Customer Acquisition and Retention Spending: An Analytical Model and Empirical Investigation in Wireless Telecommunications Markets

Sungwook Min, Xubing Zhang, Namwoon Kim, and Rajendra K. Strivastava*

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*Sungwook Min is Chair and Professor of Marketing, College of Business Administration, California State University, Long Beach, California, sam.min@csulb.edu. Xubing Zhang is Associate Professor, Faculty of Business, Department of Management and Marketing, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, zhang.xubing@polyu.edu.hk. Namwoon Kim is Professor, Faculty of Business, Department of Management and Marketing, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, namwoon.kim@polyu.edu.hk. Rajendra K. Srivastava is Dean, Indian School of Business, and ISB Chair Professor in Marketing Strategy and Innovation, Gachibowli, Hyderabad, Telangana, India, rajs@smu.edu.sg.

ABSTRACT

Strategic resource allocation in growth markets is always a challenging task. This is especially the case when it comes to determining the level of investments and expenditures for customer acquisition and retention in competitive and dynamic market environments. This study develops an analytical model to examine firms' investments in customer acquisition and retention for a new service and it develops hypotheses based on analytical findings and tests them with firm-level operating data of wireless telecommunications markets from forty-one countries during 1999 to 2007. The empirical investigation shows that a firm's acquisition cost per customer is more sensitive to market position and competition than retention cost per customer. Furthermore, whereas firms leading in market share, on average, do not have a cost advantage over other firms in retaining customers, they have a substantial cost advantage in acquiring customers and this advantage tends to increase with market penetration. The study results provide guidelines for firms' strategic resource allocation for customer acquisition and retention in competitive service markets.

Keywords*: acquisition cost, retention cost, customer relationship management, wireless communications industry, market dynamics*

INTRODUCTION

Customer acquisition and retention are the central components of Customer Relationship Management (CRM). They have been tied to business outcome metrics such as customer equity (Berger and Bechwati 2001; Blattberg and Deighton 1996; Ovchinnikov, Boulu-Reshef, and Pfeifer 2014; Schweidel, Fader, and Bradlow 2008), firm value (Gupta, Lehmann, and Stuart 2004), and the allocation of marketing resources (Reinartz, Thomas, and Kumar 2005). Despite unceasing research efforts on customer acquisition and retention with different foci (e.g., Braun and Schweidel 2011; Chan, Wu, and Xie 2011; Fader and Hardie 2010), many issues still warrant investigation. For instance, managers in the real world are faced with evolving and dynamic market situations. Then, how are customer acquisition and retention spending patterns influenced by competitive market dynamics? The current study intends to address this over-arching question. To this end, we develop both theoretical frameworks and empirical models that investigate firms' investments in customer acquisition and retention, and analyze three factors that capture important market dynamics that affect the investments in a new service market. The first factor we consider is *a firm's relative market share position* or *market leadership*. Although a firm with a larger market share is expected to exert greater effort to maintain its customers (McGahan and Ghemawat 1994), it can also leverage its larger market share or dominance to obtain some cost advantage. How will these forces play out? What are the implications of this market-share position difference for the resource allocation decisions on customer acquisition/retention?

Second, we consider the impact of *market competitive intensity* on retention and acquisition costs. Does competition increase firms' investments in customer acquisition and retention? Or does competition have different impacts on the effectiveness of firms' investments

in customer acquisition versus retention? Moreover, does the competition effect differ for firms with larger market shares compared to those with smaller shares? One firm's increase in competitive efforts can be compensated for and potentially neutralized by its rival firms' counter-efforts (Voss and Voss 2008). Thus, firms that fail to take competition into consideration may incorrectly assess the benefits obtained from their acquisition or retention efforts, and thereby suboptimal decisions (Musalem and Joshi 2009; Shugan 2005).

Third, we look at the impact of *level of market penetration (or it's flipside – market saturation)*, or *the stages of market evolution.* Does acquisition and retention effectiveness change as the market evolves? Because in the early periods, the number of existing customers is small and that of the new or potential customers is large and the reverse is true in the late periods of the product life-cycle when the market is more saturated, it seems that firms should allocate more resources on customer acquisition in the early periods and more on customer retention in the late periods. However, the resource allocation on an individual customer basis, i.e., *cost per customer*, over the stages of market penetration is unclear in the literature. How do acquisition and retention costs *per customer* change with the level of market penetration? Do firms spend more on acquiring new customers than on retaining existing customers in the early versus later periods of the new service adoption cycle?

To analyze the impact of market dynamics as discussed above, we first develop a game-theoretic model in which a market-share leader firm and a market-share follower firm conduct their CRM efforts in retaining existing customers, acquiring (or capturing) customers from the rival firm, and acquiring customers who are new to the market. With the analytical model results as a background, we provide subsequent hypotheses to examine the impacts of market dynamics on the firms' customer acquisition and retention investments. Our empirical testing is based on

large-scale, firm-level, time-series quarterly data of wireless telecommunications markets from forty-one countries during 1997 to 2007. The empirical results show that firms' market share leadership, the market penetration level, and competition status have systemic and interactive effects on the firms' customer acquisition and retention investments.

One of the key contributions of this study is that it builds and tests empirical models based on a game-theoretic framework, thereby validating that a game-theoretic competition and consequential optimal firm behaviors exist in the wireless telecommunications industry. Second, the current study offers a contingency view of customer acquisition and retention investment, which offers firms richer strategic implications on their CRM investment in dynamic market conditions. Another key contribution is that we use time series data to empirically estimate retention and acquisition costs. While the data include only total operating cost, we develop an empirical method to decompose it into per capita acquisition and retention cost components. This method provides a useful approach to estimating retention/acquisition costs per customer for a firm, and enables comparison with other firms to assess its relative cost advantages or disadvantages in retaining and acquiring a customer.

In the next section, we provide a brief review of previous literature related to firms' investments for customer acquisition and retention to position our study. Then, we develop an analytical model and build hypotheses in the context of wireless telecommunications markets. After explaining data, we present an empirical model and test hypotheses. Finally, we discuss the empirical results and their managerial implications and conclude this paper with limitations and directions for future research.

BACKGROUND

Although academic interest in customer acquisition and retention is on the rise, only two analytical studies, to our best knowledge, have investigated competing firms' decisions in the context of customer acquisition and retention (McGahan and Ghemawat 1994; Musalem and Joshi 2009). Focusing on firms' decisions on customer retention, McGahan and Ghemawat (1994) built an analytical model in which customers are either loyal or non-loyal (i.e., switchers), and competing firms set their own levels of service provisions to determine the proportion of loyal customers to their existing customer groups, respectively. Due to the presence of non-loyal customers, their model exhibits a mixed strategy equilibrium (as in Varian 1980 and Narasimhan 1988), in which a firm with a larger market share displays more effort, and thus maintains a greater customer retention rate than its rival with a smaller market share.

In a more recent study, Musalem and Joshi (2009) showed that a firm should invest most aggressively in acquiring and retaining a customer who exhibits moderate responsiveness to the firm's CRM efforts. Investing heavily in acquiring and retaining a customer who is highly responsive to CRM does not always lead to a high firm profit, because greater inter-firm competition for this type of customer tends to erode profit margins. Although Musalem and Joshi (2009) offer many insights for CRM strategies, their results shed little light on customer acquisition and retention for firms that adopt a segmented marketing strategy for a new service (e.g., differentiated marketing programs for experienced customers versus inexperienced new customers), which is widely practiced for various service industries. For instance, in industries such as (wireless) telecommunications, banking, personal investment, and financial planning, companies generally have accumulated information about their customers and thus are able to structure their marketing programs for each customer segment (Hansotia and Wang 1997, p. 18).

Although McGahan and Ghemawat (1994) and Musalem and Joshi (2009) highlight the strategic implications of competition for firms' customer development decisions, they do not explain how such decisions change over time as competition intensifies and with increasing market saturation.

Empirical research on strategic investments for customer acquisition and retention has also been few due to the difficulties of measuring acquisition and retention costs as well as obtaining credible data. Although acquisition cost and retention cost can be defined conceptually, they are difficult to estimate in an empirical research setting (Gupta et al. 2004, p. 12; Thomas 2001). Service companies generally do not disclose information concerning their customer acquisition and retention costs. Moreover, companies often use different accounting or management practices to define costs, some of which may take the form of CRM investments or customer loyalty management expenses (Maxham, Netemeyer, and Lichtenstein 2008; Ovchinnikov, Boulu-Reshef, and Pfeifer 2014). Various costs, such as those for mass advertising, customer service, employee training, fulfillment of shipping and handling (for online retailers), as well as the salaries of sales and marketing people, are difficult to categorize into acquisition costs and retention costs, although such spending often accounts for the major portion of a firm's operating costs.

Therefore, academic researchers use different measures to calculate acquisition costs and retention costs in their studies. They often come up with highly divergent estimates, even for the same industry.[1] Unfortunately, it is not clear how these numbers were estimated and compared to each other. Because acquisition costs and retention costs are critical to assessing customer lifetime value (CLV) and allocating marketing resources accordingly (Livne et al. 2011; Reinartz,

[1] For instance, in the telecommunications industry, while Gupta et al. (2004) reported the acquisition cost per subscriber to be high as a range of $4,200 to $12,400 (p. 12), the cost only ranged from $161 to $752 with a mean of $374 in Livne et al.'s (2011) study. It has been known for more than twenty years that in general, the customer acquisition cost per customer is five to eight times greater than the customer retention cost per customer (Hart et al. 1990; Reichheld 1996).

Thomas, and Kumar 2005), devising a reliable system of measurements for acquisition and retention costs poses a serious and pressing empirical challenge for both academicians and practitioners. Our empirical study presents a method to decompose or to "separate" total operating costs into acquisition costs and retention components with time series data. Our data contain total operating cost information only, but we estimate per capita acquisition and retention costs and other expenses by regressing the total operating cost with the number of base customers and the number of new customers. Our method is particularly useful when only aggregated cost information is available.

ANALYTICAL MODEL [2]

Consider a market in which two firms compete against each other for sales of a new service. In this market, a market share "leader" firm is serving λ_1 number of customers and the other firm ("follower") is serving a smaller number of customers, λ_2, where $\lambda_1 > \lambda_2$. Following Varian (1980) and Narasimhan (1988), we assume that a proportion ρ of the customers are "loyal." Having subscribed to a specific firm's service, these customers will stay with that firm, regardless of the firm's and the other firm's marketing efforts. Such loyalty can arise because customers may be ignorant of the offerings available in the market (as in Varian 1980), or because they are in a contract term and are therefore bound by the contract. The remaining proportion 1- ρ of the customers are "non-loyals" or "switchers." These customers will stay with their current service provider only if staying there yields a higher utility; otherwise, they will switch. We assume that the two firms have the same proportion of loyal customers.

[2] Throughout the paper, we view spending for customer acquisition and retention as a type of firm investment. Any spending should be considered an investment if the spending may contribute to future revenue generation. Since only those who are acquired and retained will give the firm opportunity to generate future revenue, we consider acquisition/retention spending to be a form of investment.

While fully saturated or mature markets would include only experienced customers who are either "loyals" or "switchers," a number of "new" customers (say θ) enter growth markets.[3] As these customers are inexperienced with the service, they are non-loyal customers in nature. We assume that a proportion, φ, of the new customers do not bother to compare the two firms' offers. These "non-picky" customers will simply choose a firm in a random way. In contrast, the other proportion, 1- φ, of the new customers are "picky." They will compare the offers and choose the firm that yields a higher value to them.

Note that both the proportion of loyal customers among experienced customers, ρ, and the proportion of non-picky customers among new customers, φ, represent a boundary beyond which firms need to compete to acquire or retain customers. When ρ is large, there are a large proportion of existing customers who will stay with their current service providers anyway. This will reduce firms' needs to invest in retaining existing customers or to attain customers from the competing firms. Similarly, when φ is large, there are a large proportion of new customers who will automatically subscribe to their services. This will also reduce firms' needs to invest in acquiring new customers.

The two firms are assumed to conduct segmented marketing strategies -- (i) retaining their current customers; (ii) acquiring customers from their competitors; and (iii) acquiring new-to-market customers. We conceptualize a firm's customer management efforts in terms of its monetary investments; thus, the firm's efforts and costs are interchangeable hereafter in our model. We denote the three customer management efforts as r_i, a_i and b_i, respectively; that is, r_i

[3] We assume that the size of the new customers is a constant, independent of the firms' prices and marketing efforts. This assumption is made for the tractability of the model. Alternatively, we could assume the new customer size to be a decreasing linear function of price, $\theta(1-\tau p)$, where τ represents the extent to which the demand is responsive to price change. This will complicate the analysis without altering the qualitative nature of our results (the formal proof is available from the authors upon request).

is firm i's cost in retaining its current customers, a_i is its cost in acquiring customers from its competitor, and b_i is its cost in acquiring new customers, where the subscript i=1 refers to the leader firm and i=2 refers to the follower firm.

We assume these costs to be lump sum costs[4]. This assumption is consistent with the real world practices that firms commonly budget marketing expenses on a yearly basis, allocating different funds for different marketing activities according to the size of their market base (Hughes 2008). Moreover, CRM activities such as major advertising campaigns, sales force support, activities to enhance customer support and experience such as research and development, and investments in facilities and equipment incur fixed costs. In the setting of our empirical study, the wireless communications industry, although firms are observed to contact their target customers and provide them with some air time for free, the associated costs are often marginal. In addition, while variable costs are defined primarily as "labor and materials" that fluctuate with the size of operations in manufacturing sectors, contractual labor for customer service and support is usually a fixed cost in service industries and does not vary per customer.

Firms' efforts will translate into values enjoyed by customers. We assume that the values are a linear function of firms' investments in customer acquisition and retention (as in Musalem and Joshi 2009). That is, a customer will obtain a value of $\eta \times e$ from a firm if the firm incurs a cost of e, where η is the effort-value translation rate. For simplicity of exposition, we assume that the translation rate is the same for all three tasks and for both market leader and follower firms.[5] Therefore, due to these CRM efforts, an experienced non-loyal customer using the leader firm's

[4] Although these costs are modeled as fixed costs, they increase with the size of the target segment in equilibrium in our model, as we see later.

[5] We acknowledge that in practice the translation rates are likely to be different among the three types of tasks and across different firms, and apparently, these differences can result in different levels of customer management efforts. We assume that the two firms have the same translation rate because we want to focus on the impact of market-share leadership, competition, and penetration. Relaxation of this assumption will greatly complicate the analysis. We can show that the qualitative nature of our theoretical findings remains robust as long as the two firms' translation rates are not markedly different (the proof is available from the authors upon request).

service will obtain a value of ηr_1 if the customer stays, or a value of ηa_2 if the customer switches to the follower firm. An experienced non-loyal customer who is using the follower firm's service will obtain a value of ηr_2 if the customer stays, or a value of ηa_1 if she switches to the leader firm. A new non-picky customer who is entering the market will obtain a value of ηb_1 if the customer chooses the leader firm, or ηb_2 if the customer chooses the follower firm. Noting that the firms' efforts have no effect on the experienced loyal customers and the new non-picky customers, we specify the utility functions only for the non-loyal customers and the new picky customers. That is, the utility of firm i's customers who choose to stay with firm i is

$$u_{i,i}=ln(v_i-p_i+\eta r_i)+\varepsilon_{i,i}, \quad (1)$$

where v_i is the customers' perceived value of the service provided by firm i, p_i is its price, r_i is firm i's effort in retaining customers, and $\varepsilon_{i,i}$ captures the impact of the factors unobserved by the firm on customers' utility. The natural logarithm function ensures that the utility exhibits decreasing returns to the firm's investment in retention (Rust et al. 1995). We assume that $v_1 > v_2$, because firms leading in market share generally have greater brand recognition and reputations, and because customers often associate them with a better value (Caminal and Vives 1996). For example, leader firms in the wireless telecommunications industry may provide broader network coverage, which also increases the value of their services to customers (Hughes 2008). The utility of firm i's customers who choose to switch to firm j is

$$u_{i,j}=ln(v_j-p_j+\eta a_j-s)+\varepsilon_{i,j}, \quad (2)$$

where v_j and p_j are the perceived value and price of firm j's service, respectively, a_j is firm j's effort in acquiring customers from its competitor, and s is the customers' switching cost. We assume the switching cost to be the same for all switching customers. We also assume that this cost is not too large, i.e., $v_j-p_j>s$, thus customers may switch even without firms' efforts in

customer acquisition. “Stealing” customers from competing firms is widespread in the real world and particularly predominant in matured markets. If *s* is sufficiently large, acquiring customers from competitors will be too costly to be viable. Note that in our definition, *s* refers to any switching costs except for the cost of breaking a contract, as we have assumed that customers in a contract term are loyal customers who do not switch. The utility of the new picky customers who choose firm *i* is

$$u_{0,i}=ln(v_i-p_i+\eta b_i)+\varepsilon_{0,i} \quad (3)$$

Table 1 lists the customer choices and their associated utilities to the experienced non-loyal customers and the new picky customers.[6]

[Table 1 about here]

We assume that the error terms in the above utility functions are i.i.d., with an extreme value distribution between 0 and 1 (Berry 1994; Guadagni and Little 1983; and in the context of customer acquisition and retention, Hansotia and Wang 1997; Musalem and Joshi 2009). As a result, we can derive the logit formulation of acquisition and retention likelihood, based on which we calculate the size of the lead firm's retained non-loyal customers, R_1, the size of customers acquired from the follower firm, A_1, and the size of acquired new customers, B_1, as follows:

$$\begin{aligned} R_1 &= \frac{(v_1-p_1+\eta r_1)}{(v_1-p_1+\eta r_1)+(v_2-p_2+\eta a_2-s)}(1-\rho)\lambda_1+\rho\lambda_1, \\ A_1 &= \frac{(v_1-p_1+\eta a_1-s)}{(v_1-p_1+\eta a_1-s)+(v_2-p_2+\eta r_2)}(1-\rho)\lambda_2, \text{ and} \\ B_1 &= \frac{(v_1-p_1+\eta b_1)}{(v_1-p_1+\eta b_1)+(v_2-p_2+\eta b_2)}(1-\varphi)\theta+\frac{\varphi\theta}{2}. \end{aligned} \quad (4)$$

Similarly, the size of the follower firm’s retained non-loyal customers, R_2, the size of its customers acquired from the leader firm, A_2, and the size of its acquired new customers, B_2, are

[6] We do not provide such information for (experienced) loyal customers and new non-picky customers, as these customers' behaviors are not driven by "picking an option that yields a greater utility."

$$R_2 = \frac{(v_2 - p_2 + \eta r_2)}{(v_1 - p_1 + \eta a_1 - s) + (v_2 - p_2 + \eta r_2)}(1-\rho)\lambda_2 + \rho\lambda_2,$$

$$A_2 = \frac{(v_2 - p_2 + \eta a_2 - s)}{(v_1 - p_1 + \eta r_1) + (v_2 - p_2 + \eta a_2 - s)}(1-\rho)\lambda_1, \text{ and} \quad (5)$$

$$B_2 = \frac{(v_2 - p_2 + \eta b_2)}{(v_1 - p_1 + \eta b_1) + (v_2 - p_2 + \eta b_2)}(1-\varphi)\theta + \frac{\varphi\theta}{2}.$$

Knowing the numbers of experienced customers (i.e., λ_1 for the leader and λ_2 for the follower) and the proportion of loyal customers among them (i.e., ρ), and the number of new customers (i.e., θ) and the proportion of the non-picky customers among them (i.e., φ), and anticipating how these customers' purchase decisions will be affected by their CRM efforts, the two firms determine the optimal p_i, r_i, a_i and b_i to maximize their own profits, π_1 and π_2. Without loss of generality, we assume that the marginal cost of the service is zero. Thus the price p_i becomes the margin. Therefore, the two firms' respective objective functions are

$$\max \ \pi_1(p_1, r_1, a_1, b_1) = R_1 p_1 - r_1 + A_1 p_1 - a_1 + B_1 p_1 - b_1, \quad (6)$$

$$\max \ \pi_2(p_2, r_2, a_2, b_2) = R_2 p_2 - r_2 + A_2 p_2 - a_2 + B_2 p_2 - b_2. \quad (7)$$

To focus on firms' efforts in customer retention and acquisition, we follow Musalem and Joshi (2009) and assume that $p_1 = p_2 = p$. This assumption is made mainly for tractability of the model and it is also plausible in many service industries, at least on a marginal cost basis, as firms often match competitive offers. For instance, in the wireless telecommunications industry and many mature, regulated service industries such as the insurance industry, services are easily copied, and price differentiation is difficult, if not impossible. In such markets, competition is focused on firms' efforts for customer retention and acquisition on a non-price basis (Livne et al. 2011).

We assume that the two firms play a Nash game; that is, they simultaneously determine their efforts in retaining existing customers, acquiring customers from the rival, and acquiring new customers. To derive their equilibrium effort levels, *r*, *a* and *b*, we first obtain the first order

conditions with respect to *r, a* and *b* for both firms, taking the other firm's effort levels as given. Then, we solve these six conditions simultaneously and obtain the firms' customer retention and acquisition efforts in equilibrium. The results are reported in the first two columns (in shade) in Table 2.

[Table 2 about here]

These results offer the following insights. First, the firms' efforts for customer acquisition and retention increase with the size of the target segment (i.e., λ_1, λ_2, or θ), the price margin (i.e., p), and the effort-value translation rate (i.e., η). Second, the firms' costs of acquiring customers from the competitor increases with the customers' switching cost *s*. The higher the switching cost, the greater the firm's efforts needed to induce switching. Third, the firms' efforts decrease as their service value (i.e., v_1 or v_2) increases. The higher the service value, the lower the effort needed to acquire or retain customers. Fourth, the firms' CRM efforts decrease with the proportion of loyal customers (i.e., ρ) and the proportion of non-picky new customers (i.e., φ).

Acquisition Cost per Customer (ACp) and Retention Cost per Customer (RCp)

The firms' customer acquisition and retention efforts are not successful for each and every target customer. For instance, while the leader firm invests r_1 to retain a number λ_1 of its current customers, only a number $(1+\rho)\lambda_1/2$ of them are successfully retained; a number $(1-\rho)\lambda_1/2$ of customers end up switching to the competitor.[7] It is therefore useful to calculate the two firms' *acquisition cost per customer* (ACp) and *retention cost per customer* (RCp), which are equal to the lump sum costs divided by the numbers of customers who are successfully acquired or

[7] Having made their equilibrium CRM efforts, the leader firm will retain a number $(1+\rho)\lambda_1/2$ of customers, and acquire a total number $((1-\rho)\lambda_2+\theta)/2$ of customers (of which $(1-\rho)\lambda_2/2$ are from its rival and $\theta/2$ are new). The follower firm will retain a number $(1+\rho)\lambda_2/2$ of customers, and acquire a total number $((1-\rho)\lambda_1+\theta)/2$ of customers (of which $(1-\rho)\lambda_1/2$ are from its rival and $\theta/2$ are new).

retained. We provide the following proposition and corollary about ACp and RCp of leader and follower firms.

> **Proposition** *The leader firm's costs of retaining and acquiring a customer are* $RCp = \frac{(1-\rho)p}{2(1+\rho)} - \frac{2(v_1-p)}{(1+\rho)\eta\lambda_1}$ *and* $ACp = \frac{p}{2} - \frac{8v_1-8p+p\varphi\theta\eta-4s}{2\eta(\lambda_2-\rho\lambda_2+\theta)}$*, respectively, and those of the follower firm are* $RCp = \frac{(1-\rho)p}{2(1+\rho)} - \frac{2(v_2-p)}{(1+\rho)\eta\lambda_2}$ *and* $ACp = \frac{p}{2} - \frac{8v_2-8p+p\varphi\theta\eta-4s}{2\eta(\lambda_1-\rho\lambda_1+\theta)}$*, respectively.*[8]

> **Corollary 1** *Both firms' retention and acquisition costs per customer* (a) *decrease with the value offered to customers (i.e.,* $\frac{\partial ACp}{\partial v}, \frac{\partial RCp}{\partial v} < 0$*); and* (b) *increase with the size of their existing target customers, the effort-value translation rate, and the profit margin (i.e.,* $\frac{\partial ACp}{\partial \lambda}, \frac{\partial RCp}{\partial \lambda}, \frac{\partial ACp}{\partial \eta}, \frac{\partial RCp}{\partial \eta}, \frac{\partial ACp}{\partial p}$*, and* $\frac{\partial RCp}{\partial p} > 0$*).*

Customer Acquisition and Retention Cost Advantages

A comparison of acquisition and retention costs per customer -- ACp and RCp -- between the two firms allows us to investigate cost advantages and disadvantages of the leader vis-à-vis the follower. This is because ACp and RCp are not budgetary expenses for firms to set in the hopes of acquiring or retaining a customer; rather, they are performance measures (i.e., input-output ratios). From Table 2, we can derive the firms' cost difference of retaining a customer as ΔRCp (RCp for leader firm – RCp for follower firm) $= -2\frac{v_1\lambda_2-v_2\lambda_1+(\lambda_1-\lambda_2)p}{\lambda_1\lambda_2\eta(1+\rho)}$, and that of acquiring a customer as ΔACp (ACp for leader firm – ACp for follower firm) $= \frac{2(1-\rho)(\lambda_1-\lambda_2)}{\eta(\lambda_2-\rho\lambda_2+\theta)(\lambda_1-\rho\lambda_1+\theta)}\left(s - 2(v_2-p) - \frac{2(v_1-v_2)(\lambda_1-\rho\lambda_1+\theta)}{(1-\rho)((\lambda_1-\lambda_2)} - \frac{p\eta\varphi\rho}{4}\right)$ and provide the following corollary.

> **Corollary 2 (**a) *The leader firm has a cost advantage in retaining a customer over the follower firm only if* $\frac{v_1-p}{v_2-p} > \frac{\lambda_1}{\lambda_2}$*; and* (b) *the leader firm has a cost advantage in acquiring a customer over the follower firm (i.e.,* $\Delta ACp<0$*).*

[8] A firm's acquisition cost per customer (ACp) here is its total acquisition cost of customers, both from its rival firm and from the new customer group divided by the total number of these acquired customers, as in Table 2. All the proofs are available in the on-line Appendix or from the authors upon request.

Corollary 2a shows that the market share leader firm enjoys a cost advantage in retaining a customer only if the value ratio ($\frac{v_1-p}{v_2-p}$) is greater than the market share ratio ($\frac{\lambda_1}{\lambda_2}$). If the market share leader provides a distinctively superior customer value relative to the follower, i.e., if $v_1 >> v_2$, it is likely that $\frac{v_1-p}{v_2-p} > \frac{\lambda_1}{\lambda_2}$. However, the relationship $\frac{v_1-p}{v_2-p} > \frac{\lambda_1}{\lambda_2}$ does not always hold, implying that a market share leader does not have an unconditional cost advantage in customer retention.

Corollary 2b shows that the leader firm certainly has a cost advantage over the follower firm in acquiring customers. This is mainly because the leader firm has a higher perceived value to customers ($v_1 > v_2$) and a larger market share ($\lambda_1 > \lambda_2$). It is evident from Table 2 that the leader firm' cost advantage for stealing a rival firm's customer as well as acquiring a new customer strengthens as the perceived value of the leader firm over its follower increases. Furthermore, a larger market share tends to increase cost advantage in stealing a rival's customer.

Effects of Competition and Market Penetration

In the analytical model, both the proportion of loyal customers among experienced customers, ρ, and the proportion of non-picky customers among new customers, φ, reflect the intensity of competition (c.f., Porter, 1979), because both indicate the extent to which firms need to compete to acquire or retain a customer. When ρ and φ are large, a large proportion of customers are not responsive to firms' customer management efforts. Therefore, firms' incentives to compete are low, which results in a low competition level in the market. In contrast, when ρ and φ are small, a large proportion of customers are responsive to firms' efforts. In this case, firms see the need to provide more customer management efforts, which gives rise to intensified competition. Hence,

the level of competition can be inferred from ρ and φ: the smaller their values, the more competitive the market (as in Varian 1980, p. 656; Narasimhan 1988).

We can therefore make an inference about the impact of competition on firms' retention and acquisition costs. According to the proposition, the more competitive the market (i.e., the smaller ρ and φ), the higher the firms' costs of retaining and acquiring customers. Furthermore, acquisition cost advantage of the leader firm (Corollary 2b) is highly likely to decrease as ρ and φ decrease (noting that $\Delta ACp<0$). That is, the more competitive the market is (i.e., the smaller ρ and φ), the weaker the leader firm's cost advantage in customer acquisition. Corollary 3 follows.

> **Corollary 3** (a) *Both the leader and follower firms' costs of retaining and acquiring customers increase as competition intensifies since* $\frac{\partial ACp}{\partial \rho}, \frac{\partial ACp}{\partial \varphi}, \frac{\partial RCp}{\partial \rho} < 0$ *and* $\frac{\partial RCp}{\partial \varphi} = 0$*; and* (b) *The leader firm's cost advantage in acquiring customers over the follower firm is likely to decrease with competition since* $\frac{\partial \Delta ACp}{\partial \varphi} < 0$ *and* $\frac{\partial \Delta ACp}{\partial \rho}$ *is likely to be negative.*

Although our model is static in nature, the above results offer insights on the cost advantages of the leader firm in an evolving, growth environment, as many parameters in our model correlate with market penetration. For instance, as market penetration increases, the sizes of firms' existing customer bases (i.e., λ_1 and λ_2) increase, but the proportion of new customers entering the market (i.e., θ) decreases due to market saturation. The product values (i.e., v_1 and v_2) tend to increase, because firms understand customers' needs and wants better in the progression of market development and able to find ways to offer greater values to customers. In addition, prices and margins (i.e., p) typically drop as market penetration increases. As our Corollary 1 indicates that these parameters can affect ACp and RCp, a joint consideration of these effects enables us to explore the effects of market penetration on ACp and RCp. Nevertheless, because these observations may be industry specific, we do not make them a corollary. In the following

section, we develop hypotheses regarding the impacts of market penetration based on observations in the wireless telecommunications industry.

INDUSTRY AND HYPOTHESES

In this section, we discuss a few characteristics of the wireless telecommunications industry that provide the business context of the current study. Next, based on these industry characteristics and our theoretical findings obtained in the previous section, we develop hypotheses on how ACp and RCp are affected by market penetration, competition, and a firm's market share leadership. We also hypothesize the interactive effects of share leadership with penetration and competition.

The Wireless Telecommunications Industry

The wireless industry provides a good laboratory for conducting our investigation, as this industry relies heavily on firms' customer acquisition and retention efforts to develop competitive advantages. It also allows us to draw comparisons with the customer acquisition costs reported in Livne et al. (2011) and Gupta et al. (2004).

Heavy investments are required for market entry in the wireless communications industry. According to our data that cover 53 (national) markets over eight years (1999-2007), the number of competitors in the industry remains stable after the initial market development period, due to (a) high entry barriers such as high required investments and (b) governmental regulations for new market entry in wireless communications industries. Even so, the number of firms in a wireless industry varies substantially from one nation to the others. Among 53 countries in our data, none of the markets maintained monopoly. Four markets were in duopolistic competition and the others were in oligopolistic competition ranging from three to seven firms in a market.

There was not much room for product differentiation in wireless telecommunications services between 1999 and 2007. The telecommunications service is inherently intangible and customers cannot compare service quality easily. As a result, it is often difficult to justify price differentiation and service prices tend to converge to the same level among competitors. For instance, the revenues per minute of Verizon Wireless, Cingular Wireless, and AT&T Wireless in the United States were $0.28, $0.28, and $0.22, respectively in the 4th quarter of 1999, and all converged to $0.05 by September 2007. In addition, consumers' switching costs in the wireless communications industry are low because switching normally requires no additional learning or investments from customers. And the cost of changing numbers was mitigated by regulatory changes that enabled customers to carry their number across different wireless communications service providers (Shi et al. 2006).

Effects of Market-share Leadership

According to our analytical results (i.e., Corollary 2a), it is indefinite whether a market share leader firm has a cost advantage over other firms in retaining customers. As discussed earlier, in the wireless communications industry, differentiation between firms is limited, and no firm can continuously offer a superior value than competitors. Hence, a firm leading in market-share is not expected to have a lower retention cost per customer. On the contrary, as per Corollary 2b, we expect a market share leader to have a cost advantage in customer acquisition. This should stand as long as the analytical model assumptions hold, i.e., the leader firm offers a greater value than a follower firm and the customers' switching costs are not extremely high. These conditions are likely to be met in the wireless communications industry. As discussed previously, firms leading in market share generally have greater brand recognition and reputations and often provide broader network coverage in the wireless telecommunications industry. Thus, customers

generally associate them with having greater value (Caminal and Vives 1996, Hughes 2008). In addition, customers' switching costs in the wireless communications industry have been insignificant, despite firms' continuous efforts to build them. We therefore expect that a market-share leader will not have retention cost advantage but do have acquisition cost advantage in the wireless communications industry. We formally submit[9]:

> **Hypothesis 1**: *In the wireless telecommunications industry, (a) a market-share leader firm does not have a lower retention cost per customer, but (b) it has a lower acquisition cost per customer compared to that of a follower firm.*

Effects of Increasing Number of Competing Firms

Our analytical model is a duopoly model. Thus, it does not capture the number of competing firms. However, as discussed earlier, the parameters in the model (i.e., φ and ρ) correlate with competition intensity, which allows us to make inferences about the effects of the number of competing firms in the industry on a firm's ACp and RCp. As the number of competitors increases, there are more CRM initiatives in the market, which tend to induce more customers to be picky and to switch. Therefore, the greater the number of competing firms, the greater the numbers of switchers (1- ρ) and picky new customers (1- φ), and consequently, the higher the RCp and ACp (According to Corollary 3a). We hypothesize:

> **Hypothesis 2**: *In the wireless telecommunications industry, as the number of competing firms increases, firms' (a) retention costs per customer and (b) their acquisition costs per customer increase.*

Effects of Market Penetration

The effects of market penetration on ACp and RCp can be inferred from the effects of the parameters in our analytical model that correlate with market penetration levels. First, the value

[9] In contrast to the theoretical model, our empirical model does not distinguish between the firm's cost of acquiring a customer from competitors and that of acquiring a new customer who just enters the market. This is because the "origin" of a specific "new" customer is generally impossible to identify when using aggregate public data. Hence, hereafter, AC includes both types of acquisition costs.

of services tends to increase because firms learn how to better satisfy customers' requirements as the market evolves. This is true in the wireless industry as broader network coverage, advanced technology (e.g., from 2G to 3G to 4G), and more powerful functions and applications (e.g., SMS, micro blog, and other mobile communications) have been provided by firms competing for market position. Second, prices drop. Although firms adopt a premium pricing strategy in the beginning to recover initial heavy investments, their prices have dropped significantly over time. The average year-over-year change in revenue per minute has typically been negative as cost reductions due to technology improvements have been passed on to customers in a competitive marketplace. Third, as the rate of increase in market penetration decreases and markets become more mature (but do not decline), the size of a firm's existing customer base increases, but the availability of new customers decreases. Fourth, as the market penetration increases, customers' switching costs tend to drop in the wireless telecommunications industry. Firms in the wireless telecommunications typically do not develop effective and efficient ways to increase the customer switching cost. Their endeavors, such as loyalty programs, have not been very successful in an environment where more countries have adopted the portable mobile numbers, dramatically reducing customers' switching costs.

These observations and market characteristics suggest that as market penetration increases, it is likely that a firm's value to customers (v) and the firm's current customer size (λ) increase, while the profit margin (p), the new customer size (θ), and the switching cost (s) decrease. Accordingly, as per Corollary 1, increases in v, and decreases p, θ, and s will reduce ACp and RCp, whereas an increased λ will raise RCp and the cost of acquiring a customer from a competitor. Because of these countervailing predictions, the impact of the level of market penetration on RCp is an empirical question. However, a larger customer base might help firms

to develop economies of scale, thereby increasing efficiency in operations and serving customers better. This is not incorporated in the analytical model. Furthermore, a larger customer base could reduce retention cost due to 'increasing cohort-level retention rates' with time (Fader and Hardie 2010, p. 87). A large customer base will accumulate more of the remaining 'aged-cohorts' over the next periods. These aged-cohorts are less likely to switch (i.e., have a lower churn rate). Hence:

> **Hypothesis 3**: *In the wireless telecommunications industry, as the market penetration increases, firms'(a) retention costs per customer, and (b) acquisition costs per customer decrease.*

Interactive Effects

If market-share leaders have cost advantages, do these advantages change as market penetration increases and as competition intensifies? Corollary 3b suggests that leader firm's cost advantage over follower firm in acquiring a customer decreases as competition intensifies. But, its advantage in retaining a customer is not inferred from the analytical model results.

The literature of entry barriers and competitive advantages generally suggests that an increasing number of competitors weaken the market share leader's competitive advantages. In fact, both theories of entry barriers (Bain 1956) and generic strategies (Porter 1980) are based on a premise that incumbent firms' profits and advantages diminish as the number of competitors increases in a market. Indeed there is evidence that an incumbent pioneer's survival rate decreases as the number of early followers increases (Robinson and Min 2002). Market share leaders need to protect wider competitive front lines as the number of competing firms increases. Therefore, we predict the market leader's cost advantages in retaining and acquiring a customer decrease as competition intensifies.

> **Hypothesis 4**: *In the wireless telecommunications industry, as the number of competing firms increases, (a) a market-share leader firm's retention cost advantage and (b) its acquisition cost advantage weaken.*

The analytical results suggest market share leader will have retention cost advantage only if $\frac{v_1-p}{v_2-p} > \frac{\lambda_1}{\lambda_2}$. This condition is more likely met in the introductory stage of product life-cycle than in later stages because $\frac{\lambda_1}{\lambda_2}$ tends to be highest in the introductory stage and prices drop as the market penetration increases in wireless telecommunication industry.[10] Because of price reductions and diminishing market share of the lead firm over the product-life cycle, the analytical model results imply that market share leader's retention cost advantage (if any) will decrease as market penetration levels increase.

The analytic results generally support the prediction that the acquisition cost advantage of market leaders strengthens as market penetration increases for multiple reasons. First, a market share leader will have a cost advantage to acquire inexperienced customers as the size of new customers (i.e., θ) drops with market penetration (as per Corollary 1). Second, since price drops with increasing market penetration, the share leader will enjoy a higher acquisition cost advantage in taking customers from its competitors (Corollary 1). The latter assertion is strengthened if we assume that switching costs decrease as the market penetration increases. Because these two assumptions are plausible in the wireless communications industry, we hypothesize that the market-share leader's acquisition cost advantage strengthens with market evolution.

> **Hypothesis 5**: *In the wireless telecommunications industry, as market penetration increases, (a) a market-share leader firm's retention cost advantage weakens, and (b) its acquisition cost advantage strengthens.*

EMPIRICAL ANALYSIS

[10] Suppose market shares of a share leader and a follower are 65% vs. 35% and v_1 =\$30, v_2 =\$20, respectively, and p=\$10 in the introduction stage, then market share leader has RCp advantage as $\frac{30-10}{20-10} > \frac{65}{35}$. If the price drops from \$10 to \$1 as market penetrates, the market share leader will have RCp disadvantage as the ratio becomes $\frac{30-1}{20-1} < \frac{65}{35}$.

Data

We use the Merrill Lynch Global Wireless Matrix data on market diffusion to study retention and acquisition costs in the wireless telecommunications industries. This data set has basic operating metrics for mobile operators, public and private, over eight-year-long quarterly operating data from the first quarter in 1999 to the third quarter in 2007 for wireless telecommunications companies operating in 53 countries.[11] After deleting 12 markets that have incomplete data (i.e., missing data for more than half of the observation window), we have data from 41 countries. One of the merits of the data is that the time window of our data covers a long period, during which diffusion of wireless communication services took place. As reported in Table 3, the data cover from 0% to 100% adoption. A wireless adoption of over 100% means that the number of subscribers exceeds the number of the population in the country as some customers subscribe to multiple wireless services. The average market penetration in the first quarter of 1999 was 20%. This increased to 93% in the third quarter of 2007 across the 41 countries.

[Table 3 about here]

Empirical Model

Conceptually, RCp (ACp) includes all-relevant expenses to retain (acquire) one customer[12]. In the analytical modeling, RCp (ACp) is defined as optimal total spending for customer retention (customer acquisition) divided by the number of retained (acquired) customers. To be consistent with the conceptual definition, we empirically define RCp (ACp) as all operating expenses, including marketing expenses that contribute to retaining (acquiring) one customer. $Cost_{i,j,t}$ represents the total operating cost spent by firm i in the market (i.e., country) j at time t. The total

[11] Because most companies in Asia and Europe release figures on a semi-annual basis, Merrill Lynch had to make estimates as necessary to obtain some of the quarterly data.

[12] Acquiring and retaining customers require not only a firm's marketing efforts, but also other efforts such as service and operation.

operating cost is calculated by total revenue, less earnings before interest, taxes, depreciation, and amortization (EBITDA) in each quarter (i.e., $EBITDA_{i,j,t} = Revenue_{i,j,t} - Cost_{i,j,t}$ or $Cost_{i,j,t} = Revenue_{i,j,t} - EBITDA_{i,j,t}$). EBITDA is intended to measure profit from an operation only by excluding the profit impacts of different asset bases -- cancelling amortization and interest payments. Therefore, the total operating cost includes any costs of services, as well as selling, marketing, and administrative expenses. We sort out the total cost of firm i's market j in the t^{th} quarter as:

$$Cost_{i,j,t} = Total\ retention\ cost_{i,j,t} + Total\ acquisition\ cost_{i,j,t} + Other\ expenses_{i,j,t} \quad (8)$$

Since the total retention cost (total acquisition cost) can be written as RCp times the number of base customers (ACp times the number of new subscribers), we can write the total cost function as follows:

$$Cost_{i,j,t} = RCp_{i,j} * Number\ of\ base\ customers_{i,j,t} + ACp_{i,j} * Number\ of\ acquired\ customers_{i,j,t} + Other\ expenses_{i,j,t} + r_{i,j,t} \quad (9)$$

The parameter $RCp_{i,j}$ indicates the cost for serving and retaining a customer, and the parameter $ACp_{i,j}$ is the cost for acquiring a new customer by firm i in market j, respectively. That is, the total cost of each period is separated into the cost for serving the existing customer base, $RCp_{i,j} * Number\ of\ base\ customers_{i,j,t}$, the cost for acquiring new customers, $ACp_{i,j} * Number\ of\ acquired\ customers_{i,j,t}$ and other expenses, $OC_{i,j,t}$, such as administrative expenses. We include $r_{i,j,t}$ as the random error for the total operating cost associated with firm i in market j at time t.

We utilize the hierarchical multilevel modeling technique (Goldstein 1987) to estimate the retention cost per customer and acquisition cost per customer ($RCp_{i,j}$ and $ACp_{i,j}$) empirically using 33 quarterly data points of each firm from the 2nd quarter of 1999 to the third quarter of 2007. In order to test the hypotheses regarding the changes of these costs affected by market dynamics, we specify the parameters of RCp and ACp as follows:

$$RCp_{i,j} = \mathbf{Z\beta_1} + \mu_{1i} \text{ or}$$

$$\begin{aligned} RCp_{i,j} = {} & \beta_{10} + \beta_{11} \textit{Market leader}_{i,j,t} + \beta_{12} \textit{Number of competing firms}_{j,t} \\ & + \beta_{13} \textit{Market penetration}_{j,t} + \beta_{14} \textit{Market leader}_{i,j,t} * \textit{Number of competing firms}_{j,t} \\ & + \beta_{15} \textit{Market leader}_{i,j,t} * \textit{Market penetration}_{j,t} \\ & + \beta_{16} \textit{GNI per capita}_{j,t} + \beta_{17} \textit{Population density}_{j,t} + u_{1i} \end{aligned} \quad (10)$$

Also, $$ACp_{i,j} = \mathbf{Z\beta_2} + \mu_{2i} \text{ or}$$

$$\begin{aligned} ACp_{i,j} = {} & \beta_{20} + \beta_{21} \textit{Market leader}_{i,j,t} + \beta_{22} \textit{Number of competing firms}_{j,t} \\ & + \beta_{23} \textit{Market penetration}_{j,t} + \beta_{24} \textit{Market leader}_{i,j,t} * \textit{Number of competing firms}_{j,t} \\ & + \beta_{25} \textit{Market leader}_{i,j,t} * \textit{Market penetration}_{j,t} \\ & + \beta_{26} \textit{GNI per capita}_{j,t} + \beta_{27} \textit{Population density}_{j,t} + u_{2i} \end{aligned} \quad (11)$$

We include a market-share position dummy variable, *Market leader* $_{i,j,t}$ to identify the differences in RCp and ACp between the market-share leader and other incumbent firms to test hypothesis 1. The *Market leader* variable is a time-varying dummy variable, which indicates that the firm *i* is the market-share leader during the quarter *t* in the country *j*. Negative estimates of β_{11} and β_{21} indicate that the market share leader has smaller retention and acquisition costs per customer than the other follower firms (i.e., the market share leader has cost advantages).

The *Number of competing firms* $_{j,t}$ measures the number of competing firms in country *j* at time *t.* There are only a few additional market entries over the observation period in all wireless communication markets. The positive coefficient estimates for the *Number of competing firms* (i.e., β_{12} and β_{22}) will support Hypotheses 2a and 2b, indicating that the greater the number of competitors in a market, the higher the retention and acquisition costs. We include a market penetration variable to test how retention costs and acquisition costs change as the market penetration levels increase. *Market penetration* $_{j,t}$ is defined as the ratio of wireless communications adopters to the population of the market at time *t.* As stated in Hypothesis 3, we expect both retention and acquisition costs to decrease with increasing market penetration. The interaction terms *Market leader, Number of competing firms,* and *Market penetration* are

included to test Hypotheses 4 and 5. Two error terms, $u_{1\,i}$ and $u_{2\,i}$ are included to capture the unobserved random errors in RCp and ACp for firms (i.e., between-firms variance).

Two variables are added to control for national differences. First, we include a *GNI per capita in PPP* (purchasing power parity) term to measure the national income per capita. A high national income level also implies that the overall expenses of business operations are getting more costly as labor costs tend to be higher in higher income environments. As the per capita income level increases, firms should spend more to attract new customers and retain subscribers. Second, we include the *Population density* of each country to control for higher efficiency or cost reduction stemming from high population density markets. Thus, we expect that the greater the population density, the lower the retention and acquisition costs. We take the natural logarithm on all numerical variables to capture the diminishing impacts of each of the variables on ACp and RCp. Table 4 reports the variable definitions, the values of the means and standard deviations of each variable, and the correlation coefficients between the variables.

[Table 4 about here]

We mean-centered all continuous variables in equations (10) and (11) for easier interpretations of the results. Thus, the parameter estimate β_{10} represents the retention cost of the follower firm at the average penetration with the average number of competing firms, the average GNI per capita, and the average population density. Similarly, β_{20} is the acquisition cost of the follower firm at the average penetration with the average values of the other market variables.

When we substitute Equations (10) and (11) into Equation (9), we obtain a fully specified model. Thus, the full model is specified as follows:

$$Cost_{i,j,t} = \mathbf{Z\beta_1}\ Number\ of\ base\ customers_{\,i,j,t} + \mathbf{Z\beta_2}\ Number\ of\ acquired\ customers_{\,i,j,t} + \delta_1 + \delta_2 * Market\ leader_{i,j,t} + u_{1\,i} + u_{2\,i} + r_{i,j,t} \quad (12)$$

The parameter, δ, is introduced to capture other expenses, such as administrative expenses, which do not change with the number of base customers or the number of new customers. Because the market leader has a greater market share, we expect that the market leader may have higher administrative expenses. So we control for it with the δ_2**market leader* term. We assume that $r_{i,j,t}$, the random error within each firm, is independent of the random errors between firms and is distributed normally, with mean 0 and standard deviation σ [$r_{i,j,t} \sim N(0, \sigma^2)$]. The two between-firms error terms $u_{1\,i}$ and $u_{2\,i}$ are also assumed to be normally distributed, with means 0 and standard deviations $\sqrt{\tau_{11}}$ and $\sqrt{\tau_{22}}$, respectively.[13] For the time periods of 1999 and 2004, the numbers of customers acquired are not reported. For these years, churn rates are utilized to estimate the number of customers acquired. The churn rate measures the number of subscribers that are disconnected from a network in a given month, and is expressed as a percentage of a company's average subscriber base for the period. Noting the relationship between the number of base customers and the number of new customers in a time series setting, we have *Number of base customers* $_{i,j,t}$ = *Number of base customers* $_{i,j,\,t-1}$ + *Number of acquired customers* $_{i,j,t-1}$ − *Number of customers lost* $_{i,j,t-1}$ and the number of customers lost is estimated by the quarterly churn rate (i.e., three times of monthly churn rate) multiplied by the number of base customers. Because the *Number of base customers* and the *Number of acquired customers* are highly correlated, we divide each side of the equation by the *Number of base customers* to reduce collinearity. We use the full-information maximum likelihood method (FIML) (Singer 1998) to estimate the parameters in equation (12).

Empirical Results and Discussion on Hypothesis-Testing Outcomes

[13] In addition, we assume a covariance component, a function of the correlation between two random effects, such that $\begin{pmatrix} u_1 \\ u_2 \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \tau_{11}\ \tau_{12} \\ \tau_{21}\ \tau_{22} \end{pmatrix}\right]$. A positive estimate of the covariance of τ_{12} would indicate that the random error of the retention cost component is positively related to the random error of the acquisition cost component.

Model parameter estimates are reported in Table 5. The random components of retention cost and acquisition cost are estimated with a two-level, hierarchical estimation of the parameters. That is, the time series data of each firm were assumed to be nested in the country level data when parameters were estimated.

[Insert Table 5 here]

The dependent variable in the hierarchical multilevel analyses of Table 5 is the 'quarterly' total operating cost. The total operating cost is analyzed against retention cost, acquisition cost, and other expenses as it is regressed on the number of base customers and the number of acquired customers. The parameter estimate for the *Number of base customers* represents the retention cost per customer (RCp), and the parameter estimate for the *Number of acquired customers* represents the acquisition cost per customer (ACp). The estimates for δ_1 and δ_2 indicate the other operating expenses that do not change with either the *Number of base customers* or the *Number of acquired customers.* The results in Column I show the estimates of the average retention cost per customer and the average acquisition cost per customer in wireless communications industries from 41 countries between 1999 and 2007. The estimate of the average acquisition cost per customer ($159.64) is roughly three-times greater than that of the average retention cost per customer for a quarter ($53.23). This is consistent with conventional wisdom that it is easier to keep customers than to attract switchers. The amounts of the other operating expenses (estimates of δ_1 and δ_2) are not substantially large compared to the size of the total operating cost. It is on average $10.53 million for market leaders (809.58+9719), which is 1.6% of the total operating cost ($10.53 million/$662.11 million).

The country level variables are included in the model specification, and the results are presented in Column II. The model fit improves substantially. The likelihood ratio test result

(χ^2=624, df=8, p < .01) indicates that the national level variables explain the variation in the dependent variable significantly. Indeed, the unexplained retention cost variance (τ_{11}) drops by 43% and the unexplained acquisition cost variance (τ_{22}) drops by 34% after including country level variables. After the *Market leader* dummy variables are added to the retention and acquisition costs, the model fit improves further. See the estimation results of Column III in Table 5. The log likelihood ratio (χ^2=27.8, df=2, p < .01) indicates that the *Market leader* variables help to explain the variances in the dependent variable significantly. As hypothesized, *Market leaders* have significantly lower acquisition costs (b = -31.46*, p < .10), but their retention costs are not significantly different from follower firms (b = -2.25, n. s.), supporting both Hypothesis 1(a), the null impact of the retention cost for the leader firm, and Hypothesis 1(b), the acquisition cost advantage for the leader firm. Accordingly, the unexplained variance for the acquisition cost (τ_{22}) drops substantially (from 15990 to 15027), but does not change much for the retention cost (τ_{11} from 725.9 to 707.5).

We also test Hypotheses 2 and 3 with the results reported in column III. The impact of the *Number of competing firms* on the retention cost per customer (i.e., the interaction term of the *Number of base customers* and *the Number of competing firms*) is not significant (b=8.47, n. s.). However, increase in competitive intensity increases acquisition costs as the interaction term of the *Number of acquired customers* and *the Number of competing firms* is positive and significant (b=115.79***, p < .01). Increasing competition increases the firm's cost for acquiring customers, but not for retaining customers. These results support Hypothesis 2(b), but do not support Hypothesis 2(a).

The results above suggest that when a firm offers a higher incentive to acquire customers to enhance their market position, other firms may match these incentives thereby increasing

industry-wide customer acquisition costs. Such acquisition activity, and ultimately acquisition costs per customer will go up as the number of competing firms increases. However, the impact of increasing competition on the retention cost is a different story. While new customers can observe changes in acquisition costs easily (they are sensitive to the level of new incentives when signing contracts), other competing firms and their customers can't easily observe increases in the focal firm's retention costs. Therefore, the impact of competition on the retention cost can be much smaller than the impact on the acquisition cost. This is consistent with the perspective from service sectors that suggest that loss of customers to competitors is often linked to indifferent service by the incumbent rather than superior service offerings from competitors. This empirical finding is demonstrated in Figure 1, where the quarterly retention cost per customer does not significantly change, but the acquisition cost per customer doubles as the number of competitors increases from two to four.

[Insert Figure 1 here]

The negative and significant estimates of *market penetration* impacts on both the retention cost (b= -16.61***, $p < .01$) and acquisition cost (b= -28.18***, $p < .01$) indicate that as a wireless market penetration increases, both retention and acquisition costs decrease, supporting Hypotheses 3(a) and 3(b). This result is graphically presented in Figure 2. Both costs of retaining and acquiring a customer are the highest during the early stage of wireless communications markets -- as high as $193 for acquiring a customer and $83 for retaining a customer for three months when market penetration is ten percent. Both costs drop as the market is penetrated and reaches the minimum levels, $128 for acquisition and $45 for retention when the market is fully penetrated.

[Insert Figure 2 here]

We test Hypotheses 4 and 5 based on the results in column IV in Table 5, which includes the parameter estimation results for the three-way interaction impacts of the *Number of acquired customers* with the *Market leader * ln Number of competing firms* and *with Market leader * ln Market penetration* on the acquisition cost. The log likelihood ratio (χ^2=13.4, df=4, $p < .01$) is significant as the model fit improves. Neither of the three-way interaction effects of the *Market leader* and the *Number of competing firms* are significant (b=7.22, n.s.). Thus, Hypothesis 4 is not supported.

Both interactive effects of the *Market leader* and *Market penetration* are significant in column IV in Table 5. The interaction effect of *Market leader* and *Market penetration* on retention cost is positive and significant (b = 4.25**, $p < .05$). Hypothesis 5a is supported - market leader's retention cost advantage (if there is any) diminishes as the market matures. In other words, the comparative retention cost of market leader over its follower firms is at the lowest in the introduction stage and increases as market is penetrated. Figure 3 depicts that market leader's cost retaining a customer is lower than its followers when market penetration is low. Based on the parameters estimated, the retention cost per customer (a quarterly retention cost) for market leader is $78.21 when market penetration is 10% whereas that for followers is $85.61. But, the gap narrows down with market penetration and market share leader's comparative retention cost becomes higher when the penetration rate reaches 60% or greater in the wireless telecommunications industry. Market share leaders' quarterly retention cost is predicted as $45.29 and followers' one as $42.89 when market penetration reaches 100%.

[Insert Figure 3 here]

The interactive effect of the *Market leader* and *Market penetration* on the acquisition cost is significant (b = -38.34***, $p < .01$). This indicates that the market leader's acquisition cost is the

greatest when market penetration is the lowest but decreases significantly as the market is further penetrated. This result supports Hypothesis 5b. It should be noted that the coefficient for the *Number of acquired customers * ln Market penetration,* i.e., the impact of penetration on the acquisition cost of follower firms, is not significant (b = -12.27, n.s.). That means followers' acquisition costs do not drop significantly as the market is penetrated. Based on the parameter estimates, the acquisition cost of market share leader is $198.62 when penetration is 10% but it decreases substantially to $82.08 when the market penetration reaches 100%, whereas that of followers drops far less, from $184.87 to $156.53. Figure 4 elucidates the widening cost advantage of the market leader for acquiring a customer as market penetration progresses in the wireless telecommunications industry. This observation is important and demonstrates that in markets with significant switching costs, it is better to acquire customers early in the life-cycle and therefore justifies "investment" in early market development and branding.

[Insert Figure 4 here]

Of the two control variables, *GNI per capita* strongly influences both retention and acquisition costs per customer positively. The impact of *GNI per capita* on the retention cost is 34.20 (t=10.69***, $p < .01$), and its impact on the acquisition cost is 86.15 (t=4.76***, $p < .01$), showing that the magnitude of the impact of the income per capita is 2.5 times greater for the acquisition cost than for the retention cost. The impact of *GNI per capita* is more elastic for the acquisition cost than for the retention cost. This result implies that as the income level increases within and across markets, firms are required to spend substantially more money to acquire a customer. This is to be expected as the lifetime value of customers in high income environment is greater and hence competitors will make greater efforts in both acquisition and retention activities.

The coefficients of the *Population density* for both the retention cost and acquisition cost are not statistically significant. Increasing the *Population density* does not reduce either the retention cost (b = -1.06, n. s.) or the acquisition cost (b = -6.47, n. s.). This can be speculated because given improvements in technology and the ability of cellular towers to cover larger areas, population density is a less important determinant of costs. Even if there are economies of service delivery linked to population density, the increasing cost of land prices and space rentals in high density areas may offset the cost savings from economies of scale.

In order to validate the model assumption of independence between the retention cost per customer and the acquisition cost per customer, we estimated these costs for each firm using its 8 years quarterly data (from 1999 to 2007). It has been shown that customer acquisition and retention are not two independent processes (Livne et al. 2011; Schweidel et al. 2008; Thomas 2001), and thus, the allocation of total investments for retention and acquisition may not be a decision for two independent resources. The averages of quarterly retention and acquisition costs per customer from 101 firms are 53.63 (s.d. = 37.32) and 176.71 (s.d. =183.70), respectively.[14] The correlation between retention and acquisition costs is not significant (.05, n.s). We tested a linear relationship between of ACp = a + b* RCp, but the regression coefficient for RCp was not significant (249.05, n.s.). In sum, from the results from this analysis of acquisition costs and retention costs per customer, we couldn't find a significant linear relationship between two. The regression estimation result is reported in Table 6.

[Insert Table 6 here]

To check the veracity of the Merrill Lynch data, we estimated the retention cost and acquisition cost of a dominant player in the US market, AT&T Wireless business, with additional

[14] Because the available data points are small for some firms, we report 101 pairs of RCp and ACp out of 142 firms. The δs are omitted, as its portion is less than 2 % of the total operating cost.

data from 2009 2nd quarter to 2015 1st quarter. Their RC and AC estimation results and the related information are provided in Table 7. The RC and AC estimates in Table 7 are the average values for the estimation period. Therefore, it should be noted that there might be an upward bias if the estimates are interpreted as ones *in the present time*. In particular, because RCp is the estimate from past accounting and CRM data, if we take into account an increasing cohort-level retention rate over time (Fader and Hardie 2010) the contemporaneous RCp could be lower than the estimated RCp from the aggregated past data.

[Insert Table 7 here]

Our empirical investigation of retention and acquisition costs of firms in the wireless telecommunications industry from forty-one countries provides supporting evidence for all hypotheses except for three: overall, market-share leaders do not have a retention cost advantage, but they do have a significant acquisition cost advantage (Hypotheses 1a and 1b), increasing competition augments acquisition cost significantly (Hypothesis 2b), increasing market penetration decreases retention and acquisition costs (Hypotheses 3a and 3b), and the market-share leader's retention cost advantages decreases but its acquisition cost advantage over follower firms increases as market penetration grows (Hypotheses 5a and 5b). Three unsupported hypotheses are: increasing competition does not affect the retention cost (Hypothesis 2a), and it does not decrease the market-share leader's retention and acquisition cost advantage over followers (Hypotheses 4a and 4b).

DISCUSSION

Findings and Implications

Our analytical model results provide new insights into the optimal level of investments for firms' customer retention and acquisition in the context of a dynamic market environment where

changing competition and rapid market growth are common phenomena. The analytical model results aid to build hypotheses regarding the retention cost and acquisition cost in the wireless telecommunications industry. We estimate the quarterly retention and acquisition costs per customer from time series data of the total operations cost by regressing the total operations cost with the number of base customers and the number of acquired customers. And, we estimate the impacts of market-share leadership, competition, and market penetration within the empirical model.

Overall, the empirical results are consistent with the analytical model results. While firms may behave sub-optimally in reality for various reasons that are not incorporated in our model (e.g., Ovchinnikov et al. 2014), our data suggest that firms' behaviors in the wireless telecommunications industry appear to be consistent with the Nash equilibrium predictions. This indicates firms' CRM investments in general are not much of a departure from optimization as assumed in the analytical model. Firms in the wireless telecommunications industry are fiercely competitive and their behavior appears to be consistent with profit-maximizing marketing investment decisions in terms of managing customer retention and acquisition.

The detailed results of empirical investigation add rich insights. A firm's acquisition cost is more sensitive to market share position and competition than its retention cost. That is, retention costs are less dependent on the competitive environment whereas acquisition costs are substantially different depending on market position (i.e., market share leader versus follower) and stage of the product life-cycle. Secondly, increasing competition drives up acquisition cost but not retention cost much. As plotted in Figure 1, customer retention costs are relatively stable across different levels of competitive intensity. But, with an increase in the number of competitors, acquisition costs increase significantly to the levels exceeding four times of

quarterly retention costs in the wireless telecommunications industry. As the number of competing firms in a market increases, competition intensifies with an increasing number of marketing initiatives to acquire new customers. This often results in contagious reactions to the competing firms' marketing initiatives, such as reactive matching promotions and aggressive advertising campaigns.

The greater sensitivity of acquisition cost to market share position and competition can be attributed to the difference in 'observability' of CRM efforts in customer acquisition and customer retention. Most customer acquisition efforts of a firm are more observable to its rival firms, but the firm's efforts for customer retention are more opaque to its rivals, thus, do not bring in rivalry reactions as much as customer acquisition efforts do. Additionally, while there are deal-prone switchers, many customers tend not to change vendors unless there is a service failure (Berry and Parsuraman, 2004). A managerial implication of the greater sensitivity of acquisition cost is that managers in service industry should anticipate the acquisition cost could change dramatically as competition increases and market position changes. The effectiveness of the same amount of investment on customer acquisition might be less than expected as competition increases and share position weakens. In this sense, aggressive players may bleed to death, especially as margins are also likely to be lower in such markets. More importantly, because customer switching costs are non-trivial, it pays to acquire customers early in the life-cycle giving early-moving market leaders a significant cumulative cost advantage (i.e., they pay lower retention costs, while late entrants have to make heavier marketing investments through acquisition activities. Further since loyalists are less available, acquiring switchers may be ultimately more expensive over time.

The empirical results about the impacts of market penetration on costs of customer acquisition and retention show much various and striking patterns. As charted in Figure 2, for both market-share leader firms and follower firms, the investment burdens for customer acquisition and retention are becoming lighter as the product market evolves. Firms, of course, will see the benefit of delaying customer acquisition and retention investment as the costs drop with increasing levels of market penetration. However, the marginal profit from additional spending on CRM also diminishes as the product market approaches maturity or saturation (c.f. Hanssens et al. 2008), which indicates prices typically drop faster than costs do. This also reinforces the perspective that market investment decisions should be made more for the earlier stages of new product markets so that firms spend their limited resources in a more effective way.

Comparing ACp and RCp between market share leaders and the other firms, this study notes that *on average* the required level of investments to retain a customer is not very different between market-share leaders and the other firms. However, as plotted in Figure 3, market share leader has retention cost advantage in the early stage but that advantage turns to a disadvantage at the later stages. In contrast, *on average* market share leaders have an acquisition cost advantage over their followers. Although market share leaders might have a disadvantage in acquiring a customer in the early stage of market development, their customer acquisition cost disadvantage quickly disappears as market penetration increases (see Figure 4). The market share leader's acquisition cost advantage is greatest when the market is saturated, making it hard for smaller share players to gain their share at the expense of dominant players.

Based on the above observations (linking Figures 1 to 4), our study results recommend that market followers spend more for acquiring new customers in the earlier periods than in the

mature or later periods of the product market. Before market-share leaders establish their stable customer equity created by previous/current brand reputations and loyal customer groups, market followers need to attract a good number of new customers as fast as they can in the new product market. After securing a comparable size of customers early, market followers could maintain their relative market positions as long as they spend a similar amount of RCp and ACp to the costs of market-share leaders. However, if market followers cannot obtain a comparable customer base, they may face more difficulty in acquiring new customers as the product market evolves unless they can spend much more than the share leaders do. In terms of resource allocation, the market followers' customer acquisition investment concentrated in the earlier product market also provides an effective use of endowed resources because the industry competition is often more limited in the beginning of the new product market when there are typically fewer entrants and when there is more limited spending due to market uncertainties. Therefore, the need for service differentiation to acquire new customers is relatively smaller.

However, this result does not suggest that market leaders should spend less in the early stage of market penetration. Rather, the market leader should spend enough for customer acquisition to enhance or at least maintain market-share leadership. In fact, market share leadership is obtained by early market entry or aggressive customer acquisition in the early stages of market development. This pioneering endeavor is costly because market pioneer should incur a heavy investment for early market development and acquiring customers in the early stage of market is costly due to such factors as educating customers. Pioneering endeavors are also more risky as there is more uncertainty about market size and future market share and profitability. However, pioneering investments help market leaders to enjoy an acquisition cost advantage in the later stage of the product-market life cycle.

Limitations and Future Research Directions

Our research has limitations. First, while this study focuses on the effects of market leadership, penetration and competition, there are other factors that may also affect firms' acquisition and retention costs. Firms' retention rates may vary over the course of a customer relationship (Fader and Hardie 2010), as for customers' churn exhibits time-varying propensities (e.g., Braun and Schweidel 2011). Incorporation of these factors could contribute to a more complete understanding, but it may lead to a more complex and less tractable model.

The second limitation is our assumption of independence between retention and acquisition investments. While a balanced spending scheme for customer retention and acquisition adds to our understanding of this issue (Ovchinnikov et al. 2014), the inter-relationship between the two investments may be further analyzed under more dynamic market conditions. While we found an insignificant linear relationship between ACp and RCp (reported in Table 6), we note the possibility of a nonlinear relationship. Related to this issue, our model does not analyze the link between retention and acquisition cost advantages and profitability, which is interesting to examine with more diverse content of data that include financial information.

The third limitation results from the nature of our data. Different from our analytical model, our empirical model could not differentiate between acquired customers from competing firms and those who newly entered the market because of a lack of information on the sizes of the two customer groups. Future study could provide additional insights if such information is available. Our aggregate-level data also impeded us from a deep examination of customer heterogeneity and its implications. Customer heterogeneity has been found in customer tenure length and churn rate (Fader and Hardie 2010), the level of customer satisfaction (Grewal,

Chandrashekaran, and Citrin 2010), and customer's perceived strength of the relationship with the service provider (Verhoef 2003). Prior literature suggests that identifying and managing heterogeneous customer proneness to churn is important to improve the effectiveness of firms' customer retention efforts (Braun and Schweidel 2011), and that firms that neglect customer heterogeneity are likely to underestimate the impact of retention rates on customer life-time value and thereby misallocate the required resources for customer retention (Fader and Hardie 2010). For instance, if heterogeneity in durations of customer relationship were controlled for in our empirical model specification, the impact of market penetration on retention cost would have been less than the estimate in this paper. This is because the impact of the duration dependency would be sorted out from the total impact of market penetration.

Finally, we call for application of our model to other industry contexts. When doing so, note that some of our model assumptions may need relaxation. For instance, we assume that there is insignificant price differentiation among competitors. But significant price and product differentiation exists in many industries. We also assume that firms' customer acquisition and retention efforts incur lump-sum costs. Although these costs turn out to be dependent on the numbers of target customers in our model, a variable cost model may be more appropriate in some situations. We hope that future studies can use multi-industry data to corroborate our analytical model and to help adjust or customize the empirical model specifications to incorporate more industry characteristics.

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Figure 1
The Impact of Increasing Competition on Retention and Acquisition Costs

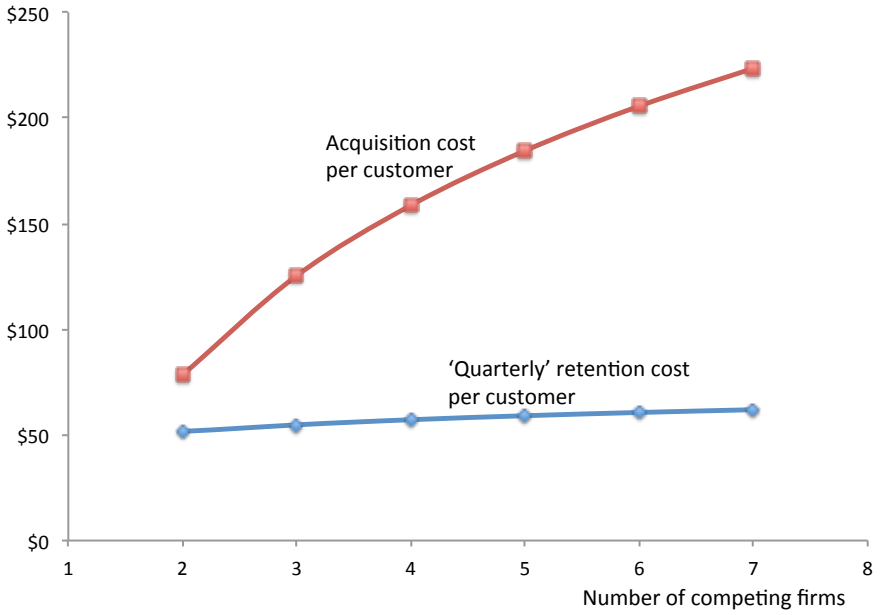

Figure 2
The Impact of Market Penetration on Retention and Acquisition Costs

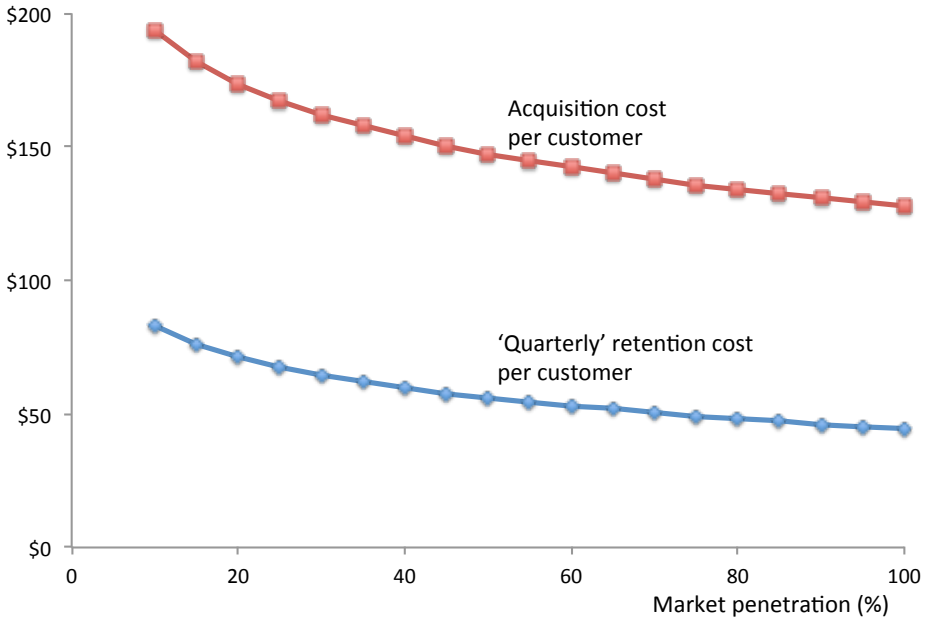

Figure 3
The Retention Cost Dis/Advantage of Market-Share Leader Firm over Follower Firms

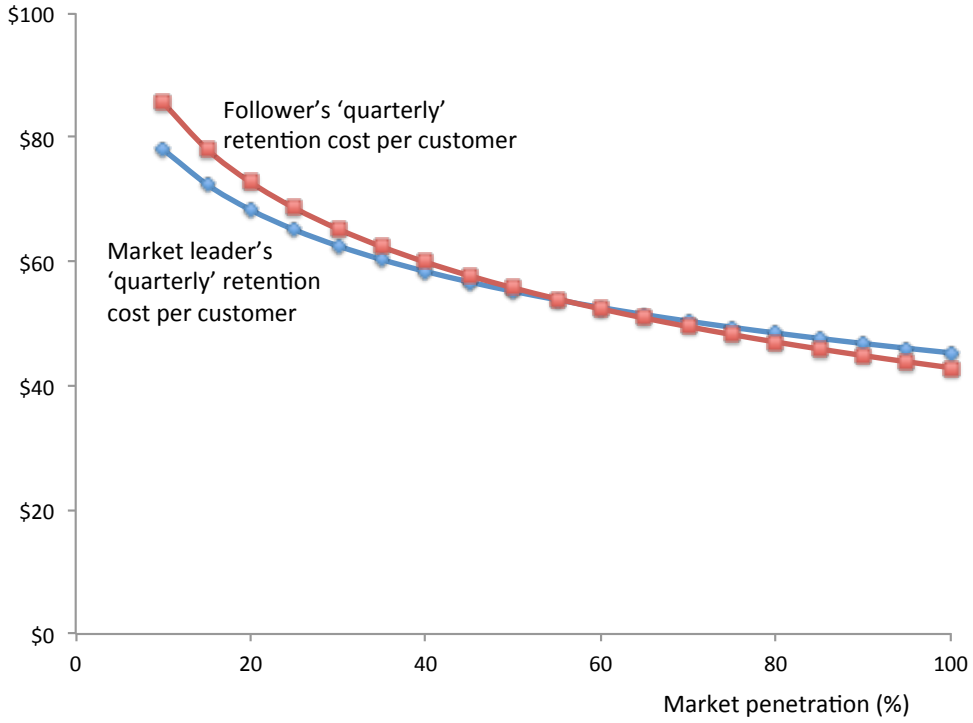

Figure 4
The Acquisition Cost Advantage of Market-Share Leader Firm over Follower Firms

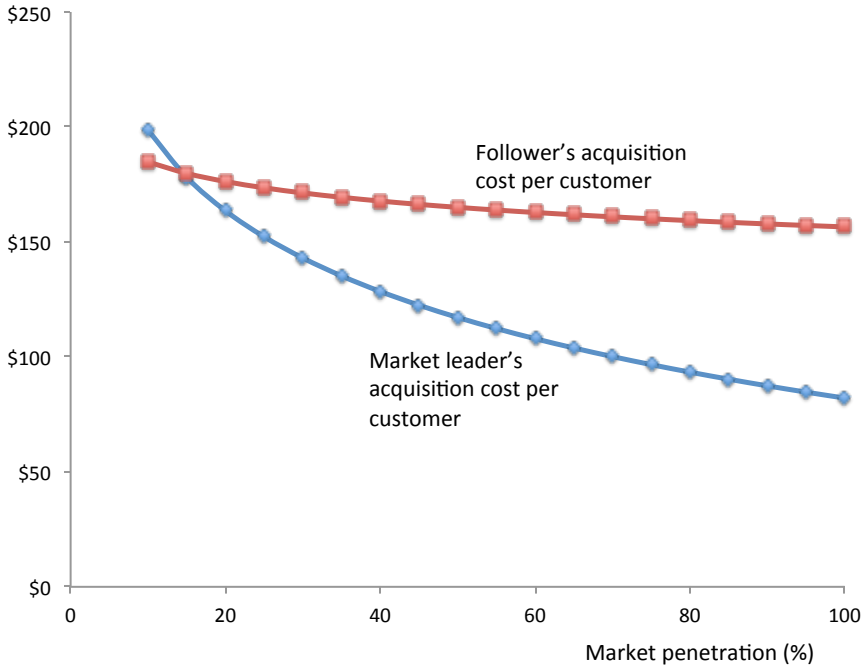

Table 1
Customer Type, Choice and Utility

Customer Type	Customer Choice	Utility of the Customer Choice
Non-loyal customers of the leader firm	Stay with the leader	$u_{1,1}=ln(v_1-p_1+\eta r_1)+\varepsilon_{1,1}$
	Switch to the follower	$u_{1,2}=ln(v_2-p_2+\eta a_2-s)+\varepsilon_{1,2}$
Non-loyal customers of the follower firm	Stay with the follower	$u_{2,2}=ln(v_2-p_2+\eta r_2)+\varepsilon_{2,2}$
	Switch to the leader	$u_{2,1}=ln(v_1-p_1+\eta a_1-s)+\varepsilon_{2,1}$
Picky customers who are entering the market	Choose the leader	$u_{0,1}=ln(v_1-p_1+\eta b_1)+\varepsilon_{0,1}$
	Choose the follower	$u_{0,2}=ln(v_2-p_2+\eta b_2)+\varepsilon_{0,2}$

Table 2
Customer Management Costs in Equilibrium

	Total Cost		Cost Per Customer	
	Leader	**Follower**	**Leader**	**Follower**
Retention	$\frac{p(1-\rho)\lambda_1}{4}-\frac{v_1-p}{\eta}$	$\frac{p(1-\rho)\lambda_2}{4}-\frac{v_2-p}{\eta}$	$\frac{(1-\rho)p}{2(1+\rho)}-\frac{2(v_1-p)}{(1+\rho)\eta\lambda_1}$	$\frac{(1-\rho)p}{2(1+\rho)}-\frac{2(v_2-p)}{(1+\rho)\eta\lambda_2}$
Acquisition	$\frac{p((1-\rho)\lambda_2+(1-\varphi)\theta)}{4}-\frac{2v_1-2p-s}{\eta}$	$\frac{p((1-\rho)\lambda_1+(1-\varphi)\theta)}{4}-\frac{2v_2-2p-s}{\eta}$	$\frac{p}{2}-\frac{8v_1-8p+p\varphi\theta\eta-4s}{2\eta(\lambda_2-\rho\lambda_2+\theta)}$	$\frac{p}{2}-\frac{8v_2-8p+p\varphi\theta\eta-4s}{2\eta(\lambda_1-\rho\lambda_1+\theta)}$
- from rival	$\frac{p(1-\rho)\lambda_2}{4}-\frac{v_1-p-s}{\eta}$	$\frac{p(1-\rho)\lambda_1}{4}-\frac{v_2-p-s}{\eta}$	$\frac{p}{2}-\frac{2(v_1-p-s)}{(1-\rho)\eta\lambda_2}$	$\frac{p}{2}-\frac{2(v_2-p-s)}{(1-\rho)\eta\lambda_1}$
- from new	$\frac{p(1-\varphi)\theta}{4}-\frac{v_1-p}{\eta}$	$\frac{p(1-\varphi)\theta}{4}-\frac{v_2-p}{\eta}$	$\frac{p(1-\varphi)}{2}-\frac{2(v_1-p)}{\eta\theta}$	$\frac{p(1-\varphi)}{2}-\frac{2(v_2-p)}{\eta\theta}$

Table 3
Wireless Communications Adoption Rates Across Countries

Country	1st quarter 1999	1st quarter 2004	3rd quarter 2007
Argentina	9%	22%	92%
Australia	31%	78%	101%
Austria	33%	91%	119%
Belgium	22%	81%	97%
Brazil	5%	28%	60%
Canada	18%	43%	59%
Chile	8%	49%	85%
China	2%	22%	40%
Colombia	4%	16%	72%
Czech Republic	11%	97%	122%
Denmark	32%	90%	120%
Egypt	1%	9%	36%
Finland	58%	92%	119%
France	21%	67%	80%
Germany	19%	80%	113%
Greece	23%	95%	142%
Hong Kong	49%	97%	129%
India	0%	3%	18%
Indonesia	1%	10%	40%
Israel	37%	102%	125%
Italy	39%	101%	148%
Japan	37%	68%	81%
S. Korea	37%	73%	88%
Malaysia	10%	46%	81%
Mexico	4%	31%	61%
Netherlands	25%	86%	108%
New Zealand	21%	72%	100%
Norway	51%	92%	110%
Peru	n.a.	11%	43%
Philippines	2%	29%	57%
Poland	6%	49%	105%
Portugal	33%	98%	131%
Russia	1%	29%	114%
Singapore	28%	85%	118%
South Africa	6%	35%	80%
Spain	22%	89%	109%
Switzerland	25%	84%	108%
Taiwan	n.a.	107%	104%
Thailand	3%	37%	78%
UK	25%	94%	119%
US	26%	56%	82%
Average	20%	62%	93%

Table 4

Variables and Descriptive Statistics (n=3522)

Variable	Description	Mean (std.)	1	2	3	4	5	6	7
1. Cost $_{i, t}$	Total quarterly operating cost of firm i in thousand US Dollar divided at time t. The revenue less EBITDA measures total operating cost.	662,114 (1,039,340)							
2. Ln GNI per capita $_{t}$	The natural logarithm of the value of a nation's GNI per capita in purchasing power parity term at time t.	9.71 (.81)	.27*						
3. Ln population density $_{t}$	The natural logarithm of the value of the population density in a square mile of a nation at time t.	5.35 (1.64)	.08*	.10*					
4. Ln Number of competing firms $_{t}$	The natural logarithm of the number of competitors in nation at time t. The number of competitors includes the focal firm.	1.39 (.32)	.36*	.06*	.08*				
5. Ln Market penetration $_{t}$	The natural logarithm of the value of the wireless communication adoption ratio times 100 of nation at time t. The adoption ration is the number of total adopters of wireless communication divided by the population of the nation.	3.87 (.82)	.18*	.76*	.20*	-.03			
6. Market leader $_{t}$	Dummy variable indicating market-share leader in nation at time t. 1 if firm is market share leader in the nation; 0 for the other firms.	.37 (.48)	.11*	-.07*	.02	-.12*	-.03		
7. Number of base customers $_{i, t}$	The number of base customers in thousand at time t by firm i.	10.07 (21.34)	.55*	-.13*	.05*	.06*	.02	.17*	
8. Number of acquired customers $_{i, t}$	The number of acquired customers in thousand added at time t by firm i.	1.12 (2.64)	.37*	-.26*	.03	.05*	-.08*	.14*	.91*

Ln GNI per capita, Ln Population density, Ln Number of competing firms, and Ln Market penetration are mean-centered after taking natural logarithm. * $p < .01$.

Table 5
Empirical Results for the RC and AC per Customers of Wireless Telecommunications Firms (n = 3522)

Variables	I	II	III	IV
Existing Customer (=RC)				
Number of base customers	53.23***	56.84***	57.21***	56.53***
	(16.34)	(18.53)	(18.54)	(18.05)
*Number of base customers * ln GNI per capita*		34.17***	34.32***	34.20***
		(10.61)	(10.75)	(10.69)
*Number of base customers * ln population density*		-1.14	-1.14	-1.06
		(-.76)	(-.77)	(-.72)
*Number of base customers * ln number of competing firms*		8.99	8.47	9.50
		(1.13)	(1.07)	(1.16)
*Number of base customers * ln market penetration*		-16.72***	-16.61***	-18.55***
		(-10.38)	(-10.34)	(-9.78)
*Number of base customers * market leader*			-2.25	-.73
			(-1.08)	(-.26)
*Number of base customers * market leader * ln market penetration*				4.25**
				(2.04)
*Number of base customers * market leader * ln number of competing firms*				-2.56
				(-.41)
New Customer (=AC)				
Number of acquired customers	159.64***	148.74***	159.08***	165.55***
	(10.23)	(9.15)	(9.60)	(9.79)
*Number of acquired customers * ln GNI per capita*		84.33***	82.90***	86.15***
		(4.52)	(4.53)	(4.76)
*Number of acquired customers * ln number of competing firms*		118.19***	115.79***	103.87**
		(2.88)	(2.88)	(2.37)
*Number of acquired customers * ln population density*		-6.18	-5.97	-6.47
		(-.76)	(-.76)	(-.83)
*Number of acquired customers * ln market penetration*		-29.56***	-28.18***	-12.27
		(-3.52)	(-3.37)	(-1.24)
*Number of acquired customers * market leader*			-31.46*	-46.26*
			(-1.87)	(-1.92)
*Number of acquired customers * market leader * ln market penetration*				-38.34***
				(-3.28)
*Number of acquired customers * market leader * ln number of competing firms*				28.04
				(.48)
δ_1	809.58***	52.07	19.06	106.89
	(3.69)	(.25)	(.09)	(.51)
δ_2 ** market leader*	9719***	3142***	5820***	4985***
	(8.46)	(2.83)	(4.75)	(3.70)
Log Likelihood	-14306.9	-13994.8	-13980.9	-13974.2
Unexplained RC variance(τ_{11})	1266.38***	725.9***	707.5***	708.3***
Unexplained covariance (τ_{12})	734.07	-433.6	-414.9	-392.6
Unexplained AC variance (τ_{22})	24137***	15990***	15027***	14324***
Unexplained within-firm variance (σ^2)	186.6***	162.73***	161.8***	161.3***

Notes: The t-statistics in the parentheses are significant at the 10%*, 5%**, and 1%*** levels.

Table 6
Empirical Relationship between RC and AC per Customers of Wireless Telecommunications Firms (N=101)

Variables	Coefficient (t-stat.)
Constant	163.36***
	(5.07)
Retention cost per customer	249.05
	(.50)
R^2	.003

Dependent variable is Acquisition cost per customer.

Table 7
Empirical Estimation of RC and AC per Customers of AT&T for its Wireless Telecommunication Business +

Estimates	1999 2nd to 2004 3rd (n=22)	2009 3rd to 2015 1st (n= 23)
Retention cost per customer (RCp)	106.37*** (8.80)	82.90*** ++ (10.12)
Acquisition cost per customer (ACp)	358.45*** (3.30)	327.58** ++ (2.45)
R^2	.35	.22
Wireless penetration	26% to 59%	87% to 110% ++

(The t-statistics in the parentheses are significant at the 5%**, and 1%*** levels.)

+ After the sequence of mergers and acquisitions between 2004 and 2006, AT&T maintained a market share leadership in the industry till 2009 when Verizon Wireless acquired Alltel. Because of Verizon's recent acquisitions of AOL (2015) and Hughes Telematics Inc. (2012), we chose to analyze AT&T Wireless, whose business hasn't experienced mergers and acquisition lately.

++ The estimates of wireless telecommunication penetration are from CTIA, The Wireless Association's annual survey (http://www.ctia.org/your-wireless-life/how-wireless-works/annual-wireless-industry-survey)

The financial data and the number of base customers are manually collected from various quarterly reports of AT&T Inc. The total number of acquired customers of each quarter was calculated with its churn rates because AT&T does not report such numbers. We used the same empirical model specified in equation (8). We assume the other expenses are roughly 1.6% of the total cost, and divide both sides of the equation (8) with *Number of base customers* to alleviate collinearity problem. The second column in Table 7 reports the estimation results from the Merrill Lynch Global Wireless Matrix data, which are used for our hypothesis testing. The (quarterly) retention and acquisition costs per customer during 1999-2004 are estimated as $106.37 and $358.45, respectively. During 2009 3rd quarter to 2015 1st quarter, those costs are decreased to $82.90 and $327.58, respectively (See the third column of Table 7). AT&T's retention cost reduced by 22% and its acquisition cost per customer by 8.6% as market is penetrated from 26%-59% to 87%-110%.