December 2003

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Abstract

Due to the rapid progress and adoption of information technologies, the decision making for technology investments has become very complex. Also, after the burst of the investment on information technologies (IT) bubble in 2000, companies and investors now require information systems decisions be based on demonstrable value creation that is aligned with the business mission and goals. In this context, it is essential for the IT community to adopt better models for decision-making regarding investments and projects. In this paper, we made a literature review of applying Real Options and Game Theory models for information system decision-making. Specifically, we formulate some research questions to analyze the delivery of software applications over the Internet on demand and on a variable pay as-you-go basis. Under this model of delivery, that is starting to be offered by Application Service Providers (ASP) like IBM and Oracle, the customer pays the software as a utility, similar to telephone or energy services. We describe how the combination of Real Option and Game Theory helps Information Systems managers to adopt an optimal strategy for the decision-making process of selecting ASP services. This extended abstract is organized as follows: first we present an overview of ASP and Real Options. Second, we explain an application of Real Options to analyzing ASP software delivery model (Techopitayakul, Johnson, 2001). Third, we consider the new research trends that extend the real option model with game theory to analyze the information system decision-making process under competition. Finally, to do a summary and we present some research questions

Introduction to ASP

The burst of the information technology bubble is accelerating the adoption of a new business model for software applications: accessing software over the Internet on demand and on a variable pay as-you-go basis. In this new model, software applications services are considered a “utility” similar to telephone or energy services. This new model is known as the “Application Service Provider” (ASP) software delivery model, and it is a fundamental shift from the “in-house” software application model, and to the “outsource” software service model.

The most obvious difference between an ASP and the other systems is the pricing model. In the “in-house” model, the firm is responsible for implementing, buying, deploying, and supporting the software. In the traditional “outsource” model where the customer is required to purchase a software license in advance and establish a multiyear contract. Instead, in the “ASP model”, the customer rents the software and pays based on the number of users, the frequency of use, and the maintenance.

Oracle was the first major software vendor to create its own ASP, called Oracle Business OnLine. In May 1999, 25 leading companies created an ASP Industry Consortium. The business strategy of the new CEO of IBM, Sam Palmisano, is completing the transformation of Big Blue from a computer company to the ASP leader. The group believes that the ASP model is poised to become a significant, perhaps dominant, model for software and services delivery to small and midsize businesses (SMBs) over the next two years. Companies like IBM are focusing the bulk of their resources on e-business on demand. This area already takes up a third of IBM's $5 billion research and development budget. The company starts by helping customers standardize all of their computing needs. Then, in the course of the next 10 years, it will handle growing amounts of this work on its own massive computer grids. They will be delivering technology that helps companies solve technical problems -- from testing drugs to simulating car crashes.

According to IBM's internal research, 60% of the profits in the $1 trillion high-tech industry will come from software and services by 2005. That's up from 45% in 2002. American Express will be outsourcing its computers to IBM and only paying for the technology they use every month. AmEx signed a seven-year, $4 billion services contract and is looking to save hundreds of millions of dollars over the course of the contract.

The benefits of ASP are attractive. A company can usually rent powerful end-to-end application solutions for significantly less than an “in-house” implementation or outsourcing. In addition to lower cost, other benefits are specialized expertise, a faster time to market, and a reduced risk due to a lower capital investment. However, customers who are unsure of the value of ASP services and their demands, in terms of the number of users and a usage level, may be reluctant to commit to ASP contracts. Many customers are also concerned with security and loss of control and performance, especially when the software becomes more critical as the company grows. Thus, for the ASP industry to move forward, ASPs must help customers cope with these uncertainties and risks. In this paper we describe a real options approach proposed by the research community to deal with the information system decision-making process of adopting an ASP service strategy.

Real Options Methodology

Real Options complement the current model for evaluating information systems projects. The net present value (NPV) methodology is the commonly used (and taught) method.. The classical managerial practice for project selection is to calculate the present value of the expected cash flows/benefits that the investment will generate, and the expenditures required to undertake the project. Then, the net present value (NPV) is determined. If NPV is greater than zero, the manager should go ahead and invest. In other words, this method states that an investment should be undertaken when the expected (discounted) present value of the revenue stream resulting from the investment project exceeds the expected present value of the expenditures. The main limitation of the NPV is that investments are considered as a now or never decision, ignoring the value opportunities of waiting. As a result, applying the net present value method alone leads to sub-optimal investment decisions.

In the most recent research literature dealing with information technology investments, a new model that overcomes the now or never limitations of NPV method is being proposed. This new model valuates the opportunity of waiting and uses similar techniques as the ones used to price financial options. This new model of technology investment is called “Real Options” different from the term “Financial Options”.

In the real options theory the analogy between a firm’s investment opportunity and a financial call option is exploited. Financial options refer to options contracts written on financial assets, like stocks, commodities or exchange rates. Real Options apply to real assets or capital investment projects. A financial call option gives the holder the right, but not the obligation, to buy a piece of the underlying derivative (e.g. stock, bond) for a specified price at a specified time. Similar to a financial call option, an investment opportunity gives a firm the right, but not the obligation, to carry out the investment project.

Real options valuation can be used when all of the following conditions apply: (Weeds, 2002, Amram, Kulatilaka 1999): The firm holding the (investment) option has the ability to delay; uncertainty is large enough that it is sensible to wait for more information; the value seems to be captured in possibilities for future growth options rather than current cash flow; there will be project updates and mid-course strategy corrections.

The real options methodology allows managers to take a “wait-and-see” approach to corporate strategy and then react to changes in the business environment, so they can limit downside losses or capitalize on upside potential. Decision-makers can use uncertainty to their advantage by understanding how a dynamic approach to future investment decisions can enhance shareholder value in an uncertain world.

A typical Real Option analysis includes the following steps, Copeland and Antikarov (2001). ***Step 1*,** complete a standard NPV analysis of the project using traditional techniques. Compute present value and forecast cash flows using a discounted cash flow (DCF) valuation model. ***Step 2***, build an event tree based on the set of uncertainties that drive the volatility of the project. The event tree can be used to model the uncertainty that drives the actual value of the underlying risky asset over time. ***Step 3**,* create a decision tree by putting the decisions that managers make into the nodes of the event tree. The event tree models the set of values that the underlying risky assets may have through time. The decision tree shows the payoffs from optimal decisions. Therefore the payoffs result from the options that are being valuated. This step introduces flexibility, which alters the risk characteristics of the project and changing the cost of capital. ***Step 4***, Valuate the payoffs using the real options methodology that is best applied to that particular investment decision. There are several different methods that can be applied. In this paper we consider the regression analysis method.

Applying Real Options to the ASP Software Delivery Model

Usage-based software pricing structure enabled by the ASP-based software delivery may in many cases be more appropriate than traditional per-copy based pricing structure. However, from the customer's perspective, a major drawback of the ASP usage-based pricing is the unpredictable cost that result, leaving the customer with a great risk of upward cost exposure.

Real options models are being applied to make an optimal ASP decision under key uncertainties faced by software owners and their customers. Three approaches are being suggested to address the usage-base pricing uncertainty. In this section, there is a summary of the model proposed by Techopitayakul, 2001. This model propose a usage-based pricing structure with a real option to switch to a fixed subscription fee, an option to bring the software in-house, and an option to end an ASP contract prior to expiration.

In the ASP model, the main uncertainties are the customer's usage and the software value (b). The usage is a function of the number of users per company (n) and the level of usage (u) per user. Therefore, the random variables (n, u, b) are used to model the system.

From the software owner's perspective, the important uncertainties are the ASP service fees, the value from indirect sources, the variable hosting and support cost and the demand for the ASP services (Q). From the customer's perspective, the key uncertainties are the software value and the ASP service fees. Some of the ASP related benefits to the customers are easy upgrades and add-ons, accessibility and scalability. Among the ASP-related costs the security risk, privacy risk and the reduction in reliability and performance are the most important. The customer has an incentive to use an ASP when the ASP prices are less than the summation of the up-front license fee, the value associated with faster time to the market, the hardware and support costs that the customer would otherwise have to spend internally on the in-house implementation, less the extra network connectivity cost required to support ASP-based use of the software. The owner has an incentive to deliver ASP-based software when it can charge ASP fees greater than or equal to the traditional up-front license plus the change in support and hosting costs, all adjusted for the change in demand which results from ASP delivery, less the extra value it receives from indirect sources.

A mean reverting process with a time-varying mean and a time varying variance is use in order to capture the evolution and correlation of the three main uncertainties of the ASP model: value per usage (b), level of usage per user (u) and the number of user per company (n). The next step is to use a Monte Carlo simulation-based algorithm suggested by Barraquand and Martineauu (1995), to find the option values and the exercise thresholds (decision triggers) for the proposed real options

> ***Option 1: Usage-based pricing with an option to switch to a subscription fee.*** From the customer's perspective, this option allow the customer to pay based on value actually received (usage-based pricing) and to put a cap or threshold to the service cost, by switching when the software usage reach some level to a subscription flat fee. The advantages of this approach for the customer are: it allows the customer to hedge against the usage risk; permits the customer to test out the software when the value is not clear. From the software owner's perspective, this option allows penetration into new markets, capturing infrequent users and users that are uncertain about their usage level, or about the value of the software.
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> ***Option 2: Option to bring the software in-house.*** With this option, the ASP allows the customer to try out the software and until the software become valuable enough for the company to bring the software in-house. Advantages for the customer: allow customer to hedge against an unacceptable level of security and performance risk that may arise from using the ASP services, as the customer as the options to bring the software in-house and thus limits these risks. From the software owner's perspective, this option allows to reach customers with security, reliability and performance concerns.

Option 3: Option to end ASP contract prior to expiration. With this option, a customer can end the ASP contract prior to expiration. The advantages for the customer are: the possibility to switch to a better software application as it becomes available; the flexibility to select a different ASP; the potential to suspend the service when a change in the business model lead to less use of certain applications. From the software owners' perspective, offering this option potentially attracts new demand from those who otherwise hesitate to commit to a specific ASP.

Complementing Real Option Analysis with Game Theory

Most of the research literature about information system decision-making using real options assumes that the firm is the only thing having the investment opportunity. That is, the firm is considered to be in isolation and the competitors and strategic interactions are ignored. However, in most industry settings, the ability of a firm to delay its investment decisions is crucially affected by the actions of *other firms*. When several firms are competing in an open market, delay by one firm could mean opportunity for another. After the rival's investment, the first firm's investment opportunity may then be reduced in value. Therefore, the first firm's ability to delay depends not only upon what contracts state, but on the actions of its competitors. The future research trends will stress the importance of project investment decisions under competition. This requires complementing the real option model with game theoretical models to find the optimal investment strategy. Investment models that incorporate strategic interactions make use of the non-cooperative game theory and are appropriate because, in general, the firms are competing against each other and there is not a willingness to cooperate.

One of the first real options models that incorporates strategic interactions is the duopoly model in Smets (1991). In this model the actual revenue stream of one firm depends on the investment decision of the other firm. Two similar firms that are sharing a particular market can collaborate in making a decision to invest in a solution. Lambrecht and Perraudin (1999) consider a model with incomplete information, in which they assume the other firm's profitability of the investment project is not known and there is only one firm that can implement the project. Finally, Weeds (2002) models a research and development race between two firms.

For the context of this paper, strategic interactions between firms will be classified into two broad types: first mover advantage (FMA) and second mover advantage (SMA). A situation is classified as FMA if the player gains a higher payoff by acting first, by investing before its rival does. Examples of FMA is a patent race, where the first to achieve a breakthrough receives exclusive rights for a certain period of time. An SMA exists when it is more advantageous to go second, preferring the rival go first. This situation arises when the first investment yields spillover into the second investment. For example, a firm may gain from the information generated and experiences of a competitor, reducing the risk level for the subsequent firm.

FMA tend to conflict with real options because real options stress the value of waiting while delay is dangerous in the FMA situation. SMA, on the other hand, enhances the motive for delay and compliment the real options methodology. A network market is one where the value of the product increases with the network of other users (Weed, 2002). The usual consequence of network effects is that a single operator ends up dominating the market. Systems wars have taken place in sectors like satellite broadcasting (Sky vs. BSB), videocassette recorders (VHS vs. Betamax) and computer operating systems (Microsoft vs. Apple Mac).

In network markets, a phenomenon known as 'tipping' occurs: an early lead by one firm induces subsequent purchasers to copy this choice and the market rapidly tips in favor of this operator. With tipping effects, there is a strong FMA. The current real options methodologies alone will not suffice. The area of game theory can lead to further advancements in these situations and are now being applied to real options. For more information on game theory, reference texts by Rasmusen (1994) and Fudenberg & Tirole (1991).

Summary and Research Questions

The decision making for technology investments has become very complex. Besides the current tight market conditions, companies, investors and society in general now require information systems decisions be based on demonstrable value creation that is aligned with the business mission and goals.

The classical methodologies used to make information system decisions regarding technology investments are based on the Net Present Value (NPV) model. This model has many shortcomings. The main limitation of the NPV is that investments are considered as a now or never decision, ignoring the value opportunities of waiting. As a result, applying the net present value method alone leads to sub-optimal investment decisions.

To overcome the limitations of NPV, the research literature is proposing a new "Real Options" model that valuates the opportunity of waiting and uses similar techniques as the ones used to price financial options.

Real options valuation can be used when all of the following conditions apply: the future is uncertain; the (investment) decision is irreversible; and the firm holding the (investment) option has the ability to delay.

Real Options are being used to analyze the value of adopting an Application Service Provider model for software delivery. In this model, software applications are accessed over the Internet on demand and on a variable pay as-you-go basis. The Real Options analysis for ASP includes the generation of a cost/price model, identify underlying uncertainties such as the software usage, propose decision options, and find the optimal values using Monte Carlo simulations.

Real Options are being extended to consider the role of competitors on a project decision. Game theory is now being used to model the interactions of the firms with the competitors.

Our PhD. Dissertation will focus on using new models and methodologies for analyzing the ASP information systems delivery model. The questions that we are trying to help to answer are : What are the Real Options for making ASP decision under a competitive environment?. What is the impact of the strategic interactions among competitors?

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