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The Role of Expectation-Reality Discrepancy in Service Contracts

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Service contracts are common practice in some industries while being eliminated in others. To investigate this phenomenon, we identify Expectation-Reality Discrepancy (ERD) as a key determinant. A provider's ERD is defined as consumers' ex-ante expected valuation minus their ex-post realized valuation of the provider's service. Our analysis reveals that providers' contract strategies critically depend on their ERDs rather than the true service valuations. A provider with a higher ERD is more likely to enforce contracts, regardless of whether the true service valuation is higher than that of the competitor. Providers should enforce contracts only when they have positive ERDs. Furthermore, contracts have a competition-intensifying effect: when providers enforce contracts, their competition on promoting consumer expectations through marketing efforts is intensified, leading to higher ERDs with contracts than without contracts. Finally, consumers and society as a whole may benefit from higher switching costs because positive ERDs may mislead consumers to make wrong switching decisions and switching costs can help deter such switching behaviors.

Key words: service contracts, expectation-reality discrepancy, pricing, competition, consumer surplus, social welfare

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1. Introduction

Service contracts are common practice in some industries but not in others. For example, SaaS (software as a service) providers and customers typically enter a service contract, whereas most mobile carriers have stopped the practice of two-year contracts (Farivar 2013, Cheng 2015, Knutson 2015, Goldman 2015). This observation motivates to investigate service providers' contract strategies.

Service providers strategically make their contract and marketing decisions based on consumers' decision-making process. One important part of this decision is the consumers'

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satisfaction of the providers' services. As the expectation-(dis)confirmation theory (Oliver 1980, Churchill and Surprenant 1982) explains about the formation of consumers' perceptions of service, consumers compare their expectations before the consumption experiences of services with their actual experiences. Positive perceptions are formed when actual experiences meet or exceed expectations; otherwise, negative perceptions are formed. Depending on the gap between the expectation and the realized quality of services, consumers decide whether or not they are satisfied with the services (Torres and Kline 2013). Further, if the gap between the expectation and the realized quality of services is positive, i.e., the realized quality is less than expected, they find that the customers will be frustrated, very dissatisfied, or dissatisfied depending on the extent of the gap. If the gap is negative, i.e., the realized quality is greater than expected, customers will be delighted, very satisfied, or satisfied depending on the extent of the gap (Torres and Kline 2013).

We define a service provider's *expectation-reality discrepancy (ERD)* as the gap between the expectation and the realization of a provider's service, i.e., consumers' ex-ante expected valuation minus their ex-post realized valuation of the provider's service. Take the cell phone service industry as an example. Large mobile carriers (such as AT&T, T-Mobile, and Verizon) spend a tremendous amount in advertising (Statista 2018), creating high expectations for their consumers. While all of them advertise the superiority of their own services, consumers often post a wide variation of the actual quality of service that they have encountered on online fora. In other words, there is a discrepancy between the expectation that a consumer forms about the service (based on advertising, word-of-mouth, online reviews, etc.) and her experience in reality. Such discrepancies have been witnessed very prominently with mobile phone service providers and many other service industries including TV service providers (cable or satellite), subscription services (e.g., journals and magazines), computer service contracts, financial advisory services, SaaS, and so on.

All these phenomenon have prompted several questions that are of interest to academics and practitioners alike. First, what is the impact of ERD on service providers' profitability and contract strategies? Under what conditions should service providers enforce or forgo service contracts? Second, how should service providers influence consumer expectations of their services through marketing efforts? Lastly, what are the impacts of service providers' contract and marketing strategies on consumer surplus and social welfare?

In this research, we develop a game theoretical model to explore the impact of ERD on consumers' purchasing decisions and providers' contract and marketing decisions under competition. The main results are as follows. First, we identify ERD as a key determinant for providers' contract and marketing strategies. We find that providers' contract strategies critically depend on their ERDs rather than the true service valuations. A provider with a higher ERD value is more likely to enforce contracts, regardless of whether the true service valuation is higher than that of her competitor. Furthermore, a provider enforces contracts only when she has a positive ERD.

In practice, service providers have different advertising budgets and marketing efforts, which lead to different ERDs. For example, large mobile carriers, such as AT&T and Verizon, invest much more on advertising than small carriers, such as Cricket and MetroPCS. Consequently, consumers' expectations are higher for large carriers than for small carriers, which may lead to higher ERDs. Our ERD results provide a potential explanation for the phenomenon that small carriers usually do not enforce contracts, while large carriers used to enforce contracts.

Second, we show that contracts have a competition-intensifying effect: when providers enforce contracts, their competition on promoting consumer expectations through marketing efforts is intensified. As a result, providers' marketing efforts and the associated costs are higher with contracts than without contracts, which leads to higher consumer expectations and ERDs.

Lastly, consumers and society as a whole may benefit from higher switching costs. This is because positive ERDs may mislead consumers to make the wrong switching decisions, which decreases consumer surplus. Switching costs can help deter consumers from making the wrong switching decisions. Thus, switching costs may be beneficial to consumers when providers have positive ERDs. Consequently, the overall social welfare may also increase with switching costs.

2. Literature review

Services, as a type of experience goods, usually exhibit significant valuation uncertainty. After experiencing the service from a provider, a consumer's realized valuation may be different from his expectation. This leads to expectation-realization discrepancy. This discrepancy impacts consumer switching decisions, which further impacts providers' pricing

and contract strategies. Therefore, our research is related to the following research streams: mechanisms that shape consumers' expectations for experience goods (word of mouth and marketing efforts such as advertising), switching costs, and service contracts. We review these research streams one by one as follows.

Consumers have valuation uncertainty for experience goods (Zhao and Stecke 2010, Prasad et al. 2011, Zhao et al. 2016, Kwark et al. 2014). There are two main mechanisms that shape consumers' expectations for experience goods. On the one hand, word of mouth, especially online reviews, has been shown to help reduce valuation uncertainty in a variety of industries, such as books, movies, among others (see, e.g., Chevalier and Mayzlin 2006, Eliashberg et al. 2006, Sun 2012). However, the extant literature has also pointed out that online product reviews cannot fully reveal a product's true quality due to purchasing bias and under-reporting bias (Hu et al. 2006, 2009), design of consumer review systems (Jiang and Guo 2015), review fraud (Luca and Zervas 2016), and differentiated sharing patterns with strangers and friends (Dubois et al. 2016, Chen 2017). On the other hand, firms' advertising and other marketing efforts can also affect a consumer's expectation of valuation. Classic papers on advertising and information signals (Nelson 1974, Kihlstrom and Riordan 1984, Milgrom and Roberts 1986) have shown that advertising can serve as a signal of product quality for experience goods. More recently, Feng and Xie (2011) demonstrate that performance-based advertising may strengthen the signaling function of advertising. Liu et al. (2012) reveal that advertising cannot fully prevent a customer from switching to another firm in the presence of IT constraints. Liu et al. (2014) study a dual-channel model and compare the advertising efficacy between manufacturer advertising and retailer advertising. One can refer to Bagwell (2005), Little (1979), and the references therein for more discussion on advertising.

Although many papers have studied the mechanisms that shape consumers' expectations, there is very limited research examining the impact of incorrect expectations on post-purchase behavior. After a consumer experiences a provider's service, he will realize the true valuation of the service. A discrepancy may be formed when the consumer compares the realized valuation to his expectation. Customers' expectations have been shown to affect their post-purchase decisions, such as product returns (De et al. 2013, Sahoo et al. 2018). In our paper, we analyze the impact of customers' expectations on another important post-purchase decision – consumers' switching behaviors. ERD values strongly

impact consumers' switching decisions and consequently providers' contract strategies. To the best of our knowledge, our research is the first to study the impact of ERD on a provider's contract strategy.

The switching cost literature has considered exogenous and endogenous switching costs. Summers (1985) and Caminal and Matutes (1990) indicate that firms can endogenize switching costs by pricing the existing consumers and newcomers differently, offering a precommitment to second-period price for loyal consumers, or providing different coupons to consumers. In addition, Caminal and Matutes (1990) point out that switching costs are sometimes exogenous and independent of firms' or consumers' decisions. For instance, they may be given by the transactions technology. Our paper considers two switching costs. The base switching cost is exogenous. Switching consumers incur the base switching cost regardless of the provider's contract decision. The extra switching cost under a contract is endogenous. Switching consumers incur the extra switching cost only if the provider enforces a contract and the contract is in effect when switching.

Quite a few papers have explicitly studied the impact of switching costs on firms' competition and profits. For example, Klemperer (1987) shows that competition between firms may look collusive in the presence of switching costs. Although switching costs can result in monopoly rents and prevent the rival firm from attracting a firm's customers, they do not necessarily make firms better. MacLeod and Malcomson (1993) indicate that fixed-price contracts are efficient under exogenous switching costs. Beggs and Klemperer (1992) suggest that the prices and profits are higher with than without switching costs. A new entrant prefers the existence of switching cost. Farrell and Shapiro (1988) conclude that switching cost can cause inefficiency in a surprising way by encouraging entry to serve new customers. Farrell and Klemperer (2007) suggest that switching cost may make competition less effective. Klemperer (1995) further advocates that switching cost reduces competition, decreases product variety, and worsens consumer surplus. In contrast to the literature, we show that switching costs may not necessarily worsen consumer surplus and social welfare.

In the OM literature, quite a few papers study service contracts from various perspectives. Cai et al. (2012) demonstrate that the exclusiveness of service contracts can affect the service providers' supply chain and channel strategies. Wei and Zhu (2018) use data from the wireless industry to demonstrate that contracts become even more important after mobile number portability policy is implemented. Yang et al. (2020) indicate that it is not

always beneficial for the manufacturer to provide uniform after-sales service contracts to both retailers unless the retailers are similar in market size. Nunez et al. (2021) show that the optimal contract strategy for cloud service capacity planning depends on service quality and market size. Our study complements this service contract research stream in the OM literature by providing a different determinant factor, ERD, on the contract decision.

3. The Model

There are two competing providers offering services to one unit mass of consumers. We consider a technology cycle, which consists of n periods. We assume that the technology, service price, and market size remain stable over the technology cycle. We summarize all notations in Table 1.

Table 1 Summary of Notations

μ_i	Consumer expectation for service valuation of provider i, where $i \in \{a, b\}$
v_i	Realized service valuation of provider i, where $i \in \{a, b\}$
ERD_i	Expectation-reality discrepancy of provider i ($ERD_i \equiv \mu_i - v_i$), where $i \in \{a, b\}$
s_0	Base switching cost whenever a consumer switches his provider
s	Extra switching cost incurred when a consumer switches his provider under an unexpired contract
x	Consumer location on the preference Hotelling line
U_{iE}	Consumer expected utility from provider i based on μ_i of provider i, where $i \in \{a, b\}$
U_{iR}	Consumer realized utility from provider i based on v_i of provider i, where $i \in \{a, b\}$.
U_{iEs_0}	Consumer expected utility from provider i based on μ_i of provider i if he switches to provider i from the other provider under an expired contract or without a contract, where $i \in \{a, b\}$
U_{iRs_0}	Consumer realized utility from provider i based on v_i of provider i if he switches to provider i from the other provider under an expired contract or without a contract, where $i \in \{a, b\}$
U_{iEs}	Consumer expected utility from provider i based on μ_i of provider i if he switches to provider i from the other provider under an effective contract, where $i \in \{a, b\}$
U_{iRs}	Consumer realized utility from provider i based on v_i of provider i if he switches to provider i from the other provider under an effective contract, where $i \in \{a, b\}$
β	Expected probability of a consumer switching providers once in the future
β^2	Expected probability of a consumer switching providers twice in the future
t	Unit misfit cost
I_i	Indicator function for whether provider i enforces a contract ($I_i = 1$) or not ($I_i = 0$), where $i \in \{a, b\}$

Providers The two service providers are denoted as a and b. If consumers do not have any experience with provider i, then they are uncertain about their valuations of the provider. They hold belief V_i for their gross valuation of provider i, where $i \in \{a, b\}$. We assume that V_i follows a general distribution $g_i(\cdot)$ with mean μ_i. Thus, μ_i is a measure of consumers' expected valuation. After experiencing a provider's service, consumers realize their true valuation v_i.

We define $\mu_i - v_i$ as the *expectation-reality discrepancy* (ERD) of provider i. In the next two sections, the ERDs of the providers are considered as exogenously given.[1] If $\mu_i < v_i$, provider i is considered to be underrated. If $\mu_i > v_i$, provider i is overrated. Finally, if $\mu_i = v_i$, provider i is referred to as neutrally rated.

At the beginning of the first period, provider i announces its service price per period, denoted as p_i. Meanwhile, she needs to decide whether or not to enforce a contract on consumers, denoted by indicator functions I_i. If provider i enforces a contract, $I_i = 1$; otherwise, $I_i = 0$. Without loss of generality, we assume that a service contract lasts for two periods. If consumers choose a provider who does not enforce a contract, consumers are free to switch providers with a switching cost of s_0 at the beginning of any period. If consumers choose a provider who enforces a contract, they are locked in for two periods. In this case, consumers may still switch to the other provider before the contract expires but with a higher switching cost of $s_0 + s$. In other words, s_0 represents the base switching cost whenever a consumer switches his provider and s represents the extra switching cost incurred when a consumer switches his provider under an unexpired contract. Note that if a provider enforces a contract and the contract expires, the corresponding switching cost is s_0. Once a provider decides her service price and contract strategy at the beginning of the technology cycle, she will maintain them over the cycle.

Given both providers' pricing and contract strategies, provider i's demand during period j is denoted as $D_{ij}(p_a, p_b, I_a, I_b)$. Provider i's objective is to maximize her total profit over the technology cycle as follows:

$$\max_{p_i, I_i} \Pi_i = p_i \sum_{j=1}^{n} D_{ij}(p_a, p_b, I_a, I_b), i \in \{a, b\}.$$

[1] In Section 6, we consider the scenarios that providers are able to influence consumers' expectation of their services through marketing efforts. Specifically, consumers' expectations μ_a and μ_b are jointly determined by the word-of-mouth effect and providers' marketing efforts. Based on the sign of ERD, providers may adopt three distinct (positive/negative/zero-ERD) marketing strategies.

Consumers Consumers are heterogeneous in terms of their service preferences. We use a unit Hotelling line to represent consumers' service preferences.[2] Without loss of generality, we assume that provider a is located at point 0 and provider b is located at point 1. Thus, the distance between a provider's location and a consumer's location on the unit line also represents the misfit of the provider's service for the focal consumer. For example, if a consumer located at $x \in [0,1]$ chooses provider a, he has a service misfit of x and incurs a misfit cost of tx; otherwise, if he chooses provider b, he has a service misfit of $(1-x)$ and incurs a misfit cost of $t(1-x)$, where parameter t represents consumers' unit misfit cost.[3] A consumer with a higher x incurs a higher misfit cost from provider a but a lower misfit cost from provider b.

During each period, a consumer compares the utilities from providers a and b to decide which provider to subscribe to or switch to. Depending on the market conditions and information that a consumer has, he may have different utility functions for a provider.

Before a consumer subscribes to provider i for the first time, he does not know his true valuation of provider i (i.e., v_i). Thus, a consumer located at x examines his expected utility from provider i, denoted as U_{iE}, based on his expected valuation μ_i. Furthermore, the consumer expects he may have to switch providers in later periods once he experiences provider i. If the consumer chooses provider a in the first period, he may switch to provider b in the second period once he realizes provider a's true valuation v_a. Then in the third period, he may switch back to provider a once he realizes provider b's true valuation v_b as well. Let the expected probability of the consumer switching once be β and his expected probability of switching twice be β^2. Every time a consumer switches his provider, the consumer incurs a base switching cost of s_0. Additionally, if the provider, of which the consumer switches out, has enforced a contract, the consumer incurs a higher switching cost of $s_0 + s$. Overall, consumer x's expected utility from provider i takes the following form:

$$U_{aE}(x) = \mu_a - tx - p_a - \beta(s_0 + I_a s) - \beta^2(s_0 + I_b s),$$

[2] We choose such a horizontal differentiation model because of the following reasons. Consumers with different locations may have different utilities from the providers. For instance, the strength of the wireless signal varies depends on the location of the providers' service towers and customers. Furthermore, quality is multidimensional for a cellphone service provider, for example, it will include dimensions such as voice quality, speed, coverage, minutes of voice, volume of data, etc. A provider may be strong in some dimensions but weak in some other dimensions. Based on different needs, different customers may prefer different providers.

[3] Unit misfit cost parameter t is also a measure for competition intensity. In order to ensure that no provider will be driven out of the market, we assume $t > \frac{2|\mu_a - v_a| + 2|\mu_b - v_b| + n(\mu_b + v_a + \mu_a + v_b) + (n-1)(1+\beta)s_0 + (n-\beta)\beta s}{3n}$.

$$U_{bE}(x) = \mu_b - t(1-x) - p_b - \beta(s_0 + I_b s) - \beta^2(s_0 + I_a s).$$

After a consumer has experienced provider i, he learns provider i's true valuation v_i. His realized utility for provider i, denoted as U_{iR}, is as follows.

$$U_{aR}(x) = v_a - tx - p_a,$$
$$U_{bR}(x) = v_b - t(1-x) - p_b.$$

Subscripts E and R refer to expected and realized utilities, respectively. For example, the subscript aE represents a consumer's expected utility from choosing provider a without considering any switching costs. The subscript aR represents a consumer's realized utility from choosing provider a without considering any switching costs. The above four utilities $U_{aE}(x)$, $U_{bE}(x)$, $U_{aR}(x)$, and $U_{bR}(x)$ are consumer x's utilities when he does not switch his provider in the current period. When deciding whether to switch his provider, consumer x compares his utilities from switching to that from not switching.

There are two cases for consumer x's utilities if he switches in the current period. In the first case, where his current provider does not enforce a contract or when his provider enforces a contract but the contract expires, consumer x incurs a switching cost of s_0. Consumer x's utilities of switching in the current period with switching cost s_0 are:

$$U_{aEs_0}(x) = \mu_a - tx - p_a - \beta(s_0 + I_a s) - s_0,$$
$$U_{bEs_0}(x) = \mu_b - t(1-x) - p_b - \beta(s_0 + I_b s) - s_0,$$
$$U_{aRs_0}(x) = v_a - tx - p_a - s_0,$$
$$U_{bRs_0}(x) = v_b - t(1-x) - p_b - s_0.$$

Subscripts s and s_0 refer to the switching costs incurred when choosing a provider. For example, subscript aEs_0 represents a consumer's expected utility from choosing provider a by incurring a switching cost s_0.

In the second case where his current provider enforces a contract and the contract has not expired yet, consumer x incurs a switching cost of $s_0 + s$. Consumer x's utilities of switching in the current period with switching cost $s_0 + s$ are (here, subscript aEs represents a consumer's expected utility from choosing provider a by incurring both switching costs s_0 and s):

$$U_{aEs}(x) = \mu_a - tx - p_a - \beta(s_0 + I_a s) - s_0 - s,$$

$$U_{bEs}(x) = \mu_b - t(1-x) - p_b - \beta(s_0 + I_b s) - s_0 - s,$$
$$U_{aRs}(x) = v_a - tx - p_a - s_0 - s,$$
$$U_{bRs}(x) = v_b - t(1-x) - p_b - s_0 - s.$$

Note that in both cases, the consumer expects to switch his provider only once and not twice because he already switched his provider in the current period.

In each period, each consumer compares his utilities from the two providers and selects his preferred provider. Expected utilities are used if the consumer has no prior experience with the provider yet and realized utilities are used if the consumer has prior experience with the provider. Furthermore, utilities with switching costs are used if the consumer switches his provider in the current period. At the aggregate level, these utility functions will be used to determine indifferent consumers when analyzing consumers' switching behaviors and deriving demands. Please refer to the figures for consumers' switching behaviors and demands in Section 4 for details.

Following prior studies using spatial competition models (Cheng et al. 2011, Kwark et al. 2014, Hsiao and Chen 2015), we assume that all consumers subscribe to one of the providers' services, i.e., the consumer market is fully covered.[4] This full-market-coverage assumption ensures that consumers' base switching cost s_0 is sufficiently low such that all consumers derive nonnegative utilities from subscribing to their preferred provider.

Sequence of Player Decisions At the beginning of the technology cycle, providers simultaneously announce prices and contract strategies (i.e., p_i and I_i). Consumers choose between the two providers at the beginning of each period.

In the following two sections, we solve the game using backward induction. We first analyze consumers' switching behaviors and derive consumer demand in each period, given providers' pricing and contract decisions. We then solve for providers' pricing and contract decisions.

4. Analysis of Consumer Switching Behavior and Demand

Consumers choose between the two providers by comparing their (expected or realized) utilities from the two providers. If a consumer does not have any experience with provider

[4] Specifically, we assume $0 \le s_0 \le \frac{\min\{2v_a - v_b, 2v_b - v_a\} - 2|\mu_a - v_a| - 2|\mu_b - v_b| - 6t - 4s}{4}$ to ensure all consumers derive nonnegative utilities from subscribing to their preferred provider.

i, then he does not know provider i's true valuation v_i and selects his preferred provider based on expected utility U_{iE}. If a consumer has experienced provider i before, then he knows v_i and selects his preferred provider based on realized utility U_{iR}. The indifferent consumers are summarized in Table 2.

Table 2 Indifferent Consumers

		Provider b		
		v_b is known (realized utility is used)		v_b is unknown (expected utility is used)
Provider a	v_a is known (realized utility is used)	If $\mu_a - v_a > \mu_b - v_b$, $x_{RRa} = \frac{v_a - v_b - p_a + p_b + t - s_0}{2t}$, which solves $U_{aRs_0}(x) = U_{bR}(x)$	If $\mu_a - v_a < \mu_b - v_b$, $x_{RRb} = \frac{v_a - v_b - p_a + p_b + t + s_0}{2t}$, which solves $U_{aR}(x) = U_{bRs_0}(x)$	$x_{RE} = \frac{v_a - \mu_b - p_a + p_b + t + I_b s\,\beta + (1+\beta)s_0}{2t}$, which solves $U_{aR}(x) = U_{bEs_0}(x)$
	v_a is unknown (expected utility is used)	$x_{ER} = \frac{\mu_a - v_b - p_a + p_b + t - I_a s\,\beta - (1+\beta)s_0}{2t}$, which solves $U_{aEs_0}(x) = U_{bR}(x)$		$x_{EE} = \frac{\mu_a - \mu_b - p_a + p_b + t - (I_a - I_b)s\,(1-\beta)\beta}{2t}$, which solves $U_{aE}(x) = U_{bE}(x)$

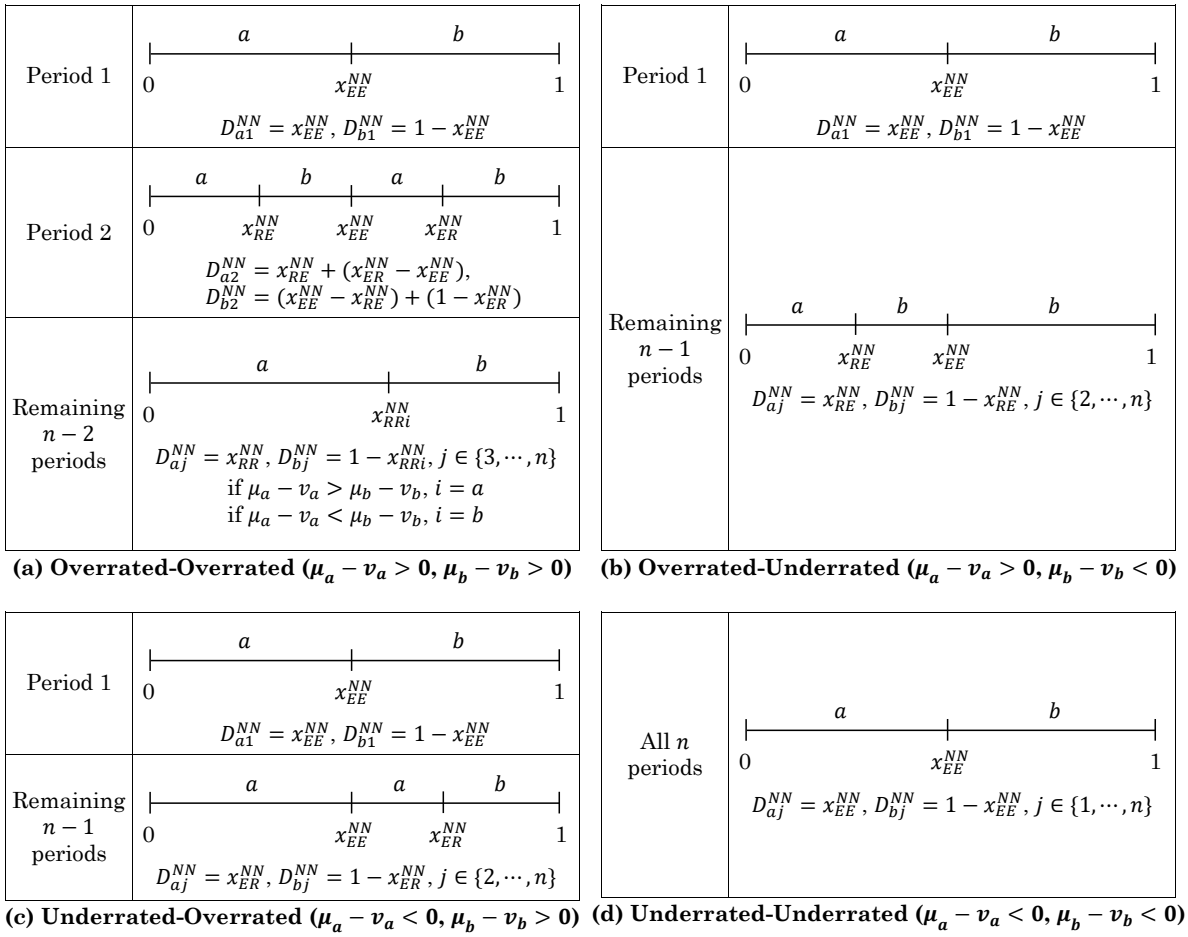
Based on whether the two providers choose to enforce contracts, there are four cases: NN (both providers choose not to enforce contracts), CC (both providers choose to enforce contracts), CN (provider a chooses to enforce contracts while provider b does not), and NC (provider a chooses not to enforce contracts while provider b does).

Both Providers Choose Not to Enforce Contracts (The NN Case) When both providers do not enforce contracts, consumers are free to switch providers at the beginning of any period. Consumers' switching behaviors critically depend on their knowledge about their service valuations and the ERDs for both providers. Figure 1 illustrates consumers' switching behaviors and demands in the NN case.

At the beginning of the first period, consumers do not have any experience with either provider and thus choose their preferred providers based on the expected utilities. As a result, consumers located to the left of x_{EE}^{NN} buy from provider a and consumers located to the right of x_{EE}^{NN} buy from provider b. Therefore, the first-period demands are $D_{a1}^{NN} = x_{EE}^{NN}$ for provider a and $D_{b1}^{NN} = 1 - x_{EE}^{NN}$ for provider b.

At the beginning of the second period, provider a's consumers realize the true valuation of provider a, i.e., v_a. However, they still do not know the true valuation of provider b, i.e., v_b. Thus, they compare utilities U_{aR} and U_{bE} to make the switching decisions.

If provider a is overrated (as shown in Figures 1a and 1b), provider a's consumers realize a valuation v_a less than their expectation μ_a. The indifferent consumer between providers



(a) Overrated-Overrated ($\mu_a - v_a > 0, \mu_b - v_b > 0$) **(b) Overrated-Underrated ($\mu_a - v_a > 0, \mu_b - v_b < 0$)**

(c) Underrated-Overrated ($\mu_a - v_a < 0, \mu_b - v_b > 0$) **(d) Underrated-Underrated ($\mu_a - v_a < 0, \mu_b - v_b < 0$)**

Notes: In this figure, the indifferent consumers are derived by solving the corresponding utility equations with $I_a = I_b = 0$. Specifically, x_{EE}^{NN} solves $U_{aE}(x) = U_{bE}(x)$; x_{RE}^{NN} solves $U_{aR}(x) = U_{bEs_0}(x)$; x_{ER}^{NN} solves $U_{aEs_0}(x) = U_{bR}(x)$; x_{RRa}^{NN} solves $U_{aRs_0}(x) = U_{bR}(x)$; and x_{RRb}^{NN} solves $U_{aR}(x) = U_{bRs_0}(x)$.

Figure 1 Consumers' Switching Behaviors and Demands in the NN Case

a and b in the second period is located at x_{RE}^{NN} (as shown in Table 2) and $x_{RE}^{NN} < x_{EE}^{NN}$. Thus, provider a's first-period consumers are further divided into two groups by x_{RE}^{NN}. The group on the left side of x_{RE}^{NN} continues to choose provider a, while the group on the right side of x_{RE}^{NN} switches to provider b. If provider a is underrated (as shown in Figures 1c and 1d), her consumers' realized utility is even higher than expected and thus nobody switches to provider b in the second period.

Similarly, consumers who chose provider b in the first period realize the true valuation of provider b, i.e., v_b. They compare utilities U_{aE} and U_{bR} to make the switching decisions at

the beginning of the second period. If provider b is overrated (as shown in Figures 1a and 1c), then the indifferent consumer between providers a and b in the second period is located at x_{ER}^{NN} (as shown in Table 2) and $x_{ER}^{NN} > x_{EE}^{NN}$. Similarly, for provider b, the consumers to the left of x_{ER}^{NN} switch to provider a, while consumers on the right stay with provider b. If provider b is underrated (as shown in Figures 1b and 1d), then nobody switches to provider a in the second period.

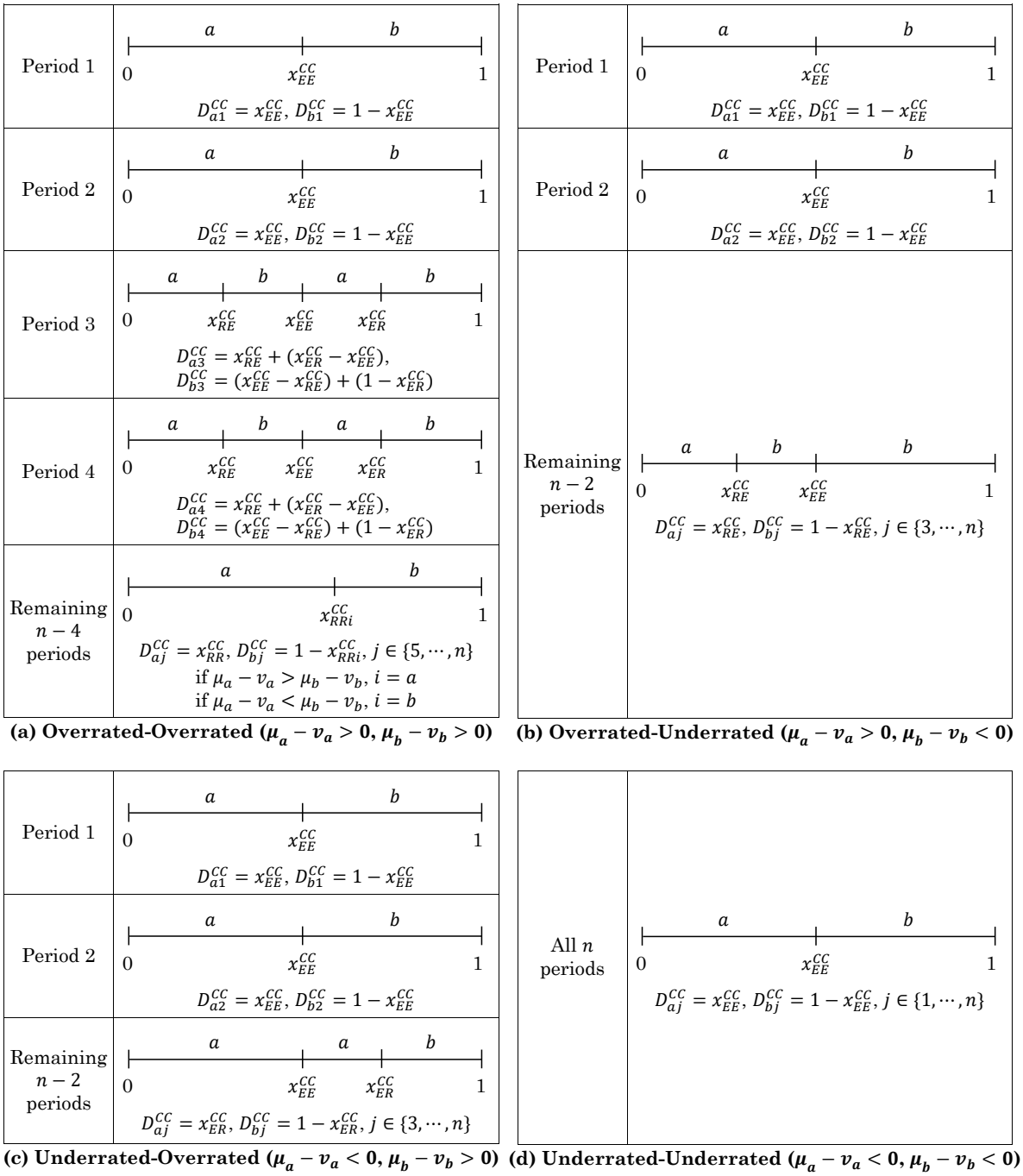
At the beginning of the third period, consumers who switched at the beginning of the second period have now realized their true valuations of both providers. With the newly realized information, these consumers may switch again. They compare U_{aR} and U_{bR} to make the switching decisions. When both providers are overrated (as shown in Figure 1a), the indifferent consumer is located at x_{RRi}^{NN}, where $i = a$ if $\mu_a - v_a > \mu_b - v_b$ and $i = b$ if $\mu_a - v_a < \mu_b - v_b$. It can be shown that $x_{RE}^{NN} < x_{RRi}^{NN} < x_{ER}^{NN}$. Thus, consumers located on the left of x_{RRi}^{NN} choose provider a and those on the right of x_{RRi}^{NN} choose provider b. In the remaining periods, consumers will not learn any new information and, consequently, there will be no further switching.

Both Providers Choose to Enforce Contracts (The CC Case) When both providers enforce contracts, consumers incur extra switching cost s if they switch before their current contracts expire. Figure 2 illustrates consumers' switching behaviors and demands in the CC case.

Consumers' switching intention in the CC case is similar to that in the NN case. However, their actual switching actions occur in different periods. For example, at the beginning of the second period, as shown in Figure 2a, although provider a's consumers located within $[x_{RE}^{CC}, x_{EE}^{CC}]$ want to switch to provider b and provider b's consumers located within $[x_{EE}^{CC}, x_{ER}^{CC}]$ want to switch to provider a, they stay in their current service contracts and wait until the beginning of the third period to avoid the extra switching cost s under a contract.[5] As a result, it takes longer for demands to stabilize in the CC case than in the NN case.

Only One Provider Chooses to Enforce Contracts (The CN Case or The NC Case) In the CN case, provider a enforces contracts while provider b does not. Provider a's consumers incur extra switching cost s if they switch before their current contracts expire. Figure 3 illustrates consumers' switching behaviors and demands in the CN case.

[5] In practice, consumers usually would not break an effective contract to switch providers. To reflect this reality, we assume the extra switching cost s under a contract is so high that consumers would not incur this extra switching cost to switch providers.

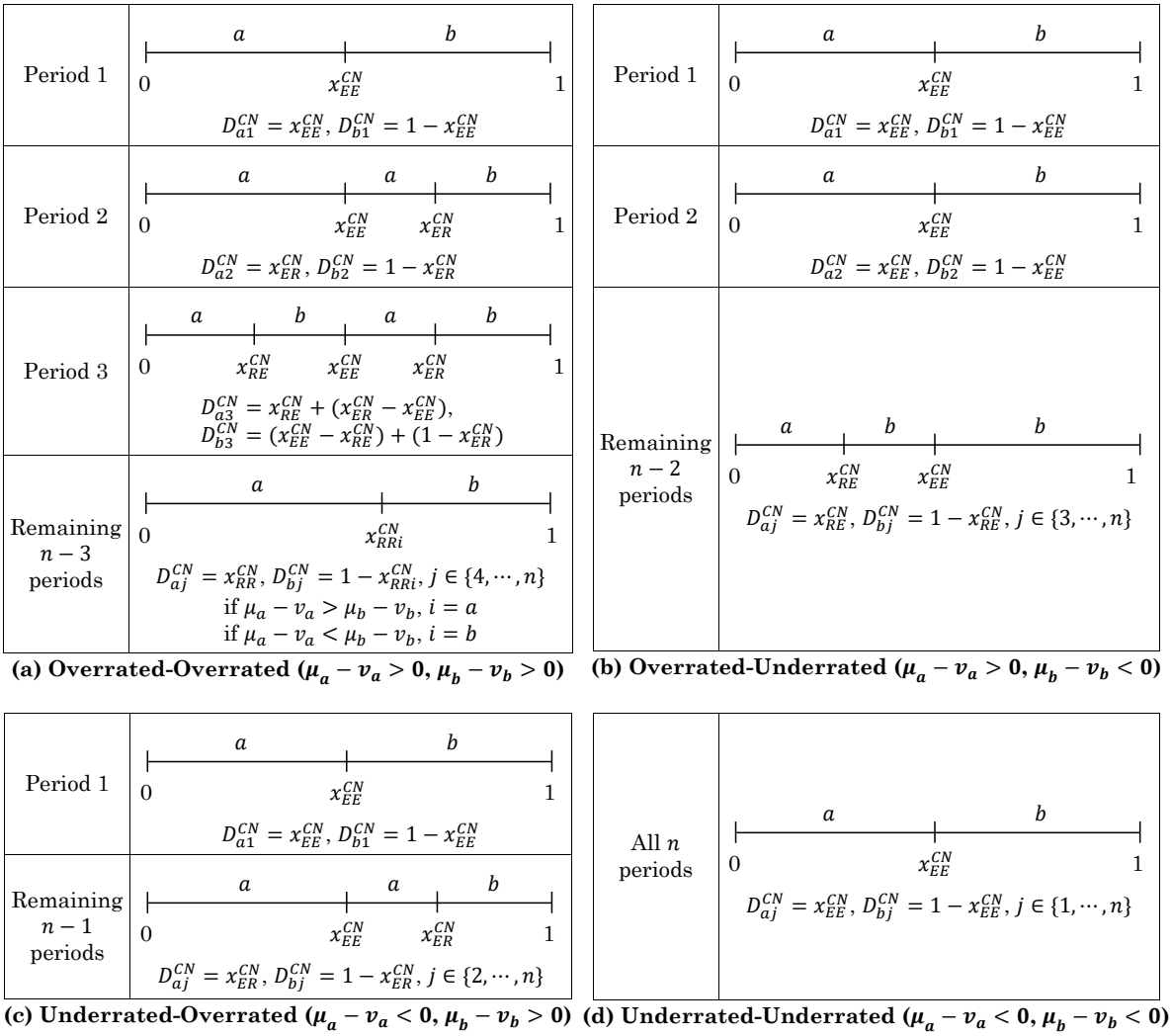


(a) Overrated-Overrated ($\mu_a - v_a > 0, \mu_b - v_b > 0$) **(b) Overrated-Underrated ($\mu_a - v_a > 0, \mu_b - v_b < 0$)**

(c) Underrated-Overrated ($\mu_a - v_a < 0, \mu_b - v_b > 0$) **(d) Underrated-Underrated ($\mu_a - v_a < 0, \mu_b - v_b < 0$)**

Notes: In this figure, the indifferent consumers are derived by solving the corresponding utility equations with $I_a = I_b = 1$. Specifically, x_{EE}^{CC} solves $U_{aE}(x) = U_{bE}(x)$; x_{RE}^{CC} solves $U_{aR}(x) = U_{bEs_0}(x)$; x_{ER}^{CC} solves $U_{aEs_0}(x) = U_{bR}(x)$; x_{RRa}^{CC} solves $U_{aRs_0}(x) = U_{bR}(x)$; and x_{RRb}^{CC} solves $U_{aR}(x) = U_{bRs_0}(x)$.

Figure 2 Consumers' Switching Behaviors and Demands in the CC Case



(a) Overrated-Overrated ($\mu_a - v_a > 0, \mu_b - v_b > 0$) **(b) Overrated-Underrated ($\mu_a - v_a > 0, \mu_b - v_b < 0$)**

(c) Underrated-Overrated ($\mu_a - v_a < 0, \mu_b - v_b > 0$) **(d) Underrated-Underrated ($\mu_a - v_a < 0, \mu_b - v_b < 0$)**

Notes: In this figure, the indifferent consumers are derived by solving the corresponding utility equations with $I_a = 1$ and $I_b = 0$. Specifically, x_{EE}^{CN} solves $U_{aE}(x) = U_{bE}(x)$; x_{RE}^{CN} solves $U_{aR}(x) = U_{bEs_0}(x)$; x_{ER}^{CN} solves $U_{aEs_0}(x) = U_{bR}(x)$; x_{RRa}^{CN} solves $U_{aRs_0}(x) = U_{bR}(x)$; and x_{RRb}^{CN} solves $U_{aR}(x) = U_{bRs_0}(x)$.

Figure 3 Consumers' Switching Behaviors and Demands in the CN Case

Consumers' switching intentions in the CN case are similar to those in the NN case. However, actual switching actions for provider a's consumers may occur in different periods. For example, at the beginning of the second period, as shown in Figure 3a, although provider a's consumers located in $[x_{RE}^{CN}, x_{EE}^{CN}]$ want to switch to provider b, they choose to

stay in service contracts and wait until the beginning of the third period to avoid the extra switching cost s. In contrast, provider b's consumers located in $[x_{EE}^{CN}, x_{ER}^{CN}]$ who want to switch to provider a are able to switch. As a result, it takes longer for demands to stabilize in the CN case than in the NN case.

In the NC case, provider a does not enforce contracts while provider b does. Provider b's consumers incur extra switching cost s if they switch before their current contracts expire. Consumers' switching behaviors in the NC case are symmetric to those in the CN case.

Analyzing consumers' switching behaviors and demands in the above four cases leads to Proposition 1. Proofs of all propositions can be found in the Appendix.

PROPOSITION 1. *Given providers' pricing and contract strategies, provider i's switching demand loss (number of consumers who switch from provider i to the competitor) increases with provider i's ERD, i.e., $x_{EE} - x_{RE}$ increases with $\mu_a - v_a$ and $x_{ER} - x_{EE}$ increases with $\mu_b - v_b$ in all four cases (NN, CC, CN, and NC). After the switching process, the total demand for the provider with a lower ERD increases while the total demand for the provider with a higher ERD decreases, if the provider with a higher ERD does not enforce a contract.*

Proposition 1 shows that provider i's ERD (i.e., $\mu_i - v_i$) plays an important role in its demand. When a provider's discrepancy is higher than her competitor's, she loses more market share to her competitor. Therefore, after the switch, the total demand for the provider that has a relatively higher discrepancy level decreases and the total demand for her competitor increases.

After the first period, some consumers may switch providers once or twice until their current choices match up with the newly realized information; then, demands for both providers are stabilized. This switching process shifts some of the market share from the provider with a higher ERD to the provider with a lower ERD.

5. Analysis of Providers' Contract Strategies

Anticipating consumers' response to providers' decisions, providers set their prices and decide whether to enforce contracts at the beginning of the technology cycle. Based on whether the providers are overrated or underrated, there are four scenarios: the overrated-overrated scenario (ERDs for both providers are positive); the overrated-underrated scenario (ERD for provider a is positive while ERD for provider b is negative); the underrated-overrated scenario (ERD for provider a is negative while ERD for provider b is positive);

and the underrated-underrated scenario (ERDs for both providers are negative). We solve for providers' equilibrium prices and the corresponding profits for each of the four cases (CC, NN, CN, and NC) under each scenario. We then compare these profits to derive providers' equilibrium contract strategies, summarized in Proposition 2.

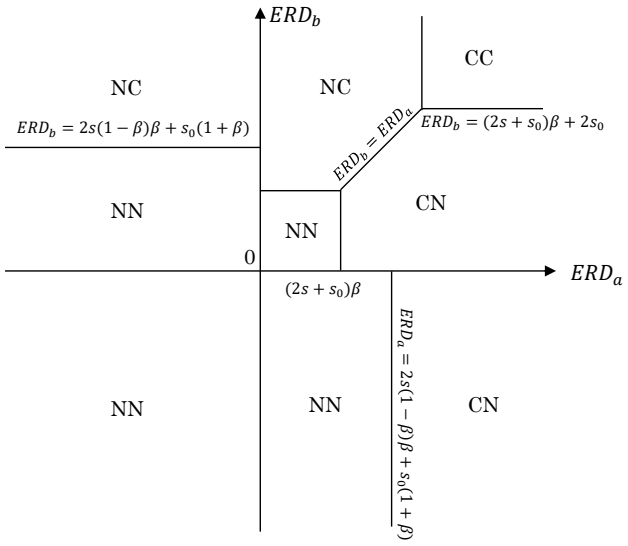
PROPOSITION 2. *There are four possible equilibria:*

- *CC equilibrium (i.e., both providers choose to enforce contracts) when both providers' ERDs are high, specifically,* $min\{ERD_a, ERD_b\} > (2s + s_0)\beta + 2s_0$*;*
- *NN equilibrium (i.e., both providers choose not to enforce contracts) when both providers' ERDs are low, specifically,* $max\{ERD_a, ERD_b\} < (2s + s_0)\beta$ *if both ERDs are positive or* $max\{ERD_a, ERD_b\} < 2s(1-\beta)\beta + s_0(1+\beta)$ *if at least one ERD is negative;*
- *CN or NC equilibrium (i.e., only the provider with a higher ERD chooses to enforce contracts), otherwise.*

Providers' contract strategies in Proposition 2 are also illustrated in Figure 4. Market conditions can be represented by a two-dimensional parameter space based on the two providers' ERDs. Based on whether a provider's ERD is positive or negative, we can divide this parameter space into four quadrants in Figure 4, representing the overrated-overrated, overrated-underrated, underrated-overrated, and underrated-underrated scenarios.

Proposition 2 demonstrates that all four cases (CC, NN, CN, and NC) could be the equilibrium in the overrated-overrated scenario. Enforcing contracts has two countervailing effects on provider i's demand: the base-demand-reducing effect and the switching-demand-locking effect. On the one hand, due to extra switching cost s under contracts, consumers may be reluctant to choose a provider with contracts, especially when the competitor does not enforce contracts. Therefore, the base demand (consumers who choose provider i in the first period) is reduced for provider i when she enforces contracts. This effect is referred to as the base-demand-reducing effect, which increases with the extra switching cost caused by contracts (i.e., s). On the other hand, contracts help provider i retain most switching demand (consumers who would switch from provider i to the competitor) for one more period, which is referred to as the switching-demand-locking effect. Furthermore, as shown in Proposition 1, provider i's switching demand increases with her ERD (i.e., $\mu_i - v_i$).

Providers assess the tradeoff between the above two effects to decide their contract strategies. If a provider's ERD is high, her switching-demand-locking effect is substantial



Notes: Figure 4 illustrates the parameter regions based on ERD_a and ERD_b for the four possible equilibria – CC, NN, CN and NC. The separating lines are $ERD_b = ERD_a$, $ERD_i = 2s(1-\beta)\beta + s_0(1+\beta)$, $ERD_i = (2s+s_0)\beta$, and $ERD_i = (2s+s_0)\beta + 2s_0$, where $i \in \{a, b\}$.

Figure 4 Providers' Equilibrium Contract Strategies

such that she has a strong incentive to enforce contracts, even if the impact of the base-demand-reducing effect is negative. When both providers enforce contracts, the impact of the base-demand-reducing effect is weakened, because the negative impacts on both providers due to consumers' preferences against contracts partially cancel each other out. As a result, when both providers' ERDs are high, the switching-demand-locking effect dominates the base-demand-reducing effect, such that both providers choose to enforce contracts. Similar arguments apply to other cases.

When provider a is overrated but provider b is underrated as shown in Figure 4, provider b's consumers are satisfied with their subscribed service (the realized valuation higher than the expected valuation, i.e., negative ERD) and will not switch to provider a. As a result, provider b has no incentive to enforce contracts. In contrast, since provider a is overrated, some of provider a's consumers are dissatisfied with their subscribed service. Furthermore, if their realized utilities of provider a are lower than their expected utilities of provider b, then they will switch to provider b. If provider a's ERD is sufficiently high, she can benefit more from locking in the majority of these potential switching consumers for one more period through enforcing contracts. However, if provider a's overrated ERD is not

sufficiently high, the switching-demand-locking effect is not substantial enough to compensate for the negative base-demand-reducing effect caused by enforcing contracts, provider a will instead choose no contracts (i.e., NN is thus the equilibrium). The equilibrium results in the underrated-overrated scenario are symmetric to those in the overrated-underrated scenario.

When both providers are underrated, consumers' realized valuation of the service is higher than what they expected. Thus, consumers have no incentive to switch to the other provider, which negates the benefit of enforcing contracts (i.e., delaying consumers' switching actions). Therefore, in equilibrium both providers choose not to enforce contracts.

Based on Figure 4, when switching costs (s or s_0) increase, the region of adopting equilibrium NN expands while the region of adopting equilibrium CC shrinks. This implies that providers are more likely to eliminate contracts when switching costs increase. In practice, some providers subsidize devices for customers who sign up for service contracts. If a customer wants to switch to a different provider before the service contract expires, the customer is typically required to pay an early termination fee. When device manufacturers (such as Apple, Samsung, and Nokia) roll out new phone models with new features frequently, consumers under contracts are restrained from upgrading to a newly released device due to such early termination penalties. Thus, subsidized devices and more frequent release of new devices correspond to a higher extra switching cost under contracts (i.e., s in our model). Our results suggest that providers may eliminate their service contracts as a response, which is consistent with what we observe currently in the cell phone service industry (Farivar 2013, Cheng 2015, Knutson 2015).

In reality consumers' expected valuation for the "untried product" may increase over time, e.g., μ_a and μ_b increase by γ in each period. A direct impact of such an increase is a decrease in x_{ER} and an increase in x_{RE}, while all the other indifferent consumers remain unchanged. The implication of these changes in x_{ER} and x_{RE} is: the portion of switching demand increases in each period after trying a provider. Consumers are more likely to switch to the other provider after they tried a provider because the increased expectation of the untried provider creates an illusion for consumers. Enforcing a contract has the switching-demand-locking effect. As the switching demand increases, the switching-demand-locking effect generates more benefits for the provider who enforces a contract. Therefore, providers are more likely to enforce contracts when consumers' expected valuation increases.

COROLLARY 1. *Providers' contract strategies have the following properties:*

- *A provider's contract strategy critically depends on her ERD (i.e., $\mu_i - v_i$) instead of her true valuation (i.e., v_i). A provider with a higher ERD is more likely to enforce contracts, regardless of whether her true valuation is higher than that of the competitor.*
- *A provider enforces contracts only when she has a positive ERD.*

Surprisingly, we find that a provider's contract strategy does not depend on whether her true valuation is higher than the competitor's. Rather, providers should carefully evaluate their ERDs when choosing their contract strategies. Since consumers' expectations can be influenced by marketing communications, a provider should coordinate her marketing efforts and contract decisions. In practice, within the cell phone service industry, large mobile carriers (such as AT&T, T-Mobile, and Verizon) spend a tremendous amount in advertising (Statista 2018), creating high ERDs for their consumers. Although they show similar (or even superior) performance in terms of metrics such as download speed, latency, and availability (OpenSignal 2018), these large mobile carriers are all near the bottom in consumers' overall satisfaction ratings (Consumer Reports 2018). This evidence demonstrates the negative impact of high ERDs on consumer satisfaction, which creates an incentive for consumers to switch their providers. Providers in turn may strategically choose to enforce service contracts in order to prevent such switching behavior.

A provider enforces contracts only when she has a positive ERD. If a provider has a negative ERD, after subscription, consumers find the service better than expected, i.e., their realized valuation is higher than their expected valuation. Thus, no consumer wants to switch to the competitor. Therefore, the provider does not need contracts to retain consumers.

Next, we explore the impact of providers' contract strategies on consumers and society as a whole. The payoff of all consumers can be measured by consumer surplus, denoted as CS. Consumer surplus is the sum of net utilities for all consumers, which can be specified as:

$$CS = \sum_{j=1}^{n} \left[\int_{R_{aj}} U_{aj}\, dx + \int_{R_{bj}} U_{bj}\, dx \right],$$

where R_{aj} and R_{bj} are the sets of consumers for providers a and b, respectively, in period j; U_{aj} and U_{bj} are the net utilities of consumers for providers a and b, respectively, in period

j. Sets of consumers (R_{aj} and R_{bj}) and their net utilities (U_{aj} and U_{bj}) vary according to providers' contract strategies in different ERD scenarios. For example, in Figure 2a, both providers enforce contracts under the overrated-overrated scenario. In period 3, consumers located in $[0, x_{RE}]$ and $[x_{EE}, x_{ER}]$ choose provider a while the rest of consumers choose provider b, i.e., $R_{a3} = [0, x_{RE}] \cup [x_{EE}, x_{ER}]$ and $R_{b3} = [x_{RE}, x_{EE}] \cup [x_{ER}, 1]$. Provider a's consumers located in $[0, x_{RE}]$ and provider b's consumers located in $[x_{ER}, 1]$ did not switch their providers at the beginning of period 3. Thus, $U_{a3} = U_{aR}$ and $U_{b3} = U_{bR}$ for these consumers. Provider a's consumers located in $[x_{EE}, x_{ER}]$ and provider b's consumers located in $[x_{RE}, x_{EE}]$ switched their providers at the beginning of period 3. Thus, $U_{a3} = U_{aRs_0}$ and $U_{b3} = U_{bRs_0}$ for these consumers.

The payoff of society as a whole can be measured by social welfare, denoted by SW. Social welfare is the sum of consumer surplus and the profits of both providers. Analyzing consumer surplus and social welfare levels yields Proposition 3.

PROPOSITION 3. *Consumer surplus and social welfare have the following properties:*

- *Consumer surplus and social welfare may not necessarily decrease with base switching cost s_0.*
- *Consumer surplus and social welfare may not necessarily decrease with extra switching cost s under a contract.*

Detailed conditions under which CS and SW increase with s_0 and s can be found in the online appendix.

Proposition 3 reveals that consumer surplus may not necessarily decrease with consumers' base switching cost s_0 and extra switching cost s under a contract. This is in contrast to prior findings in the literature where switching costs have been shown to worsen consumer surplus (Klemperer 1995). In fact, switching costs may even enhance consumer surplus. This is because a positive ERD may induce consumers to make wrong switching decisions, which hurts consumer surplus. Switching costs discourage consumers from switching providers and thus reduce the possibilities of such wrong decisions. Hence, switching costs may be beneficial to consumer surplus when providers have positive ERDs.

Furthermore, Proposition 3 shows that the society as a whole may also benefit from higher switching costs. The rationale behind this result is twofold. First, it is intuitive that providers stand to profit from higher switching costs due to lessened competition. Second,

consumers may also benefit from not making undesirable switching decisions. As a result, social welfare may increase with switching costs.

Proposition 3 also provides guidance for public policy makers such as Federal Communications Commission (FCC) and Federal Trade Commission (FTC). Under certain circumstances, it is beneficial to the consumers and the society as a whole if the policy makers do not remove the switching barriers.

6. Providers' Strategies When They Have the Capability to Influence Consumers' Expectation

In the previous section, we demonstrated that providers' pricing and contract decisions critically depend on consumers' ERDs. In this section, we investigate providers' incentives to influence such discrepancies through their marketing efforts.

In practice, consumers' expectations for the two providers (μ_a and μ_b) are influenced by two information sources. First, consumers may learn about providers' true valuations (v_a and v_b) through trial periods of services or from existing consumers through service reviews, social media, etc. For ease of exposition, we refer to all mechanisms that can partially reveal providers' true valuations to new consumers as the word-of-mouth effect. Second, providers can also influence consumers' expectations through marketing efforts such as advertising. We use e_a and e_b to denote providers' marketing efforts. In summary, μ_a and μ_b are jointly determined by the word-of-mouth effect and providers' marketing efforts, i.e., $\mu_a = \alpha v_a + (1-\alpha)e_a$ and $\mu_b = \alpha v_b + (1-\alpha)e_b$, where α represents the strength of the word-of-mouth effect. We assume that the cost of marketing efforts are ce_a^2 and ce_b^2, where c is the marketing cost parameter.

At the beginning of the technology cycle, prior to their decisions on contract strategies and prices, providers first simultaneously choose their marketing efforts to influence consumers' expectations. If consumers' expectations are higher than/the same as/lower than the true valuation, we refer to providers' corresponding marketing strategy as the *positive/zero/negative-ERD marketing strategy*. Consumers choose between the two providers at the beginning of each period. Similar to the main model, we assume that all consumers subscribe to one of the providers' services, i.e., the consumer market is fully covered.[6] Using backward induction, we solve this game and derive the equilibrium results. For simplicity, we focus on analyzing symmetric providers with $v_a = v_b = v$.

[6] Specifically, we assume $0 \le s_0 \le \frac{\beta s - 3t + (3-\alpha)v}{1-\beta} - \frac{(1-\alpha)^2}{3(1-\beta)c}$ to ensure all consumers derive nonnegative utilities from subscribing to their preferred provider.

Proposition 4 reveals four possible equilibria (CP, NP, NZ, and NM) when providers have the capability to influence consumers' expectations. The two letters in the equilibrium notation correspond to providers' contract and marketing strategies. The first letter C/N denotes providers' contract/no-contract strategy and the second letter $P/Z/M$ denotes providers' positive/zero/negative-ERD marketing strategy. For providers' negative-ERD marketing strategy, we use M instead of N to distinguish from the N for the no-contract strategy.

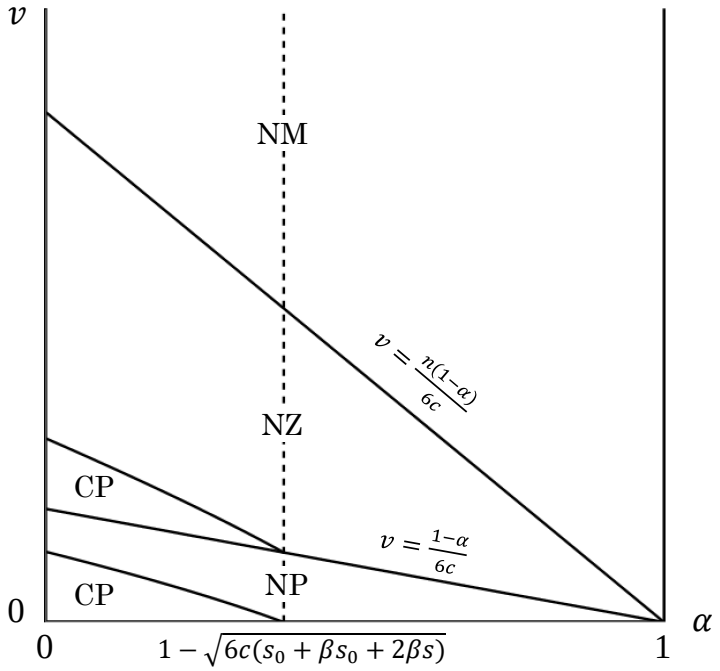
PROPOSITION 4. *When providers have the capability to influence consumers' expectations, there are four possible equilibria – CP, NP, NZ, and NM. Specifically,*

- *When* $\alpha < 1 - \sqrt{6c(s_0 + \beta s_0 + 2\beta s)}$ *and* $(v < \frac{1-\alpha}{6c} - \frac{s_0+\beta s_0+2\beta s}{1-\alpha}$ *or* $\frac{1-\alpha}{6c} < v < \frac{1-\alpha}{3c} - \frac{s_0+\beta s_0+2\beta s}{1-\alpha})$, *contract and positive ERD (CP) is the equilibrium with* $e_a^* = e_b^* = \frac{1-\alpha}{3c}$.
- *When* $\frac{1-\alpha}{6c} - \frac{s_0+\beta s_0+2\beta s}{1-\alpha} < v < \frac{1-\alpha}{6c}$, *no contract and positive ERD (NP) is the equilibrium with* $e_a^* = e_b^* = \frac{1-\alpha}{6c}$.
- *When* $max\{\frac{1-\alpha}{3c} - \frac{s_0+\beta s_0+2\beta s}{1-\alpha}, \frac{1-\alpha}{6c}\} < v < \frac{n(1-\alpha)}{6c}$, *no contract and zero ERD (NZ) is the equilibrium with* $e_a^* = e_b^* = v$.
- *When* $v > \frac{n(1-\alpha)}{6c}$, *no contract and negative ERD (NM) is the equilibrium with* $e_a^* = e_b^* = \frac{n(1-\alpha)}{6c}$.

Proposition 4 and Figure 5 demonstrate providers' equilibrium contract and marketing strategies. When providers have the capability of influencing consumers' expectations through marketing efforts, they adopt the positive-ERD marketing strategy when true valuation of services v is low; for intermediate values of v, they adopt the zero-ERD marketing strategy; when v is high, they adopt the negative-ERD marketing strategy, i.e., they under-invest in their marketing efforts and let consumers underrate their services.

Figure 5 shows two disjoint parameter regions for the CP (contract and positive ERD) equilibrium. The driving force behind this disjointed parameter regions for a CP strategy is as follows. When v is small, it is relatively easy for a provider to achieve a positive ERD. When α is small, marketing effort is relatively effective to influence consumers' perception. So in the lower left areas of Figure 5, positive ERD (either CP or NP) is the equilibrium because of the cost efficiency. Furthermore, the marketing effort cost is higher under CP than under NP due to the competition-intensifying effect. Therefore, the profit is higher under NP than under CP for both providers. However, a provider has

CP = contract & positive ERD; NP = no contract & positive ERD
NZ = no contract & zero ERD; NM = no contract & negative ERD



Note: Figure 5 illustrates the parameter regions based on ERD_a and ERD_b for the four possible equilibria – CP, NP, NZ and NM. The separating lines are $v = \frac{n(1-\alpha)}{6c}$, $v = \frac{1-\alpha}{6c}$, $v = \frac{1-\alpha}{6c} - \frac{s_0+\beta s_0+2\beta s}{1-\alpha}$, and $v = \frac{1-\alpha}{3c} - \frac{s_0+\beta s_0+2\beta s}{1-\alpha}$.

Figure 5 Providers' Equilibrium Contract and Marketing Strategies

an incentive to deviate from N to C when v is very small (i.e., $v < \frac{1-\alpha}{6c} - \frac{s_0+\beta s_0+2\beta s}{1-\alpha}$) or when v exceeds a certain threshold (i.e., $v > \frac{1-\alpha}{6c}$). When a provider switches from N to C, she incurs a higher cost on marketing efforts due to the competition-intensifying effect but she expects to increase her demand due to the demand-locking effect. When v is very small (i.e., $v < \frac{1-\alpha}{6c} - \frac{s_0+\beta s_0+2\beta s}{1-\alpha}$), the extra cost on marketing efforts is limited. Thus a provider is attempted to switch from N to C. When v increases and exceeds a threshold (i.e., $v > \frac{1-\alpha}{6c}$), although the extra cost on marketing efforts is higher, the benefit from extra market share due to the demand-lock effect also increases because the price increases with v as well. The high benefit motivates a provider to switch from N to C in this case. Therefore, in the left bottom areas in Figure 5, we observe two disjoint areas where CP is the equilibrium. As valuation v further increases or word-of-mouth effect becomes stronger, providers' marketing effort becomes less efficient. As a result, zero-ERD and eventually negative-ERD turns out to be the equilibrium.

Considering providers' strategy to influence consumers' expectation of their services through marketing efforts, we find that providers may adopt the positive-ERD marketing strategy. This finding explains the extensive advertising campaigns by the leading mobile carriers in the U.S. (Bergen 2014, Statista 2018) and also in the SaaS industry (IndustryToday 2019). But providers might not always adopt the positive-ERD marketing strategy. When the quality of a provider's service is exceptional in an area, it may be beneficial for the provider to limit their marketing costs and let consumers underrate their services at the beginning of the technology cycle. In this case, our result suggests reducing their marketing efforts and relying more on word-of-mouth to influence consumers' expectations of their services.

Proposition 5. *When providers have the capability to influence consumers' expectations, providers' contract and marketing strategies have the following properties:*

- *Providers enforce service contracts only when they adopt the positive-ERD marketing strategy.*
- *The contract strategy has the competition-intensifying effect, which leads to a higher ERD and a lower profit with contracts than without contracts.*

Proposition 5 reveals that providers' contract and marketing strategies interact with each other. Specifically, contracts are offered only when providers adopt the positive-ERD marketing strategy, which is consistent with the finding in Corollary 1.

Enforcing contracts has the switching-demand-locking effect, which retains consumers who want to switch to the competitor for one more period. Note that this switching-demand-locking effect also exists in Section 5. Interestingly, however, the switching-demand-locking effect also generates a side effect on providers' marketing competition. Since switching demand (the number of consumers who want to switch to the competitor) increases with the focal provider's ERD, providers have the incentives to further increase ERDs so that they can benefit more from the switching-demand-locking effect of contracts. Therefore, the switching-demand-locking effect intensifies providers' competition on influencing consumer expectations through marketing campaigns. We refer to this effect as the competition-intensifying effect of contracts, which did not appear in our prior analysis in Section 5.

The competition-intensifying effect results in higher marketing efforts and thus higher costs, whereas the switching-demand-locking effect generates extra sales. Driven by the

competition-intensifying effect, both providers create a higher positive ERD with contracts than without contracts. Hence, both providers' marketing costs are higher with contracts than without contracts. However, the increased sales from the switching-demand-locking effect depend on the provider's expected service quality relative to the competitor's. When two providers are symmetric, they create the same level of expected service quality, leading to the same positive ERD. Thus, both providers' marketing efforts cancel each other out and the switching-demand-locking effect of contracts does not increase sales. As a result, the competition-intensifying effect dominates the switching-demand-locking effect under contracts. Therefore, the contract strategy yields lower profits for providers than the no-contract strategy.

Proposition 5 explains a possible vicious circle in practice. A service provider with a high ERD is motivated to adopt a contract strategy, which in turn leads to an even higher ERD due to the competition-intensifying effect. This finding helps explain the high ERD and increasing marketing spending in many service industries. For example, the SaaS industry, where contracts are common practice, has seen an increase in their spending on marketing over the past 5 years (Blissfully 2020).

Furthermore, we find that the provider's effort level depends on the duration of the technology cycle. When the cycle duration n is large, providers are more likely to advertise more to avoid negative ERD.

PROPOSITION 6. *When the technology cycle duration n increases, providers are more likely to adopt NZ (no contract & zero ERD) and less likely to adopt NM (no contract & negative ERD). Meanwhile, the effort level in NM also increases with n.*

Under the equilibrium NM, consumers realize valuations higher than expectations. So no one switches providers in the following periods. Thus the initial expectation μ_i for provider i determines the provider's demand in n periods. When n increases, provider i is further motivated to improve μ_i because of its impact on more demand periods. As the provider exerts more efforts in increasing the valuation of her service, negative ERD eventually becomes zero-ERD under some circumstances, i.e., the providers switch from NM to NZ.

Next, we explore the impact of providers' contract and marketing strategies on consumers and society as a whole when providers have the capability to influence consumers' expectations. Analyzing consumer surplus and social welfare levels under providers' different contract and marketing strategies yields Proposition 7.

PROPOSITION 7. *When providers have the capability to influence consumers' expectations, consumer surplus and social welfare have the following properties:*

- *Consumer surplus and social welfare may not necessarily decrease with base switching cost s_0.*
- *Consumer surplus and social welfare may not necessarily decrease with extra switching cost s under a contract.*

Detailed conditions under which CS and SW increase with s_0 and s can be found in the online appendix.

Proposition 7 shows that when providers have the capability to influence consumers' expectations and thus create discrepancies between consumer expectation and reality, it is possible that consumer surplus and social welfare increase with switching costs s_0 and s. Proposition 7 provides important policy implications. Policymakers such as Federal Communications Commission (FCC) and Federal Trade Commission (FTC) are typically advised to help reduce consumers' switching costs. Our finding suggests that policymakers should carefully assess conditions such as consumer valuation and providers' marketing efforts to determine whether to remove barriers to switching.

7. Conclusion

In this paper, we propose a game theoretical model to analyze the tradeoffs of enforcing service contracts and shed light on when a provider should enforce contracts. This paper provides potential explanations for different contract practices in various industries; for example, SaaS providers continue to adopt contracts while most wireless carriers have eliminated service contracts. In addition, we explore a provider's marketing strategy on influencing consumer expectations and the interaction between contract and marketing strategies.

This paper captures some unique features of service contracts and consumers' switching behaviors in services. Some digital services are essential and ubiquitous such as internet and the cell phone service, which is consistent with the full market assumption in the model. Switching behavior in services differs from that studied previously. Different from physical products, when the service is terminated, there is no product returned. Instead, the switching cost is often realized, as captured in the proposed model.

We identify a key determinant, expectation-reality discrepancy (ERD), which measures the discrepancy between consumers' expected valuation and consumers' realized valuation of a provider's service. We summarize some of the interesting findings as follows.

- Providers' contract strategies critically depend on their ERDs rather than their true service valuations. A provider with a higher ERD is more likely to enforce contracts, regardless of whether the true valuation is higher than that of her competitor. Furthermore, providers should enforce contracts only when they have positive ERDs.
- Contracts have a competition-intensifying effect. When providers enforce contracts, their competition on promoting consumer expectations is intensified, leading to higher ERDs with contracts than without contracts.
- Switching costs may not necessarily hurt consumer surplus and social welfare.

Our research can be extended in various ways. For example, in this paper, the true valuation of the service is considered exogenous. It would be interesting to allow the providers to invest in quality improvements (i.e., higher true valuation for consumers) and investigate the interaction between providers' contract and quality investment decisions. Another direction for future work is to consider that strategic consumers may view the providers' contract and marketing effort choices as a signal for providers' true service quality and adjust their beliefs accordingly. Future work can study the impact of such strategic consumer behavior on the providers' strategies. Finally, we use a Hotelling line to model one dimension of consumer heterogeneity in provider preferences. However, consumers may also be heterogeneous in terms of price sensitivity. As a direction of future work, the utility function can be modified to consider consumer heterogeneity in both price sensitivity and provider preferences.

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