Mobile Telephony Pricing in Emerging Markets

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Abstract

Over 90% of wireless mobile subscribers in emerging wireless markets such as India employ pay-as-you-go prepaid plans. In contrast, over 90% of subscribers in mature markets such as the US pick postpaid plans with long-term contracts. Indian wireless firms fret about this because prepaid consumers generally have low loyalty and generate lower average revenue per unit than postpaid consumers. However, the outcome is not surprising, considering the pricing strategies employed in the two markets. Postpaid plans in India are quite unattractive relative to prepaid plans, do not exhibit quantity discounts, and do not encourage consumers towards higher-level tiers, unlike the US where postpaid plans offer a much lower per-unit rate, feature aggressive quantity discounts, and impose such a high penalty for above-allowance consumption that consumers tend to move towards higher-tier plans. Why then do firms in India embed these characteristics into their pricing strategies? We identify puzzling characteristics in the Indian market, develop an innovative model that explains the pricing strategies employed in India, and propose evolutionary steps for wireless firms to adapt their strategies as the market matures. We show that the pricing plans are driven by firms’ desire to compensate for fixed costs of offering postpaid plans, and a focus on instantaneous profit margins. Reversing the outcome will require shifting the focus to lifetime revenues from customers, and a willingness to offer postpaid plans to customers whose account size does not, at the time, justify incurring the additional fixed cost of postpaid service.
1 Introduction

Industry practice and market outcomes in emerging markets such as India present a striking contrast to those in more mature markets such as the US. Consumers choices in the two countries are starkly different. (1) In the US, over 90% of consumers pick postpaid plans, implemented via three-part tariffs, while in India over 90% pick linear-rate prepaid plans. (2) Over 90% of postpaid consumers in the US utilize less than their allowance, while the forfeiture rate in the Indian market is around 5%. (3) In the US, most postpaid consumers would have been better off under a lower-tier plan than the one they picked, hence they provide excess monthly revenue to the firm, whereas Indian consumers tend to pick plans with the least commitment. Indian firms fret over such outcomes; they desire a greater fraction of postpaid consumers and to move consumers towards higher-tier plans. Yet, apparently, their pricing strategies are inconsistent with these objectives. In the US, wireless firms (4) make their postpaid plans far more attractive (much lower per-unit fee than the prepaid rate), (5) offer significant quantity discounts (per-unit rate drops significantly for plans with higher levels of fixed fee and usage allowance), and (6) set a high penalty (i.e., per-unit rate) for above-allowance consumption, inducing consumers to pick tiers with higher levels of usage allowance and fixed fee. In contrast, per-unit rates for postpaid plans in India are the same or higher than prepaid plans that require no commitment; carriers do not provide substantial quantity discounts; and per-unit rates for above-allowance consumption are not greater than those for basic consumption.

Pricing strategies for mobile telephony services around the world can broadly be classified into two categories. Postpaid plans typically feature three-part tariffs where users commit to a monthly fee $F$ in return for inclusive consumption (or allowance) of $Q$ minutes and an option to consume additional minutes at a price $r$ per minute. The final payment ($F + s(Q - q)^+$) is determined at the end of the billing cycle, usually a month, after the total consumption $q$ is realized. Postpaid plans usually feature a bundle of handset and service, with a generous handset subsidy in return for a long-term contract (12 or 24 months). Prepaid plans require no commitment, and usually feature a linear, pay-as-you-go, scheme where the user purchases a phone card from which the balance is debited at a constant rate $r$ per minute. Most mobile telecommunications firms offer both postpaid and prepaid plans, typically several of each. Each customer then picks the plan
### Table 1: “Individual” Postpaid plans offered by AT&T, July 2012. Among prepaid plans, the classic offering is a 10c/minute “pay as you go” plan; postpaid plans have a lower rate for the base allowance but a higher penalty rate.

<table>
<thead>
<tr>
<th>Allowance (minutes)</th>
<th>Monthly Fee</th>
<th>Night/weekend minutes</th>
<th>Penalty Rate for Additional Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>$39.99</td>
<td>5000</td>
<td>$0.45/min</td>
</tr>
<tr>
<td>900</td>
<td>$59.99</td>
<td>unlimited</td>
<td>$0.45/min</td>
</tr>
<tr>
<td>unlimited</td>
<td>$69.99</td>
<td>unlimited</td>
<td>0</td>
</tr>
</tbody>
</table>

which maximizes her expected surplus. This decision usually involves some estimation of her future consumption, using which she can compute her total payment under each plan. The classic approach for doing so involves solving the incentive compatibility constraints and picking the plan that maximizes net surplus.

This paper attempts to understand industry practices and outcomes in emerging mobile telephony markets in contrast to those in more mature markets. To focus our research, and to keep the exposition clear, we use India as the example for an emerging market and the U.S. for a mature and developed market. We identify puzzling practices in India, which stand in stark contrast to those in the US. More importantly, these pricing practices in India stand against insights and heuristics developed in the last several decades of theoretical and empirical research in telecommunications pricing. For brevity, we will use the phrase “in the US” to stand in both for the US market as well as aggregate insights from the literature. The objective of this paper is to postulate an alternate model of the mobile telephony market, one which can explain these puzzling contrasts and uncover the noteworthy properties of pricing strategies in both sets of markets. Having uncovered the logic behind these pricing models, we then combine extant theory on telecommunications pricing with the corporate strategic objectives proposed by industry executives to extend the model and propose evolutionary steps in the Indian market.
2 Market Characteristics

Mature markets for mobile telephony services exhibit a few readily distinctive characteristics which stand in stark contrast to the corresponding metrics in emerging markets. As noted above, we identify these contrasts by observing the US and Indian markets; see [?] for comparison of the US, China and Europe markets on a subset of these characteristics. Because the focus of our research is wireless voice, which presently accounts for over 90% of cellular revenue in India, our observations about the US market are based on the period upto a year ago. This is because in the last few months, the US market has altered radically with tablet devices, smartphones, and multi-carrier availability of the iPhone, due to which firms have altered their voice plans and designed them around concerns about data consumption. The more appropriate point of comparison are the tiered three-part tariff plans that were the norm until a year ago (and are still offered, among others, by the leading US firm, AT&T, see Table 1).

2.1 Pricing Plans

Observation 1 (Per-minute rate in Prepaid vs. Postpaid Plans) Fig. 1 presents a typical prepaid and a postpaid plan from a leading carrier in India. The postpaid plan commits the user to pay at least Rs. 199/month, for which it provides 12,000 seconds usage allowance (i.e., a rate of Rs. 0.0166 per-second when one uses the entire allowance), with additional consumption at the rate of Rs 0.015/sec (Rs. 0.012/sec) to landline (mobile) phones. The Rs. 150 prepaid plan has the same per-minute rates as the penalty rate but a lower rate for the first 12,000 seconds. Moreover, it requires no monthly commitment, and has a validity of 1 year. Hence the prepaid plan dominates the postpaid plan: it is more attractive at all consumption levels, and even more so for users who consume fewer than 200 minutes in the month.

Observation 1 demonstrates that the postpaid plan is made redundant by the prepaid plan so that, under the classic consumer choice model, every consumer should prefer the prepaid plan regardless of her expected consumption level. The same properties hold for recently redesigned plans depicted in Figure 1. In contrast, consider the US market where users who commit to a fixed monthly rate are rewarded with a low effective per-minute rate for the allowed minutes;
the "break-even consumption level" is much below the allowance level. For example, AT&T’s prepaid "pay as you go" plan charges 10c/min, while the most basic postpaid plan has a monthly fee of $40 and provides a usage allowance of 450 daytime and 5000 nighttime minutes, implying a per-minute fee far less than 10c, and a break-even consumption level of 400 total minutes (see Table 1). More generally, telecommunications firms in mature markets have developed pricing strategies that drive consumers towards postpaid plans, while Indian firms appear to drive consumers towards prepaid plans. These expectations are borne out by market share realizations for the two categories of plans. In the US, over 90% consumers pick postpaid plans while in India the reverse is true.

Observation 2 (Quantity Discounts)  Compare the two plans from Example 1 with higher-tier plans from the same carrier, a Rs. 351 prepaid and a Rs. 299/month postpaid plan. The Rs. 351 prepaid card has the same usage rates as the Rs. 150 card and a 1-year validity, hence it offers no quantity discount. The Rs. 299 postpaid plan provides a 20,000 seconds usage allowance, which amounts to Rs. 0.01495/sec. This rate is lower than the 0.166/sec for the first 12,000 seconds under the Rs. 199 plan, however the Rs. 199 plan would still be cheaper at higher levels of consumption because of its lower per-unit rate for above-allowance consumption. Hence the
higher tier Rs. 299 plan does not offer a quantity discount relative to the Rs. 199 plan, and moreover it requires a higher committed cost. Consequently, the Rs. 299 plan is dominated by the prepaid plans and by the lower-tier plan (except for the special case when a user consumes the entire 20,000 seconds in calling landline phones, and even then the Rs. 299 is barely a better deal).

<table>
<thead>
<tr>
<th>Plans</th>
<th>VF Talk 299 One Sec Plan</th>
<th>VF Talk 199 One Sec Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>To local Vodafone mobile phones</td>
<td>1.2p/sec</td>
<td>1.2p/sec</td>
</tr>
<tr>
<td>To other Local mobile phones</td>
<td>1.2p/sec</td>
<td>1.2p/sec</td>
</tr>
<tr>
<td>To other phones in Mumbai</td>
<td>1.2p/sec</td>
<td>1.2p/sec</td>
</tr>
<tr>
<td>To STD Vodafone mobile phones</td>
<td>1.2p/sec</td>
<td>1.2p/sec</td>
</tr>
<tr>
<td>Local SMS Charges</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>National SMS Charges</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>International SMS Charges</td>
<td>Free</td>
<td>2000 seconds</td>
</tr>
<tr>
<td>Free local talktime per month- local voice calls only (mins)</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Free Local &amp; STD talktime per month (mins)</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Free Local &amp; STD Talktime per Month (seconds)</td>
<td>12000 seconds</td>
<td>nil</td>
</tr>
<tr>
<td>To STD other Mobile phones</td>
<td>1.2p/sec</td>
<td>1.2p/sec</td>
</tr>
<tr>
<td>To STD other phones</td>
<td>1.2p/sec</td>
<td>1.2p/sec</td>
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<tr>
<td>Free local talktime per month - local voice calls only (mins)</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Free Local &amp; STD talktime per month (mins)</td>
<td>Free</td>
<td>Free</td>
</tr>
</tbody>
</table>

Figure 2: Multiple postpaid plans: Lack of Quantity Discount.

Observation 2 illustrates the lack of quantity discounts in the India market. Because of the fixed fee commitment, the lack of quantity discounts makes the higher-tier plans irrelevant. Figure 2 provides another example using some recently introduced plans (June 2012). The more expensive Rs. 299 plan provides a 12,000 second allowance, while a consumption of 12,000 seconds would cost Rs. 319 under the Rs. 199 plan, reflecting a mild quantity discount relative to the additional fixed commitment of Rs. 100. In contrast, AT&T’s $60/month plan provides 900
daytime and unlimited nighttime minutes, and the $70/month plan provides unlimited calling, reflecting aggressive quantity discounts. It would be the preferred choice for any user who consumes at least 22 minutes above the 450-minute allowance provided in the $50 plan. For instance, someone who expects to use 500 minutes would prefer the $60 plan with a 900-minute allowance. This sort of pricing strategy leads to the outcome that several users (in the US) forfeit much of their allowance. In contrast, the pricing plans in the Indian market are set up in a manner that users would utilize their entire allowance.

**Observation 3 (Penalty for Above-allowance Consumption)** For the postpaid plans in Examples 1–2, the usage rate for above-allowance consumption is Rs 0.015/sec (Rs. 0.012/sec) to landline (mobile) phones. This is on average lower than the average rate of Rs. 0.016/sec or Rs. 0.01495/sec for the included consumption levels in the two plans.

In the Indian market, the usage rate after exceeding the allowance is, on average, lower than the per-unit rate for the initial allowance. This lack of penalty for above-allowance consumption, combined with lack of quantity discounts, should drive users towards the lower-tier plan, making the higher-tier plan irrelevant. In contrast, AT&T’s above-allowance rate of 45c/min imposes a steep penalty over the price (less than 10c/min) for included consumption. This penalty, combined with the aggressive quantity discount as one moves up the plan tiers, would induce users with uncertainty in consumption level to pick the $60 plan.

The plan characteristics illustrated in Observations 1–3 naturally drive Indian mobile customers towards prepaid plans; moreover, the minority of users who pick postpaid plans also find the lowest tiers most attractive since they require lower commitment and offer the same marginal rates as higher tiers. For the firm, however, having a majority of its customers on prepaid plans has at least two disadvantages. First, prepaid customers churn frequently: they make a purchase decision each time their block of time is exhausted, and are presented with several choices in the highly competitive Indian market. This is a particularly serious threat in India where a large fraction of users recharge at small amounts (e.g., Rs. 10) every day. Second, prepaid customers generate lower revenue for the firm. This is consistent with economic theory and empirical evidence: prepaid users face a positive marginal rate for every call they make and must produce cash before
the call; postpaid customers have a zero marginal rate within their allowance and they spend on credit, both factors that lead to greater consumption.

## 2.2 Business Practice

Prepaid and postpaid plans are marketed and managed in a very different way. Buyers of prepaid plans typically charge or recharge their cards using a variety of retail outlets (e.g., drug stores in the US, and ubiquitous street shops and kiosks in India). These retail outlets usually are independent agents that serve multiple service providers. Prepaid cards can also be recharged electronically over the Internet or via SMS. Prepaid customers can easily check their balance, and the cost of a specific call (e.g., via an inquiry or an automated SMS after every call), and can also initiate queries using their phone, but do not receive an itemized statement of expenses or any other communication from the provider. In fact, the customer may not even connect with the provider while signing up for the plan; the process is handled by the agent and the provider receives only the minimal information that the agent is required to collect by the government, and even this information is considered unreliable. Hence prepaid plans are characterized by a minimal relationship between the customer and the service provider.

In contrast, postpaid plans involve substantial transfer of information from customer to the provider, and the firm conducts a thorough credit check and other security checks. A postpaid customer receives a monthly itemized statement, and the firm offers better customer support and other services. Postpaid customers cannot determine their spending or balance during a month, because computing the invoice requires the firm to combine the subscriber’s usage data for the period with her plan characteristics, a process that is run at the end of the month. The firm incurs a cost in producing the invoice, shipping it, and collecting it.

Despite the extra costs of billing, firms earn far higher profit margins on postpaid customers than prepaid ones. In the US, this is unsurprising because customers exhibit overestimation of consumption when choosing their plan level (or, perhaps treat a high allowance level as an insurance against unexpectedly high consumption). But even in India, the realized per-unit
rate of postpaid plans is about Rs. 0.68/minute, well above the realized prepaid rate of Rs. 0.53/minute, largely because of intermediary payments when selling prepaid service. Moreover, prepaid customers tend to churn at a much higher rate. Hence firms desire to have a larger fraction of postpaid customers. Because this fraction in India is extremely small, firms make substantial efforts to market postpaid plans to selected prepaid customers, but the conversion success rate is only about 5%. From consumers’ point of view, prepaid plans are more advantageous, as illustrated in Observations 1–3. Why, then, do firms design their tariff options in a way that leaves the postpaid plan at a huge disadvantage? While studying this apparent paradox we consulted with senior executives in the Indian wireless industry. Our conversations revealed market considerations that are ignored in the theoretical models of wireless pricing and price discrimination, wherein consumers’ benefits are defined primarily as a function of consumption quantity rather than on the choice of the plan.

1. Customers may perceive a “hassle” cost, a negative standalone value for postpaid service. This includes the one-time activities in signing up for the service or providing a “rental” deposit, as well as recurring monthly costs related to lack of transparency and timely information regarding accounting and billing. Postpaid customers cannot completely trust the firm’s statement, and must exert time and effort to review the statement and resolve disputes with the firm. There is also an information burden relating to the actual cost of a particular call, because the cost depends on several factors such as origin and destination, peak vs off-peak minutes, remaining balance, local vs long-distance, calls to mobile vs. landline numbers, in-net vs out of network calls, etc.

On the other hand, postpaid plans also have a positive stand-alone value because they provide an itemized statement and offer a credit facility. The statement is of value to business users, any users who get reimbursed or can claim taxable expenditures, or users who otherwise appreciate having a written statement of expenditures. The credit facility defers the user’s cash outlay and becomes more valuable to subscribers with higher levels of consumption.
2. The firm faces a substantial monthly expenditure in supporting a postpaid subscriber, exceeding the corresponding expenditure for prepaid customers. This additional expense including costs for printing and mailing the monthly statement, and customer support costs. Industry executives in India hinted that this expenditure was in the range of Rs. 100-200 per month.

3. Firms are quite concerned about the possibility that newly-converted postpaid customers would default, leading to a loss of the customer acquisition cost (about Rs. 1100 in India) and the first few months’ unpaid bill. In contrast the high acquisition cost in US (e.g. discounted handsets) are offset by guaranteed higher life time of customers through long term contracts.

The hassle cost (conversely, stand-alone benefit) of postpaid service can cause postpaid plans to become more (conversely, less) attractive than similarly-priced prepaid plans for some users. Similarly, the additional monthly cost to service postpaid subscribers makes it undesirable to sell postpaid plans to users who generate relatively low monthly revenue. The possibility of default makes firms ultra-caution in converting users to postpaid plans. This explains the low percentage of postpaid users, and poses a conundrum to firms who anticipate higher lifetime value on creating a postpaid subscriber but are worried about the loss from default. Hence these factors lend some weight towards the pricing practice observed in India and emerging markets. But, are they so decisive as to overcome other forces that drive firms in other markets (such as those in the US) towards radically different designs? That is, could they truly explain that the optimal design would be identical to that observed in India and in stark contrast to conventional wisdom and theoretical insights in telecommunications pricing? In the next section, we develop a model to examine these questions.1

1While our model is inspired by distinctive aspects of the Indian market, one distinction that we did not feel necessary to incorporate into our model is that in India incoming calls are free, whereas both incoming and outgoing calls count in the US market. One may expect that this may play an important role in tariff designs. However, we believe that because incoming calls are free for both types of plan it does not alter consumer choice decision between prepaid and postpaid plan.
3 Model Setup

We model a mobile telephony firm which offers a combination of a prepaid plan with a constant per-unit fee \( r \) and a postpaid plan with a three-part tariff \((F, Q, s)\). We assume that the firm has a zero variable cost for calls and, due to the commoditization and fierce competition in the prepaid market, that the prepaid tariff is set at an exogenous constant price per minute \( r \). The firm faces a market of consumers who are heterogeneous in their demand for mobile telephony, expressed as the desired minutes of consumption \( k \) under the prevailing prepaid rate. For mathematical convenience we assume a uniform distribution in \([0, K]\), however our results are robust to the use of any other log-concave distribution. Inspired by the above-mentioned conversations with industry executives, we also include (i) a parameter \( c \), representing the additional service cost to the firm for a postpaid subscriber, reflecting the cost of billing and providing better customer support (see e.g., [5]), (ii) a function \( b(k) = \alpha k + B \), representing the additional value of postpaid service to subscriber \( k \). The component \( B \) is the common effect, invariant across all consumers, covering a one-time hassle cost and other factors that do not vary with consumption, and could be positive or negative. The component \( \alpha k \) covers features such as the credit facility and a stable phone number which become more valuable with increased consumption (\( \alpha \) is the incremental utility per minute of service). Finally, the model includes a parameter \( \mu \geq 1 \) representing the increased longevity (or lower churn) under postpaid service.

Faced with the combination of a prepaid plan and a postpaid plan, each customer selects the plan which maximizes her net surplus. The customer choice process follows the classic approach of solving incentive compatibility and individual rationality constraints. [5] studies consumer choice when the set of offers includes a fixed-fee (unlimited use) tariff and a menu of quantity-price bundles. [2] study self-selection between a menu of two-part tariffs when customers are uncertain about their consumption quantity. [1] examine the case where the firm offers a menu of two-part or three-part tariffs. [3] build a detailed dynamic model in which potential calls arrive according to a Poisson process and with random valuation, and each time the customer makes a decision about whether to engage the call or not. While none of these papers specifically studies a
combination of prepaid (i.e., linear) and postpaid (i.e., three-part tariff), our approach developed below is consistent with all of them except for the inclusion of the $c$ and $B$ parameters.

### 3.1 Customer Choice

Consider the choice process of customer $k$ who is offered a prepaid tariff with price $r$ per unit and a postpaid plan with a fixed fee $F$, allowance $Q$ and marginal rate $s$. From a customer’s perspective, the postpaid plan has the disadvantage that it imposes a fixed fee $F$ regardless of consumption, which is especially burdensome for low-$v$ consumers. The benefit, relative to prepaid service, is the free allowance $Q$ and the incremental utility $\alpha$ (worth $(\alpha + r)Q$). Hence we should expect low-$k$ customers to pick the prepaid plan, and this kind of assignment appeals to the firm because the low-$k$ customers would not generate enough revenue to offset the additional fixed cost $c$ of offering a postpaid plan. Finally, for customers with very high $k$ ($> Q$), if they choose to consume additional units beyond $Q$ then the excess per-unit benefit from the postpaid plan is $\alpha$ while the incremental cost is $s - r$. Define the relative advantage $A$ from purchasing a postpaid plan as the difference in net surplus from the two plans, i.e.,

$$A(k) = (B - F) + (\alpha + r)Q + (\alpha + r - s)(k - Q)^+ = (B - F) + (\alpha + r)k - s(k - Q)^+. \tag{1}$$

For all $k < Q$, it is obvious that $A$ increases in $Q$. For $k > Q$, $A$ continues to increase as long as $(s - \alpha) \leq r$, i.e., the net marginal rate for the postpaid plan is no higher than the prepaid rate. If the firm sets $s > \alpha + r$, then $A$ diminishes with $k$; but postpaid customers with $k > Q$ could switch their above-$Q$ consumption to a prepaid plan. This would occur when consumers perceive a low sign-up cost for a secondary plan. For instance, this appears true in India where many customers hold multiple SIM cards or phones, and optimize repeatedly on which phone or plan to use for different calls. In such settings it is logical to assume that the firm sets the postpaid marginal rate to satisfy $(s - \alpha) \leq r$, and in the absence of any other constraint on $s$ we should expect that $s = (\alpha + r)$, as we will prove formally later in the paper. When customers perceive
a high cost for adopting a secondary phone, then the firm can set \( s > \alpha + r \). Such pricing (i.e., penalty rate higher than prepaid rate, see Table 1) is also observed when firms offer multiple plan tiers and seek to drive customers to plans with higher \( F \) and \( Q \). Because we presently do not model multiple plan levels, we will assume that

**Assumption 1 (Penalty Rate in Postpaid Plan)** The net penalty rate \( s \) for above-allowance consumption under the postpaid plan is no higher than the marginal rate under the prepaid plan \( r \) plus the incremental utility from postpaid service, i.e., \( s \leq (\alpha + r) \).

Now we evaluate customer choice among the two plans. The individual rationality constraint under prepaid service is satisfied by construction. The individual rationality constraint for postpaid service is automatically satisfied whenever the incentive compatibility constraint indicates a preference for postpaid service. Therefore, customer \( k \) would prefer the postpaid plan when \( A(k) \geq 0 \), i.e.,

\[
k(\alpha + r) - s(k - Q)^+ \geq (F - B) \tag{2}
\]

All \( k \) for whom Eq. 2 holds purchase a postpaid plan, with the rest purchasing the prepaid plan. Because of the \((k - Q)^+\) term, the computation of these market shares involves the two intervals within \([0, K]\) separated by \( Q \), with the postpaid plan being preferred by

\[
\{k : (k \leq Q) \land (k > k_1)\} \cup \{k : (k > Q) \land (k > k_2)\},
\]

where \( k_1 = \frac{F - B}{\alpha + r} \) and \( k_2 = \frac{F - B - sQ}{\alpha + r - s} \), with \( k_2 \geq k_1 \) by definition (because \( k_1 \in [0, Q] \) and \( k_2 \in [Q, K] \)). Potentially, the set of consumers who prefer one plan could be non-contiguous. However, we show in Lemma 1 that the standard outcome holds, and each plan is preferred by a contiguous set of customers. Let \( R \) and \( S \) denote the market shares for the prepaid and postpaid plans respectively. Then,

**Lemma 1 (Optimal Market Shares)** Optimal prices under the two plans are such that the indifferent customer is \( Q = k_1 = k_2 = \frac{F - B}{\alpha + r} \), with \( S = \frac{K - Q}{K} \) and \( R = \frac{Q}{K} \).
3.2 Optimal Plan Design and Properties

The plan design problem involves optimally setting three parameters \((F, Q, s)\), with the fourth parameter \(r\) being the competitive rate for prepaid plans. Lemma 1 describes a relation between \(F\) and \(Q\), namely \(Q = F - \frac{B}{r + \alpha}\), eliminating one parameter from the optimization. The firm aims to optimize long-term profit based on customer lifetime value, hence the instantaneous profit under postpaid service is adjusted with the multiplier \(\mu\) representing incremental longevity. The formal optimization problem is stated below.

\[
\max_{F, Q, s} \Pi = \int_0^Q r \cdot x \, dx + \mu \int_0^K ((F - c) + s(x - Q)) \, dx \\
\text{with } Q = \frac{F - B}{r + \alpha} \quad \text{(4)} \\
s.t. \ s \leq (r + \alpha)
\]

**Lemma 2** The optimal postpaid plan design is

\[
s^* = (r + \alpha) \quad \text{(5)} \\
Q^* = \frac{\mu(c - B)}{\alpha \mu + r (\mu - 1)} \quad \text{(6)} \\
F^* = \frac{\mu c (r + \alpha) - r B}{\alpha \mu + r (\mu - 1)} \quad \text{(7)}
\]

When \(B \geq c\), the entire market tilts towards postpaid service, hence to continue the analysis we assume that \(B < c\). Computing the ratio \(\frac{F}{Q}\) under postpaid service, we determine conditions under which postpaid plans would carry higher, or lower, per-minute prices than the prepaid products.

**Proposition 1** A mobile telephony market features aggressive (i.e., discounted relative to pre-
3.2 Optimal Plan Design and Properties

paid) postpaid service when

\[
\frac{F}{Q} \leq r \iff \frac{\alpha}{c} \leq -\left(1 - \frac{1}{\mu}\right)B
\] (8)

This result helps explain the stark contrast in pricing strategies across India and the U.S. Because \(c > 0, \alpha > 0\) and \(\mu > 1\) (both in India and the US), discounted or aggressive postpaid pricing (i.e., \(\frac{F}{Q} < r\)) requires negative \(B\) and is enabled by high \(\mu\), while \(B > 0\) (or slightly negative) ensures that \(\frac{F}{Q} > r\). That is, higher \(B\) (more benefits rather than hassle) makes it possible for the firm to entice prepaid subscribers even while offering an unattractive \((F, Q)\) combination. Several factors indicate higher \(B\) (or less negative \(B\)) in India than in the US, due to which postpaid plans in India will not look as attractive. First, plan setup in India imposes the same hassle on both prepaid and postpaid customers (because the “know your customer” regulations apply to both types of service), whereas in the US postpaid service imposes a greater burden of credit check, personal information, and more time. Second, in the US, firms can entice customers towards postpaid plans by offering handset subsidies, recovering these over a 12 or 24 month contract duration. Indian telecom firms cannot easily employ this practice because a weak, slow and more expensive judicial system makes contract enforcement very difficult (i.e., \(\mu\) is small and closer to 1 than in the US). But the long-duration contract, and the implied monetary commitment, imposes an extra decision burden on the postpaid subscriber in the US. Third, billing and itemization creates a more positive advantage for postpaid service in India. In the US, both prepaid and postpaid services are sold institutionally with appropriate paperwork and official receipts, whereas in India this is true primarily only for postpaid subscribers. All these factors lead to higher \(B\) in India relative to the US. Moreover, the lack of efficient and automated billing and mailing systems in India leads to higher \(c\) (incremental cost of postpaid service, about Rs. 100-200 per month according to industry executives), tilting the condition in Proposition 1 further toward \(\frac{F}{Q} > r\).
Second, consider the effect of the magnitude and direction of $B$ (relative to the other parameters) on the market share of prepaid vs. postpaid services. A higher or more positive $B$ suggests a lower $Q^*$, indicating a high share of postpaid subscribers $S$. Since $B$ is higher (or less negative) in India, this would indicate, contrary to reality, that postpaid service should be more popular in India than in the US. However, because $S = 1 - \frac{Q^*}{K}$ the magnitude of $Q^*$ must be viewed in relation to $K$. Adjusting for $r$ in the two countries ($r$ in India is on the order of 1c per minute relative to 10c in the US), the $K$ would be a far smaller number in India, so that the model would indeed predict a lower postpaid market in India than in the US. Equivalently, we can examine the market share from the lens of $F^*$ in relation to overall income distribution.

The cheapest postpaid plans in the US, at about $40 per month, represent about 1% of median monthly income, whereas a Rs. 200/month plan in India is about 5% of monthly income. Hence even though Rs. 200 corresponds to only $4, it is affordable to far fewer households in India.

What are the implications of these analyses for firms, especially in India, which seek to expand their share of postpaid subscribers? First, despite the discussion above, it still remains true that an increase in $B$ leads to a greater share of postpaid service. Hence firms should examine other “goodies” that can be made available to postpaid subscribers at relatively low cost. Second, the postpaid share also expands with $\mu$ because $\frac{\partial Q^*}{\partial \mu} < 0$, hence firms must look for ways to increase customer longevity, either via legal and institutional means, or through efficient incentives.

Next, consider how the firm sets the fixed fee $F$ which is the primary driver in determining the market shares of the prepaid and postpaid plans. Recall that the firm incurs a fixed cost $c$ in offering the postpaid plan, but consumers also derive additional benefit $B + \alpha k$ on choosing the postpaid plan because they value having an itemized and official statement of their spending, receiving better customer support, etc. Moreover, such consumers deliver higher lifetime value because of greater longevity with the firm. The question then is whom should the firm market the postpaid service to, and how should it incentivize adoption. For instance, should the firm offer postpaid service only when there is a positive current-period net surplus from the transaction (i.e., $B + \alpha k > c$ applied at the margin $k = Q^*$), i.e., the firm’s excess cost can be recovered?
Rearranging terms, we can write $F^* = c + \frac{\alpha}{\mu} Q^*$. This indicates that the firm aims to recover its fixed fee for postpaid service plus the foregone revenue opportunity under prepaid. To see this, note that when $\mu = 1$ (i.e., prepaid and postpaid customers have equal longevity), then $F$ is exactly $c + rQ$. This interpretation also confirms the role of $F$ in recovering the basic costs for providing postpaid service to the customer. When postpaid service offers no longevity gain to the firm, then it also seeks to acquire at least the same tariff that the marginal consumer would have paid under prepaid service. But when postpaid service creates extra longevity, the firm is willing to discount the additional fee $rQ$ by a weight $\mu$. Computing the incremental value $B + \alpha Q^*$ of postpaid service for the marginal postpaid buyer, we get the following result.

**Proposition 2 (Fixed Fee and Whom to Offer Postpaid Plan)** When $\mu = 1$, the postpaid plan, priced at $F = c + rQ$ is offered only to those consumers whose service benefit from the postpaid plan exceeds the firm’s fixed cost $c$ of offering the postpaid plan. For $\mu > 1$, the firm prices $F$ at $c + \frac{rQ}{\mu}$, with a discount corresponding to the longevity factor under postpaid service, covering at least some buyers whose incremental benefit from postpaid service is below the firm’s incremental cost.

This result is striking in its resemblance to the perspective offered by industry executives we interacted with in India, but it also offers useful directions for managerial intervention. Even though executives agree that postpaid consumers generate higher revenue, they hesitate to offer postpaid plans because of the fixed cost $c$ of these plans. Specifically, they expressed reluctance to offer postpaid plans to consumers who would not contribute extra revenue of at least $c$ on switching to the postpaid plan. We see that is exactly the case under the optimal design as long as $\mu$ is close to 1: the extra benefit derived by the marginal consumer ($\hat{k} = Q$) on switching to the postpaid plan is exactly $c$ (because $B + \alpha Q = B + (c - B) = c$ when $\mu = 1$), and this incremental benefit is rolled into the fixed fee $F$ which equals $c$ plus the usage fee $rQ$ that the firm would have accrued under the prepaid plan. The firm’s net margin from selling the postpaid plan to the indifferent consumer $\hat{k}$ is exactly the margin it would have earned from selling the
prepaid plan. For customers higher than $\hat{k}$, the firm makes a higher profit margin by selling them the postpaid plan because it can charge a per-unit usage fee that is higher than the prepaid rate.

However, when (and if) $\mu > 1$ can be achieved, then the above strategy is no longer optimal; the firm should be willing to take a current-period hit on postpaid customers because such customers will deliver higher lifetime value in the long run. The current strategy appears not to account for the possibility that a postpaid customer might over her lifetime generate higher revenue and be less likely to churn or defect to a competitor. It is well known in the service goods literature that postpaid customers have lower churn and generate higher lifetime value. Due to this, firms in more developed markets have evolved sophisticated strategies (such as aggressive pricing, quantity discounts, handset subsidies) to convince a majority of consumers to adopt postpaid plans. These strategies usually carry some risk because they all require the firm to spend a high initial cost of customer acquisition (or conversion), which the firm gradually recovers over several months of service. The telecommunications industry in India also appears to recognize the higher lifetime value potential of postpaid plans, but it seems to be heavily limited by the lack of a widespread and well-functioning credit rating and enforcement infrastructure.

4 Future Work

The present paper is a work in progress. We have presented the motivation for our research—the puzzling features of the Indian mobile telephony market relative to that in the US—and a model that is preliminary but nevertheless produces results that are uncanny in their fit with observed industry practice in India. There are several additional directions that we intend to pursue between now and the September conference and later for the journal submission. The first is to extend our model to incorporate multiple plan tiers. Preliminary analysis suggests that our previous results hold, and we obtain an additional result that explains the lack of aggressive quantity discounts in India. The second is to extend our model to incorporate lifetime customer value, rather than the current optimization which is based on instantaneous or monthly revenue. The monthly revenue
based model has served its value by producing results which explain current industry practice, but the lifetime value based model is more correctly aligned with firms’ long-term objectives. Third, we will consider the role of customer uncertainty in consumption quantity, and why it might motivate firms to offer postpaid plans with generous allowances but severe overconsumption penalties.

Mobile telephony has grown rapidly in India in the last decade, and the market now covers over 700 million subscribers. Telecommunications markets around the world offer researchers and practitioners an unusual setting for creating new designs in pricing and marketing, because consumption occurs in small bits over a long time period, and consumption can be monitored and metered along many metrics such as bandwidth, time, and quality of service [4]. This paper builds on profound differences observed in the nature of mobile pricing practice between the Indian market and developed markets such as the U.S. and Europe. An understanding of these differences, and their impact on optimal designs of products and prices, is crucial as the the Indian market matures in terms of subscriber demand for services, spectrum availability, technological infrastructure and government policy.

References


