PROFIT MAXIMISING CONTRACT PLANS FOR CLOUD COMPUTING SERVICES

Christian Schlereth, Siham El Kihal

Abstract

Providers of cloud computing services commonly offer contract plans (e.g., subscriptions) with different contract lengths as an alternative to single period plans. Contract plans are attractive for consumers who use the service periodically because the consumers benefit from significant price discounts if they commit themselves to the service provider for the time of the contract length. However, deciding on price discounts and contract lengths for contract plans is challenging, as binding consumers leads to greater profit, while offering greater price discounts negatively impacts the provider’s profit. The goal of this study is to outline the factors that drive the differences in profitability when offering a contract plan in addition to a single period plan. Therefore, we model consumers’ decision-making process between the two pricing plans and develop a method to maximise the profitability of these plans. The proposed model separates the consumers’ ex-ante probability of needing the service, which is assumed to be independent from the price of the contract plan, from the decreasing marginal utility that arises through the discounted benefits of future usage. In a Monte Carlo simulation, we show that offering a contract plan in addition to a single period plan increases profits by up to 10% and on average by about 3%.

Keywords: Cloud computing; Pricing; Contract plan; Contract length; Monte Carlo simulation.

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1 Introduction

Cloud computing is emerging at an impressive speed, and its global market value is predicted to exceed $109 billion in 2012 (Pettey and van der Meulen 2012). To attract more consumers, cloud providers utilise various pricing instruments to differentiate and attract new consumers (Lehmann and Buxmann 2009) and also to bind consumers to the service for a longer period of time. One prominent pricing instrument is the use of contract plans, which offer price discounts if consumers commit themselves to use the service for the length of the contract. From a provider perspective, contract plans lock-in consumers for a certain period of time and can lead to increased repeat sales and cross-selling opportunities (Heitz, Ruckstuhl, and Dettling 2010). From a consumer perspective, contract plans yield a considerable price discount and therefore allow for great savings (Stadel et al. 2012).

When considering today's infrastructure-as-a-service market, as illustrated in Table 1, we observe that nearly every provider is offering contract plans in addition to a single period plan (i.e., a plan in which a consumer is always allowed to switch plans or churn). For example, when comparing the single period plans of a computing instance that have 1 to 2 CPUs, 1 to 2 GBs of memory, and 100 GBs of storage, providers charge approximately the same price. However, the contract plans, respectively the price discounts, substantially differ among providers. For example, looking only at the 12-months plans, price discounts range from 10% to 51%.

<table>
<thead>
<tr>
<th>Provider</th>
<th>Single period plans Price per month</th>
<th>Contract plans Contract length</th>
<th>Price discount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon</td>
<td>$58</td>
<td>12 months</td>
<td>51%</td>
</tr>
<tr>
<td>Nephoscale</td>
<td>$73</td>
<td>12 months</td>
<td>18%</td>
</tr>
<tr>
<td>Microsoft</td>
<td>$61</td>
<td>6 months</td>
<td>16%</td>
</tr>
<tr>
<td>Cloud Sigma</td>
<td>$65</td>
<td>3 months</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 months</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>36 months</td>
<td>45%</td>
</tr>
<tr>
<td>eApps</td>
<td>$60</td>
<td>3 months</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 months</td>
<td>10%</td>
</tr>
</tbody>
</table>

*Computing instance: 1-2 CPU, 1-2 GB memory, and 100 GB storage, assuming full usage during 1 month*

Table 1: Examples of single period and contract plans for computing instances

The noticeable differences in the contract plans suggest that today’s cloud providers are missing a common quantitative approach in setting price discounts and contract lengths. Even though contract plans are both relevant from a theoretical perspective and widespread in practice, little is revealed in the literature about their implementation. The majority of studies provide managerial recommendations in the context of B2B, where contract plans are negotiated individually (e.g., Joskow 1987). Behavioural studies complement this research and provide insights into how consumers discount the benefits of future service usage (Loewenstein and Prelec 1992). No study is known to the authors that models consumers’ intertemporal choice between a single period plan and a contract plan. The term intertemporal is associated here with consumer choice between pricing plans, which vary in their contract length.

From a provider’s perspective, we aim to identify the drivers of differences in provider’s profitability when introducing a contract plan in addition to a single period plan. Thereby, we seek how to determine optimal contract and single period plans and whether the price of a single period should change, when a contract plan is added. To achieve this goal, we develop a model for consumers’ intertemporal choices, which separate consumers’ ex-ante probability of needing the service, which is assumed to be independent of the prices of the contract plans, from the decreasing marginal utility that arises through the discounted benefits of future usage. We also develop provider’s profit function and propose the use of the gradient heuristic to determine optimal contract plans and single period plans.
Finally, we study the drivers of differences in profitability between a single period plan and an additional contract plan and provide managerial insights into implementing contract plans.

2 Literature Review

Contract plans with different contract lengths are widely used in several industries, especially for cloud computing services – a highly competitive market of commodity services, where contract plans serve to bind a consumer to a service for a certain number of periods. Many cloud computing services can also be seen as commodity services, i.e., they are easily exchangeable and their pricing is easy to compare. However, many other services, such as gym membership, magazine subscriptions, transportations, and telecommunications, also employ these plans and benefit from their capabilities of price differentiation. To provide managerial recommendations on setting profit maximising contract plans, the following literature streams are relevant for our study: (1) pricing of cloud computing services, (2) contractual relationships, and (3) consumer response to pricing plans.

2.1 Pricing of Cloud Computing Services

An increasing number of studies focus on the economic challenges of cloud computing. Pricing — especially price differentiation — is considered to be a potential obstacle of cloud services but also one of the major success factors for cloud providers (e.g., Lehmann and Buxmann 2009; Weinhardt et al. 2009). For example, Lehmann and Buxmann (2009) provide a structured overview of pricing instruments that are frequently employed for software-as-a-service (SaaS). Koehler et al. (2010) also study SaaS and demonstrate that consumers prefer a flat-rate over pay-per-use plans. Anandasivam (2009) introduces a bid-pricing method for cloud computing services, while El Kihal, Schlereth, and Skiera (2012) argue that service providers use price differentiation, such as bundling, to decrease price transparency and to differentiate their offers from those of their competitors.

All studies agree that current pricing knowledge does not meet the challenges of today’s cloud computing business models, and these studies recommend further research. Contract plans are a relevant type of pricing plans for cloud services and have been mostly neglected. Subsequently, we describe insights from prior studies on contractual relationships and consumer choices of pricing plans, motivating the current study.

2.2 Contractual Relationships

Research has shown that contractual relationships have mixed effects for both providers and consumers. Providers benefit from offering contract plans because consumers are bound to the firm for a certain amount of time and lock-in effects can easily be achieved (Heitz, Ruckstuhl, and Dettling 2010; Stadel et al. 2012). Contract plans also generate higher repeat sales and cross-selling opportunities for the provider and lead to a more predictable demand. Moreover, long life consumers are less costly to serve than short life consumers, bringing a monetary gain for the provider and giving him a competitive advantage by building strong consumer relationships (Reinartz and Kumar 2000). However, revenues per consumer in contract plans are lower than in single period plans due to the significant price discounts to incentivise the longer contract length. In addition, providers face higher risk costs for non-availability of the service and cannot compensate by increasing their own costs with higher prices as prices are often fixed during the contract length.

From a consumer perspective, significant price discounts, more predictable costs, and the greater value a consumer receives from a longer relationship with the service provider encourage the consumer to choose contract plans (Stadel et al. 2012). However, because of the unknown risk of decreasing prices in the future or the risk of not needing the service in the future, consumers often regard contract length to be a daunting switching barrier (Dellavigna and Malmendier 2004).
To comprehend how consumers evaluate relevant alternatives and respond to contract plans, a deeper understanding of their WTP and consumer surplus is necessary. The following section summarises how consumers respond to several pricing plans and the factors driving consumer choice.

2.3 Consumer Response to Contract Plans

To make appropriate pricing decisions, providers must know how consumers react to different pricing plans and on which criteria their preferences are based. A rich stream of research dedicated to intertemporal decision making shows that consumers discount future monetary benefits, with annual discount rates ranging between 0% and 100% or even higher (for a meta-analysis, see Frederick, Loewenstein, and O’Donoghue 2002). Loewenstein and Prelec (1992) investigate how consumers build reference points that influence their evaluation of alternatives in intertemporal decisions. In a recent study, Stadel et al. (2012) investigate how consumers discount future benefits and show that individuals’ discounting is heavily biased toward the present.

Another stream of literature studies contractual relationships in the B2B setting, in which contracts are negotiated individually. Fullerton (2003) analyses the role of different forms of commitment in the relationship between the provider and the consumer. He demonstrates that consumer commitment has mixed effects on consumer loyalty when it is based on switching costs and dependence. Joskow (1987) analyses coal contracts and examines the importance of relationship specific investments on determining the length of the contract. He outlines that as relationship specific investments become more important, contract plans of increased length are more advantageous.

Most research concerning consumer response to different pricing plans in a B2C setting has considered non-intertemporal choices. Contract plans are a special case of bucket pricing plans, which have been studied by Schlereth and Skiera (2012) and which consist of a periodic price for a discrete quantity per period (i.e., the allowance). Providers differentiate consumers according to their demand by offering larger price discounts per unit when buying larger quantities. These plans belong to the class of nonlinear pricing plans, such as flat-rates or two- and three-part pricing plans. Iyengar, Jedidi, and Kohli (2008) propose the use of discrete choice experiments to learn about consumer decision making. Schlereth and Skiera (2012) augment this model by accounting for differences in service attributes. Danaher (2002) demonstrates in a field experiment that providers can actively use these nonlinear pricing plans to incentivise consumers to buy larger quantities.

Altogether, a review of relevant research shows that no study has yet analysed consumer choice process when choosing between plans with different contract lengths, i.e., how contract lengths and price discounts affect willingness-to-pay (WTP), consumer choices, and provider’s profit. The aim of this study is to close this research gap and provide better insights into plans with different contract lengths.

3 Modelling Consumer Choices between a Single Period Plan and a Contract Plan

In this section, we present our model for consumer choice between a single period plan and a contract plan. We consider one provider who offers a single period plan with a periodic (e.g., monthly) price \( p \) whereby the consumer can use the service for an unlimited time within the period (i.e., a flat rate). The provider also offers a contract plan with a contract length \( T \) and a reduced price of \( p \cdot (1-d) \), where \( d \) is the price discount, and therefore continuous between 0 and 1. We treat the single period plan as a special case of a contract plan with \( T=1 \) and \( d=0 \).

Subsequently, we describe consumer \( i \)’s process of choosing between a single period plan and a contract plan. We then model the consumer’s willingness-to-pay for using the service over the next \( T \) periods. We also derive consumer surplus and model the consumer’s probability of choosing the single
period plan, the contract plan, and neither of the plans. Because no decision model is known to the authors for intertemporal plan choices and for ease of exposition, our model aims to capture the non-dynamic drivers of choice and use this information to implement profit maximising contract plans. Thus, the model is suitable for experiments, such as discrete choice experiments, in which consumer choices are only observed in one time period. These experiments are frequently employed by providers before a service or new pricing plan is launched to obtain recommendations about the optimal pricing (Wertenbroch and Skiera 2002).

3.1 Choice Process between a Single Period Plan and a Contract Plan

Research on consumer choice process has shown that consumer behaviour is complex and not fully understood. Louviere, Hensher, and Swait (2000) decompose consumer choice process into three successive steps before a decision is made (see Figure 1 for a reduced illustration). The process begins with the “need awareness” step, in which the consumer must first realise his desire or need for the service. The probability of this step is associated with probability \( P_{\text{need}}^t \), which we assume to be independent from the actual offer (i.e., the pricing plans) of the provider. The consumer then seeks information about the pricing and choice alternatives of the provider and assesses the utility of each alternative in the “alternative evaluation” step. Finally, in the “choice” step, the consumer makes a final decision regarding whether to purchase and, if so, which plan to choose.

In case of choosing the single period plan, the consumer uses the service only in this period. In the next period, the same choice process starts again from the beginning. In contrast, when choosing the contract plan, the consumer commits himself to the service for \( T \) periods, such that he does not pass through the decision tree.

Most of the models proposed in the context of nonlinear pricing cover only the second and the third steps of the consumer choice process and neglect the first step, the “need awareness” (e.g., Iyengar, Jedidi, and Kohli 2008; Schlereth and Skiera 2012). This first step is often neglected because they consider only one single period and assume that consumers are already aware of their need for the service. However, the distinction between the “need awareness” step and the “alternatives evaluation” step is necessary to explain consumer choices between a single period and a contract plan.

Figure 1: Consumer choice process in period \( t=0 \)

When evaluating the single period plan, we can assume that a consumer is aware of his need for the service for this period. Otherwise, he would not have been in the situation of making a choice or

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1 For example, Narayanan, Chintagunta, and Miravete (2007) demonstrate for nonlinear pricing plans, how to extend non-dynamic choice models with dynamic effects, such as learning effects and experience, as observed in transaction data.
evaluating the alternatives. In contrast, when choosing the contract plan, consumers take into account whether and to what extent they will need the service in the subsequent $T$ periods.

For example, when evaluating a contract plan for a computing instance, a cloud user might consider the probability that he in fact needs the computing service in each of the $T$ periods. Another example is travelling to work via train and deciding between a monthly and a discounted annual season ticket. Consumers must then consider, for example, how many weeks they are on vacation, when evaluating whether to pay the price of the discounted annual season ticket, even though they are not always using the train during the year.

### 3.2 WTP Function

We transfer the concept of the WTP functions, defined by Wilson (1993) as the price consumer $i$ is willing-to-pay for a given quantity of a product or a service, into the intertemporal setting. In our model, the WTP function $WTP_i(T)$ models consumer $i$’s cumulated willingness-to-pay for committedly using the service in the next $T$ periods. Consistent with Iyengar, Jedidi, and Kohli (2008) and Schlereth and Skiera (2012), we assume that the willingness-to-pay function increases with each additional period ($\frac{dWTP_i(T)}{dT} \geq 0$) and that the marginal WTP decreases ($\frac{d^2WTP_i(T)}{dT^2} \leq 0$). This assumption accounts for consumer’s discounted benefits of future usage as well as other disutility with increasing $T$, such as being locked into a contract and not being able to benefit from potential future price reductions in the single period plan.

Such behaviour is frequently captured by a quadratic functional form (e.g., Iyengar, Jedidi, and Kohli 2008; Schlereth, Skiera, and Wolk 2011). The WTP function is described by consumer-specific parameters $a_i$ and $b_i$, his probability of actually needing the service $Pr_{need}^{i_{new}}$, as well as the contract length $T$:

\[
WTP_i(T) = \begin{cases} 
Pr_{need}^{i_{new}} \cdot (a_i \cdot T - \frac{b_i}{2} \cdot T^2) & \text{if } T \leq \frac{d_i}{b_i} \\
Pr_{need}^{i_{new}} \cdot \frac{a_i^2}{2 \cdot b_i} & \text{if } T > \frac{d_i}{b_i} 
\end{cases} \quad (i \in I; T \geq 2).
\]

The parameters $a_i$ and $b_i$ are assumed to be continuous and greater than or equal to zero to ensure a quasi-concave functional form as illustrated in Figure 2. The parameter $a_i$ is responsible for the increase in WTP, and the parameter $b_i$ for the decrease in the marginal WTP. With each additional period, the cumulated WTP increases until it reaches a saturation level at $T = a_i/b_i$. In other words, being committed to staying with the service longer than $a_i/b_i$-periods does not increase the consumer’s WTP; thus, the WTP function remains constant.

![Figure 2: Consumer's WTP function](image)
Equation (1) incorporates $\Pr_{\text{need}}^i$, which describes the consumer’s probability of needing the service (i.e., step one), as a multiplier. This probability is assumed to be continuous between 0 and 1 and constant over time.\(^2\)

As the single period plan is a special case of the contract plan with $T=1$, we can derive the consumer’s WTP from Equation (1) as:

\[ (2) \quad WTP_i(1) = a_i - \frac{b_i}{2} \quad (i \in I). \]

In contrast to Equation (1), the WTP for using the service under the single period plan does not require the multiplier $\Pr_{\text{need}}^i$. As illustrated in Section 3.1, when consumers are evaluating a single period plan, they already know that they want the service, as they have already moved beyond the “need awareness” step. Data analysts benefit from this distinction because, at this point, $\Pr_{\text{need}}^i$ will become identifiable.

### 3.3 Consumer Surplus and Choice Model

Deciding between the single period plan and the contract plan depends on the surplus consumer $i$ gets from both plans. Typically, consumer surplus is calculated as WTP minus the price. For single period plans, the price is $p^s$, whereas the price of the contract plan over $T$ periods is calculated as $p^s \cdot T = (1 - d) \cdot p^s \cdot T$. Thus, in our research setting, we cannot directly compare the consumer surplus for both plans because the time frame being considered differs. Instead, we assume that consumers normalise their consumer surplus for the contract plan to one time period by calculating the average consumer surplus as:

\[ (3) \quad CS_i^c = \frac{WTP_i(T) - p^s \cdot T}{T} = \begin{cases} 
\Pr_{\text{need}}^i \left(a_i - \frac{b_i}{2} \cdot T\right) - p^s & \text{if } T \leq \frac{a_i}{b_i} \\
\Pr_{\text{need}}^i \left(a_i^2 / 2 \cdot b_i \cdot T\right) - p^s & \text{if } T > \frac{a_i}{b_i}
\end{cases} \quad (i \in I). \]

Consequently, the consumer surplus for a single period plan becomes:

\[ (4) \quad CS_i^s = \frac{WTP_i(1) - p^s}{1} = a_i - \frac{b_i}{2} - p^s \quad (i \in I). \]

To account for any additional factors that influence consumer surplus and are not captured in our model, we introduce a stochastic component $\epsilon_{\text{plan}}$ (usually labelled the error term), and thus, we can make statements about the probabilities $\Pr_{\text{top}}^i$, $\Pr_{\text{top}}^i$, and $\Pr_{\text{none}}^i$ that consumer $i$ picks one of the two plans or neither of the plans. We assume that the error term is distributed as extreme value type 1 with a mean of 0 and a covariance matrix $\Sigma$. Then, consumer’s probability of choosing one of the pricing plans can be calculated in a closed form by the convenient logit function. For example, for the contract plan, we can write its probability as:

\[ (5) \quad \Pr_i^c = \frac{\exp(CS_i^c)}{1 + \exp(CS_i^c) + \exp(CS_i^s)} \quad (i \in I). \]

\(^2\) Depending on the concrete service, the model can be adjusted using a time-dependent $\Pr_{\text{need}}^i$.
4 Providers’ Profit Function

To assist providers in identifying the optimal pricing plans, we formulate the profit maximisation problem for a provider when offering a single period plan and a contract plan. The decision variables of the profit maximisation problem are $p^s$, $d$, and $T$. If the consumer selects the single period plan, the provider receives a profit of $\pi^s = p^s - k$ in that period, where $k$ is the variable cost. Most likely, the same variable costs occur when offering a contract plan such that the profit per period under the contract plan is $\pi^c = p^c - k = p^s \cdot (1 - d) - k$.

Let $N$ be the planning horizon of the provider, which is assumed to be finite. We use the decision tree presented in Figure 3 to illustrate the calculation of profit for consumer $i$, such that the provider’s profit is $\pi = \sum_i \pi_i$. The reason for using a decision tree is that no closed equation of profit $\pi$ exists, even if we let $N$ be infinite.

![Figure 3: Provider profit maximisation problem after N periods](image)

In the first period, the provider obtains the profit of the single period plan with the probability $\Pr_{i \text{ Need}} \cdot \Pr_{i \text{ Service}}$. Then, in the following period, consumer $i$ is assumed to determine whether he needs the service and whether he selects the single period plan again. These decisions are associated with the same probabilities. The probability of choosing the contract plan in the first period is $\Pr_{i \text{ Need}} \cdot \Pr_{i \text{ Service}}$. In contrast to the single period plan, the probability of being in the contract plan for the next $T$ periods is 100% (see Figure 3).

For a given $p^s$, $d$, and $T$, we calculate profit by evaluating all possible sequences of decisions, which are then weighted by their respective probability that consumer $i$ actually makes these decisions in the order of the sequence. For the subsequent study, we implement the calculation in Matlab using recursion techniques.
5 Drivers of Differences in Profitability

To better understand the environmental settings under which providers benefit from offering a contract plan in addition to a single period plan, we conduct a Monte Carlo simulation (Schlereth, Stepanchuk, and Skiera 2010). Thereby, we assist providers in their decision, whether the increase in profit due to the additional contract plan can be justified, despite the additional expenditures required to address the (most likely unknown) administrative burden and marketing efforts. We also support providers in setting optimal prices. For example, we can test whether and to what extent the provider should increase the price of the single period plan, when a contract plan is added, to offer a price discount.

Within the Monte Carlo simulation, we systematically vary the factors that influence differences in profit between a single period plan (specified by price $p_s$) and the combination of a single period and a contract plan, specified by the decision variables $p_s+c$, $d$, and $T$. The factors also include variable costs $k$ and the length of the provider’s planning horizon $N$, as well as consumer specific parameters, such as the mean value of the WTP function parameters $\bar{\alpha}$ and $\bar{b}$, their probability of needing the service $Pr_{\text{Need}}$, and consumer heterogeneity $\phi$. We sample 100 consumers by drawing their parameter values from a multivariate normal distribution with a given mean and standard deviation (see Table 2), setting the covariance terms to zero. For example, we sample parameter $a_i$ by $a_i = \bar{a} + r \cdot \sigma_a \cdot \phi$, where $r$ is a random number from a standard normal distribution $r \sim \mathcal{N}(0,1)$.

Table 2 details the set-up of the Monte Carlo simulation, which considers 640 observations.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Notation</th>
<th>Numbers</th>
<th>Factor Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable costs</td>
<td>$k$</td>
<td>2</td>
<td>Low: $k = 0.5$</td>
</tr>
<tr>
<td>Planning horizon</td>
<td>$N$</td>
<td>2</td>
<td>Low: $N = 10$</td>
</tr>
<tr>
<td>WTP for the service</td>
<td>$\bar{\alpha}$</td>
<td>2</td>
<td>Low: $\bar{\alpha} = 10$</td>
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<tr>
<td>Decrease in marginal WTP</td>
<td>$\bar{b}$</td>
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<td>Heterogeneity</td>
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<td>Low: $\phi = 0.5$</td>
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</tbody>
</table>

Table 2: Design of the simulation study

For each environmental setting, we solve the profit maximisation problem described in Section 4 and determine the optimal price $p_s^*$ of the single period plan, as well as the optimal combination of the single period plan and the contract plan, i.e., the price $p_s^*+c^*$, the price discount $d^*$, and the contract length $T^*$. The price and price discount are continuous, and the contract length is discrete. Thus, the maximisation problem of the objective (profit) function belongs to the class of mixed-integer nonlinear programming problems.

To identify a suitable optimisation technique, we systematically vary the plan parameters $p_s^*$, $p_s^*+c^*$, $d^*$, and $T$. The objective function is convex and monotonically increasing up to a global maximum (see Figure 4 for an illustrative example). In other words, an optimal contract length $T^*$, for example, exists up to which profits increase. However, offering contracts with contract lengths exceeding $T^*$ will decrease profits, no matter what price and price discount values the provider chooses. This convex property of the objective function with mainly one (global) maximum – no local maxima – allows us to obtain robust results using a gradient search as a fast and convenient heuristic (e.g., Himmelblau 1972).
To compare the differences in profitability between offering a single period plan alone and offering a contract plan in addition, we compute the relative difference in profit $\Delta \pi$ using Equation (6).

$$\Delta \pi = \frac{\pi^{* \text{c}} - \pi^*}{\pi^*}$$

We also study the extent to which the Monte Carlo simulation factors influence the choice of the optimal plan parameters $p^*$, $p^{*\text{c}}$, $d^*$, and $T^*$. We use ordinary least squares (OLS) for each dependent variable, $p^*$, $p^{*\text{c}}$, $d^*$, $T^*$, and $\Delta \pi$ separately and report in Table 3 the standardised coefficients. As all regressors (i.e., the factors) are identical across all equations, our results are mathematically identical to seemingly unrelated regressions (SUR) estimation (Greene 1991, p. 488f), which is frequently proposed for systems of equations.

<table>
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<tr>
<th>Factors</th>
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<td>19.66</td>
<td>0.60</td>
<td>13.00</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>2.56%</td>
<td>12.61</td>
<td>12.77</td>
<td>0.23</td>
<td>5.58</td>
</tr>
</tbody>
</table>

*: p<0.05; **: p<0.01; ***: p<0.001

Table 3: Monte Carlo simulation results

Our results, displayed in Table 3, show that offering a contract plan in addition to a single period plan increases profits by as much as 10%. However, under some environmental settings, profit does not increase at all. The standardised coefficients in Table 3 outline factors with the greatest influence on the relative difference $\Delta \pi$, such as the WTP for the service (parameter $a$ with -0.55) and probability of need (0.51). The planning horizon has no significant impact on the increase of profitability (0.02) providing it is large enough. However, surprisingly, variable costs also seem to have a negligible effect (-0.05). This result is unexpected because low variable costs are one of the major requisites for the success of other related price differentiation techniques, such as bundling (Venkatesh and Mahajan 2009) or nonlinear pricing (Iyengar and Gupta 2009).

Our results also support providers in setting the optimal single period and contract plans. The optimal decision variables $p^*$, $p^{*\text{c}}$, $d^*$, and $T^*$ can vary substantially. The parameter $\bar{\alpha}$ has the greatest positive impact on setting the prices $p^*$ and $p^{*\text{c}}$ (0.98). However, the choice of the optimal price discount $d^*$ and contract length $T^*$ are primarily influenced by $Pr_{\text{Need}}$ (0.89 and -0.53).
Finally, our results provide insights into changing the price of the single period plan, if it was offered alone and the provider wishes to introduce a contract plan. In this case, providers are advised to just retain the price of their optimal single period plan, i.e., $p^*_s \approx p^{s+c}_*$. Under nearly all environmental settings of our simulation, $p^{s+c}_*$ was slightly greater than $p^*_s$; however, the optimal prices differ by only 1.34%, on average. Thus, providers do not have to fear exacerbating existing consumers who wish to stay with the single period plan, with higher prices. Rather, the providers just have to focus their attention on setting $d^*$ and $T^*$. Figure 4b indicates that if the optimal price discount is unknown, providers should choose a price discount that is too low rather than too high. In the first case, consumers will just stay with the single period plan (which is easily observable), whereas if it is too high, providers are giving away significant proportions of their profits.

6 Conclusion

Almost all cloud service providers offer contract plans and incentivise their consumers to stay longer with the provider. Surprisingly, no economic model yet addresses the relevant task of establishing optimal contract plans. Therefore, we propose a non-dynamic model that allows us to study the drivers of differences in profitability when offering a contract plan in addition to a single period plan. The model highlights the influence of consumers’ ex-ante probability of needing the service from the decreasing marginal utility arising from discounted future benefits and uncertainty about future price reductions. We also develop provider’s profit function and propose the gradient heuristic as a suitable method to determine optimal pricing plans.

The results of a Monte Carlo simulation show that contract plans can increase profit by up to 10%. The WTP parameters and the probability of the need for the service are the major drivers of difference in profitability between offering a single period plan (alone) and a contract plan (in addition). An interesting result for further investigation is that adding a contract plan does not require a change in the single period prices to achieve optimum results, which simplifies the implementation of contract plans.

For the ease of the model, we have not included a discount rate for the provider, which would devaluate profits that derived later in time (however, it is straightforward to incorporate the rate). Depending on the empirical data, future models might also consider accounting for dynamic effects, such as switching costs, consumer learning, reduced churn rate or cross-selling (e.g., Narayanan, Chintagunta, and Miravete 2007).

Altogether, when correctly implemented, contract plans are a profitable instrument and allow cloud providers to bind consumers to their service. Our model can assist cloud providers in their decision about the appropriate pricing plans and can build a foundation for further research to consider the relevant impact of contract plans on consumer choice.

References