the Sampling Stage and some will switch to Vendor *H* at time 1; and (3) θ_h type clients will try out Vendor *H* in the Sampling Stage and some will switch to Vendor *L* at time 1, and θ_l type clients will try out Vendor *L* at the Sampling Stage and some will switch to Vendor *H* at time 1. In equilibrium, clients' decision-making will follow our analysis, with *marginal switchers* defined by Equations 2 and 3.

deeply about the inner workings of the IT services market, and to reflect on the effectiveness of our modeling choices and the implementation issues that arise the strategies we have indicated.

We offer three recommendations to managers to build on our analytical results:

- **Recommendation #1:** *After the Sampling Stage concludes, offer your SaaS clients value co-creating contract flexibility to reflect their need to iteratively address their potentially changing fit costs for the vendor's services.*

In the SaaS market, many vendors have adopted a marketing strategy involving free sampling periods for potential clients, typically of one-month duration, and offering opt-out flexibility. For example, Salesforce (www.salesforce.com) allows new clients to test-run its CRM applications for thirty days for free. A client only needs to register on Saleforce's website, and after sharing a little information, it will be able to run the software and quickly gauge whether the fit costs are high and unacceptable.

Our modeling approach accords clients the flexibility of sampling a vendor's SaaS offering, and reaching a conclusion about whether the fit costs are acceptable, similar to Salesforce.com's approach. Although our model requires clients to make switching decisions at a certain point in time, different clients may need different lengths of time to learn about the fit costs of working with a given vendor. So a decision to switch by the client may happen at any time during the contract period. This makes the modeling setup different, since it will require a continuous-time decision-making approach for the clients. This may be modeled in a different way than we have so far: as an embedded option in the decision process [7]. The managerial implications of embedded option models are clear and compelling: including them tends to make any contract more valuable, and so the client will have a higher level of willingness-to-pay. The worst case with an option-bearing contract is that it will not be exercised under unattractive conditions.

The arrangements that we have considered with respect to SaaS offerings are *incomplete contracts*: not all of the details are always pre-specified. During the period of the use of the services, different kinds of risks and uncertainty have to be borne by the vendor and its client, so SaaS contracts should be designed with enough flexibility to accommodate the different stakeholders' concerns. Clients face downward price uncertainty in the SaaS market, for example. So there is a need to permit *benchmarking*, which allows clients to utilize a third-party auditor to conduct an analysis of the current market prices for SaaS services, and then to adjust the price during the period of the contract, after services sampling has finished and a longer-term relationship has been established [16]. Clients may also switch to another services vendor even after a longer-term contract has been established. The discovery of true fit costs also may be influenced by changes in a client's business activities and strategy.[6]

Based on how this market operates, SaaS vendor senior managers need to address two questions in their competitive market operations. How can a firm convince potential clients to try out its services, as opposed to those of others? And what can be done to increase the *conversion rate* from free to paid services and the likelihood that a

[6] In addition, when demand volatility exists for computing cycles in a market, or a client experiences a precipitous drop in demand, flexibility will be of value. Clients might be permitted to opt out; a front-loaded fee for this option may compensate the vendor for its expected costs [3].

client will not opt out after this period passes, but enter into a longer-term relationship with the vendor? According to Sixteen Ventures [21], an IT services metrics provider, 66% of SaaS vendors reported conversion rates to longer-term service sales of 25%, a disappointing level.

Based on our ongoing field study discussions with managers in the United States, Canada and Singapore, interactions with vendors around the world, and assessments of what market pundits have been saying, there seem to be no simple answers. We conjecture that, as time goes by, vendors may need to be more aggressive, even going to subsidized longer-term sampling period durations to create a more compelling value proposition to attract new clients. Vendors need to make investments to ensure that clients trying out their services will be satisfied, though they only bring an expectation of future profit – not a guarantee. Though the first image of a SaaS vendor may be as a pure *digital services market intermediary*, our expectation is that intermediaries will strategically morph to match the needs of their clients. So we encourage SaaS providers will do more to create service adoption consulting and business facilitation services involving domain experts, experienced clients in the same industries, and more effective initial support to serve them. It is costly to provide these kinds of flexibility and support to clients. Strategic necessity is likely to win out though. Plus, a vendor that does the right things at the right points in time will be able to turn flexibility and extensive service facilitation into a strongly profitable business in the long run:

- **Recommendation #2:** *Lock in your SaaS clients, but only with mutually-beneficial impacts that are understood in the marketplace to balance the related risks and rewards.*

For SaaS vendors, experience and knowledge learned from serving one client can be used to enhance efficiency and create value in serving other clients. This approach is practiced by the large accounting, IS and marketing consulting firms: many firms reuse the business logic associated with their service excellence – many times over, in fact. Potential SaaS clients may view this as a dangerous practice though, because it gives rise to *poaching and misappropriation* of sensitive business information [5]. A collateral concern is *knowledge lock-in*. This will occur when the vendor can leverage the threat of using experience with the client and the resulting business knowledge to engage with and provide services to other firms. Clients face lock-in, but we conceptualized it more narrowly as a switching cost that involves data recovery from the SaaS vendor, a limitation of our modeling approach.

Real-world business settings involve other hidden switching costs though. Consider a large SaaS client firm that has used a particular SaaS vendor for some time, and also is an industry leader in its business sector. The vendor will learn industry-specific knowledge from serving this client over time. It also will gain a deep understanding of the client's business operations, a key enabler of the client's competitive advantage. The client will worry that – if it opts out from the vendor's service – it may be subject to exploitation of its business information. This could harm its competitive position.

The potential for lock-in occurs due to the extent to which competitive advantage may be lost. Lock-in that arises due to the vendor's intimate knowledge of a client's business is *adverse lock-in*, and is undesirable in a long-term IT services relationship. Other outcomes are possible, including *beneficial lock-in* to vendors. Consider the case of IBM and General Motors, a client of IBM's IT services organization (www.ibm.com/ services). The firms have worked together to develop a CRM solution "to align [IBM's] technologies with GM's business processes." Leveraging its experience in the automotive industry, IBM was "able to provide industry-based intellectual capital" that few other firms could [15]. The idea, in beneficial lock-in terms, is that having a long-term relationship has deepened IBM's industry-based intellectual capital for automotive industry IT services, and will benefit GM more than its competitors. Here, the vendor co-invests in R&D, creates new innovations, and works as a partner with GM as its client. Knowledge is shared and value is created from a cooperative strategic alliance.

Senior managers also need to think about how to retain their clients by leveraging beneficial lock-in in different ways. One way may be to subsidize those who are likely to be profitable high service demand customers. This is appealing due to the visibility of the vendor's commitment to concentrate the attention of a somewhat larger, more expert IT services staff as a way of helping the client to minimize the fit costs of adopting the vendor's services. This is why, we think, some SaaS vendors are offering the capability to partially customize the services they offer to big clients – a subtle morphing of the way they define their roles as SaaS vendors beyond the constraints of multi-tenancy structure. Vendors, including Salesforce.com and Amazon EC2, claim they are willing to cooperate, co-invest, and co-customize their applications to satisfy a client's business needs. The outcome is that the vendors truly need to achieve high profitability in the longer term: clients should be locked into the vendor's services, but in a way that achieves mutual benefits.

Our findings show that the competitive outcome will be different for competing SaaS vendors under different levels of cost efficiency for the SaaS business model. As a result, we advocate the strategy of employing differential pricing tied to a vendor's knowledge of the relative cost efficiency of the competition. We assert:

- **Recommendation #3:** *Leverage your firm's SaaS cost efficiency for stronger market positioning.*

In duopoly competition, the two vendors are likely to have different cost functions for the production of high quality SaaS at the firm level. This enables us to generalize our findings and make it easier for a business strategist to observe the competition and decide what business policy actions to undertake.

A vendor's SaaS capabilities also are subject to under-investment and over-investment. These include over-investment in the ownership of interorganizational networks [2], under-investment in the enhancement of financial risk management systems forecast quality [12] and a spectrum of over-investment, under-investment and right-sized investments in customer-protecting information security capabilities [18]. The result in these cases is that the firms will not be efficient in the production of profit unless they can identify the proper levels of investment.

The same value maximization logic applies to SaaS vendors: over-investment and under-investment in appropriately high quality SaaS capabilities will be a source of competitive disadvantage. For highly-capable firms to gain advantage on other SaaS providers that sell lower quality services will not be about how service quality can be enhanced. Instead, it will be about what it costs to offer an appropriate difference in quality. This will be determined by the overall cost efficiency of the firm.

Vendors will benefit from economies of scale and best practices that strong management can bring. Serving many clients contributes to a vendor's capacity to deliver service quality enhancements too. In addition, quality-related investments, including training customer support staff and expanding database and IT infrastructure capabilities, will help in other ways. Paul Strassmann [24], a past-CIO of Xerox, the U.S. Department of Defense and the National Aeronautics and Space Administration, for example, has claimed that these kinds of things promote *managerial productivity*.

An important question remains to be answered though. What kinds of firms will be more likely to have the capabilities to enhance the quality of their SaaS offerings to match the clockspeed of the market's demand growth for higher quality? We observed that the firm-level cost functions of different firms will be different, but in what ways? Will a long-established software vendor be at an advantage compared to a start-up in the SaaS patch? Large vendors may be able to leverage expertise and experience in the packaged software market to provide reliable, high-quality IT services. In contrast, a new start-up may need to position itself as a market follower, by offering lower quality services at a lower price. A start-up may discover dramatic new ways to do business that a large firm may not. Salesforce.com has proven to be an outstanding example.

5 Conclusion

This research offers competitive strategy and economics analysis for the SaaS business model. The duopoly setting we used was helpful to support our development of some fundamental and useful insights. We have been able to make some relatively refined observations about competition between SaaS vendors, especially related to how switching costs affect the vendors' pricing strategies. We identified a number of conditions that may motivate a vendor to employ an aggressive pricing strategy aimed at driving another IT services competitor with relatively lower cost efficiency out of the market. We also saw the surprising usefulness of a non-competitive pricing strategy that encourages the vendors to find a way to share the market. We saw that the two vendors were best off by cooperating with one another to ensure that each only targeted SaaS clients with an appropriate level of willingness-to-pay, a unique insight into the inner workings of competitive markets that economic analysis can support. Based on our findings, we provided additional commentary on mechanism design choices in the SaaS market. We highlighted: the importance of offering clients value co-creating contract flexibility; beneficial lock-in practices by SaaS vendors; and the danger of over-investment and under-investment in vendor service quality. These represent practical strategies for SaaS vendors to adopt.

There are some other limitations in our approach that deserve final comment. First, we assumed that all clients have only a limited time to sample the fit costs of the vendor whose software services they select. In practice, different firms have different capabilities to acquire and process information to make value-maximizing decisions. Some learn fast, some slow, and some very little. Thus, in practice, there will not be a single time by which switching decisions must occur. Second, our assumption that clients make their switching decisions at some predetermined point in time eliminates the possibility of assessing a more realistic valuation problem with an option embedded in a client's decision-making process. Third, we assumed also that switching cost is exogenously fixed. More likely is that switching cost will vary over time, and may not be entirely exogenous. There are a variety of things that firms can do to create some degree of endogeneity of choice related to how large their switching cost becomes over time [1]. Investments in the adoption of services-oriented architecture is such an approach.

Finally, market competition and incentives are such that one can imagine some competitor in the future doing a contract buyout for a new client's commitment to a prior service vendor. This is similar to buyouts of sports stars' contracts. The new vendor might also be willing to absorb and share some of the switching cost, possibly in the manner of Shapley value-based assignment of value stream rights to different stakeholders, who will be better off figuring out some way to split them [13]. All these are interesting directions to consider enhancing the future richness of our understanding of IT services strategy and management.

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