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Valuation of Benchmark Provisions on IT Services Contracts

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ABSTRACT
Information technology (IT) services are often subject to downward price pressures due to improvements in technology and business processes in a competitive market. When clients enter into IT services contracts, they are faced with the future risk that their services will be overpriced relative to the broader IT services market. To mitigate this risk, clients often add benchmark provisions, whereby a neutral third party assesses the prevailing market price for services. It will support fair price adjustments if the market prices are lower than the current prices. We model the decision to benchmark in order to provide managerial information on the value of benchmark provisions. We ground the model empirically with data from a leading IT service provider.

Categories and Subject Descriptors
D.3.3 [**Programming Languages**]: H.1.1 Systems and Information Theory, Value of Information

General Terms
Algorithms, Management, Measurement, Performance, Design, Economics, Theory.

Keywords
Benchmarks, Contracts, Economics, IT Outsourcing, Risk Management

1. INTRODUCTION
As information technology (IT) services continue to evolve, pricing remains a challenge. Both clients and providers seek the stability that long-term contracts offer. Unlike many goods and services though, the prices for IT services tend to decline over time. Moore's Law drives the prices of storage and computing power downward, and service providers also benefit from economies of scale and best practices, which also serve as downward price drivers. Thus, a client firm may expect that, over time, the prices negotiated at the beginning of the contract are no longer competitive as compared to the marketplace. In order to mitigate the risk of over-paying for IT services, clients require that their contracts contain a benchmark clause. Benchmark clauses vary among clients and providers. A typical benchmark utilizes a third-party to conduct an analysis of the market price of IT services. Prices are then adjusted according to the terms of the contract.

One of the ongoing concerns for client firms is when to include the benchmark clause in a contract, and how to exercise these clauses during the lifetime of the contract. Practitioners differ in their advice on the frequency and timing of exercising benchmark provisions, from consistent yearly intervals to the use of infrequent benchmarks after at least eighteen months in contracts with durations of longer than three years. We seek to provide actionable, managerial advice on the valuation of benchmark provisions.

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We draw on theory from financial economics and utilize dynamic programming and simulation methods. The exercise of a price benchmark in IT services contracts shares characteristics with the decision to refinance a home mortgage in the face of declining interest rates. Dunn and Spatt [2] and Agarwal et al. [1] provide theoretical models for the optimal time to refinance mortgages based on observed interest rates. The main difference in comparison to our scenario is that IT service prices are opaque, whereas mortgage holders observe the prevailing interest rates in the marketplace for home loans.

A second perspective we draw on is options pricing theory and real options models for IT investment [4]. Our model utilizes a contingent expectations approach to modeling risk, which has been traditionally utilized by actuarial science [5]. This approach allows us to relax the assumption that IT services are traded, liquid assets. This has been a criticism of real options models for IT investments.

Our main research question is: What is the value of price benchmarking provisions in IT services contracts from the point of view of client firms? We will examine four key variables and their effects on the value of benchmark provisions. They include: (1) the expected IT services price drift rate, which represents the expected decline in IT services prices over time; (2) the extent of IT services price volatility, which represents the uncertainty in the IT services price drift rate; (3) the estimated costs of carrying out the benchmark provisions; and (4) the number of benchmark provisions for a given contract.

Our computational finance model applied to IT services shows that, although the value of benchmarks increases with uncertainty in pricing, we can obtain robust findings except under conditions of extreme volatility. To illustrate, we will ground our model empirically with data on network services price points over a five-year time horizon. Furthermore, we will incorporate managerial estimates into the model, and highlight the boundary conditions to represent the inflection points for managerial decisions.

2. MODEL
We develop a continuous-time computational decision model that values benchmark provisions in terms of the discounted total contract costs a client firm will face under different pricing strategies. In earlier work, we developed a closed-form solution for optimal benchmark exercise timing [3]. In contrast, our goal is to consider uncertainty and the number of benchmark provisions that can be considered. We offer this model as a basis for managerial decision support, and provided numerical solutions to illustrate the applicability of our modeling approach in the assessment context that we have specified.

2.1. Model Setup
We will consider a firm that is negotiating a long-term contract for networking services with a service provider. Table 1 provides

a summary of our modeling notation. We assume the firm has an estimate of the expected drift rate of IT services prices, μ, and the volatility of IT services price drift, σ. These estimates could be provided by historical data, as we utilize with our empirical example, or by managerial estimates, similarly to those utilized in project management. Examples include PERT techniques. We further assume that the client and provider have negotiated an initial price P_0, and duration T for the IT services. This is a continuous time representation of per period prices, such that the contract would have a total cost to the client of P_0T.

The main decision points for the client are whether to include a benchmark provision, and how many benchmarks, n, to include in the contract. The decision will then be weighed by the discounted value benchmark that the client will receive based on exercising the benchmark at an appropriate time t. A final parameter of the model is x_n, the transaction costs of the benchmarks. A benchmark is costly to exercise, both in terms of fees and goodwill between the client and provider. Often providers contest benchmarks, and the process can even lead to court cases, such as the well-known example of IBM versus Cable and Wireless. A client firm must consider all of these tangible and intangible costs in setting a figure for the costs associated with exercising a benchmark and enforcing a price adjustment.

2.2. Value of IT Service Price Benchmarks

The benchmark provision provides the right, but not an obligation, to replace existing contract pricing with the prevailing market price determined by the third-party benchmark provider. We assume, as is consistent with most benchmark provisions, that any increase in IT service prices would not trigger an increase in prices for the client. Contracting helps the client firm in this respect. These two characteristics hold true in financial options also, where a holder has the right, but not the obligation, to exercise a call option in the event that the price of the security is higher than the strike price. By holding the option, rather than the underlying asset, the holder is indemnified against the risk of the underlying asset losing value. Losses are limited to the price of the option, much as losses are limited to the cost of exercising the benchmark in our IT services contracting setting.

Thus, the total cost of a contract with a single benchmark provision C is represented by:

$$C = P_0 t + \text{Min}\,[P_t, P_0]\,(T - t) - x_1 \quad (1)$$

The first term on the right-hand side of the equation represents the contract costs up to the point of the benchmark. The second term represents the costs after the benchmark provision is exercised, with a price adjustment occurring only if $P_t > P_0$.

Since the price at the time of exercise t is unknown, we can derive the expected price at the time of exercise as:

$$E[P_t] = E\left[P_t \mid P_t < P_0\right] \Pr\left(P_t < P_0\right) + E\left[P_t \mid P_t > P_0\right] \Pr\left[P_t > P_o\right] \quad (2)$$

In order to derive the optimal time to benchmark we adopt the method used by Whaley [6] to derive conditional expectations of IT service prices. The conditional expectation if $P_t > P$ is $E[P_t \mid P_t > P] = P_0 e^{\mu t} (\Phi[d_1]/\Phi[d_2])$, where $d_1 = [\ln(P_t e^{\mu t} / P) + .5\sigma^2 t] / \sigma\sqrt{t}]$ and $d_2 = [\ln(P_t e^{\mu t} / P) - .5\sigma^2 t]/\sigma\sqrt{t}]$. Φ is the cumulative density function of the normal distribution. Also, $E[P_t \mid P_t < P] = P_t e^{\mu t} (\Phi[-d_1] / \Phi[-d_2])$. The probabilities of P_t exceeding and falling below a threshold P are given by $\Pr[P_t > P] = \Phi[d_2]$ and
$\Pr[P_t < P] = \Phi[-d_2]$.

The objective function is then given by:

$$\underset{t}{Min}\, C = P_0 t + \min[E[P_t],\ P_0]\left(T - t\right) \quad (3)$$

3. RESULTS

Our model relies on a partial expectations approach to modeling the expected price at a future point in time. We have produced results for the single and multiple benchmark cases utilizing price data on network infrastructure services provided by a leading third-party benchmarking firm. Our data are intended to ground the model and provide reasonable estimates of the expected price decline and drift. We have 27 quarterly observations of estimated market prices for network services from 2005-2011. From these estimates, we calculated period-to-period growth of IT services.

Our base model assumes that the expected price drift μ is normally- distributed. We conducted a goodness of fit test for normality and were not able to reject the null hypothesis that the data are normally distributed. The p-value was 0.976, so we feel comfortable using the assumption of normality. We normalized the drift and volatility to set T = 1. Thus, a time frame of 5 years or 20 quarters yielded a drift rate of $\mu T = -0.572$, and a voliatility $\sigma\sqrt{T} = 0.746$. Here, σ is the standard deviation of IT services price drift.

We modeled the multiple benchmark case utilizing a dynamic programming approach and a recursive algorithm involving numerical inputs for price drift μ, the volatility of the price drift σ, and the transaction cost x_n of the n_{th} benchmark. We solved the model we specified by utilizing the combinatorial technique FINDMIN in Mathematica, which finds local minima within bounded constraints.

We are currently pursuing further research to extend the related computational solution to value market price information available to the firm prior to benchmarking. This will give managers the ability to avoid unnecessary losses in cases in which IT services prices do not decline. Another extension involves the consideration of trigger points for the benchmark. The idea, for example, is that price adjustments may only need to occur if the market prices are 25% or more below the current prices paid by the clients. It is our hope that these models can be further developed and built into decision support systems. Further empirical work will need to be done to validate the estimations of our model's parameters though.

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