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First Mover Advantages in the Mobile Telecommunications Industry: A Consumer-Centric Perspective

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Abstract

This study offers a consumer-centric view of entry order advantages and the role of firm-level capabilities. Specifically, we consider the fact that early adopting consumers will be different from late adopting ones. We suggest that early entering firms will attract higher-profitability customers, and that this will be a key source of first-mover advantages. Additionally, this effect will be stronger for firms with strong technological capabilities as early adopters are generally more technology-oriented than late adopters. Conversely, firms with existing marketing and branding resources in the country will do better at attracting a high volume of less-profitable customers ? standard late adopters that are swayed by brand effects. Our empirical results, drawn from data on the global mobile telecommunications industry, support our

assertions and help us offer important depth to the discussion about first-mover advantages and the contingent role of firm capabilities.

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ABSTRACT

This study offers a consumer-centric view of entry order advantages and the role of firm-level capabilities. Specifically, we consider the fact that early adopting consumers will be different from late adopting ones. We suggest that early entering firms will attract higher-profitability customers, and that this will be a key source of first-mover advantages. Additionally, this effect will be stronger for firms with strong technological capabilities as early adopters are generally more technology-oriented than late adopters. Conversely, firms with existing marketing and branding resources in the country will do better at attracting a high volume of less-profitable customers – standard late adopters that are swayed by brand effects. Our empirical results, drawn from data on the global mobile telecommunications industry, support our assertions and help us offer important depth to the discussion about first-mover advantages and the contingent role of firm capabilities.

Keywords: First-Mover Advantage; Mobile Telecommunications; Consumer-Centric; Pre-Entry Experience; Firm Capabilities

INTRODUCTION

Despite the attention dedicated to first mover advantage research in the fields of economics, marketing and strategy, the role of consumers in the effect of entry timing and industry evolution that has been conspicuously absent. Specifically, while some research discusses how switching costs limiting consumer mobility improve early entrant performance (Lieberman and Montgomery 1988; Makadok 1998; Robinson 1988), little attention has been paid to the heterogeneity among different consumer groups in an emerging industry. This is surprising as the heterogeneity of adopters plays a central role in a related, but largely parallel stream of research that also deals with the emergence of new products and markets, specifically work on the diffusion of innovation. There, consumer segmentation and the characteristics of different consumers depending on when they adopt an innovation play a central role in the research tradition (Mahajan, Muller and Srivastava 1990; Rogers 1962/1995). This literature suggests that consumers available to early entering firms will be systematically different from those reached by firms entering later, and yet the implications of this perspective for our understanding of first mover advantages have not been explored.

In this study we offer an integrated view of which types of firms should be able to create advantages in a new market based on important differences in consumer segments, and then investigate these arguments empirically. We build on recent research suggesting the contingent nature of first mover advantages (Suarez and Lanzolla 2007) based in part on the fit between the capabilities of the firm and the needs of the external environment (Franco, Sarkar, Agarwal and Echambadi 2009). This consumer-centric view of advantages created by entrants suggests that some firms will appeal most to highly-profitable early adopters while others will be successful in attracting more, but not necessarily the most profitable adopters, and the granularity of our data allows us to demonstrate this relationship. These findings

contribute to research on capability development and pre-entry experience (Bayus and Agarwal 2007; Helfat and Lieberman 2002; Klepper and Simons 2000) by considering the fit between capabilities and consumer needs, and to the literature on the mechanisms behind first-mover advantages (Kerin, Varadarajan and Peterson 1992; Lieberman and Montgomery 1988; Robinson 1988) by focusing on consumer-driven means of advantage creation.

To assess the fit between capabilities and consumers, we use data on the emergence of second-generation mobile phone markets across thirty countries. Our exceptionally detailed and comprehensive data allow us to show how an established brand name helps firms attract mass-market consumers, while the reputation developed by early entry and the possession of prior technological capabilities help firms attract more profitable technologically-savvy and business consumers. We also address a common but often unaddressed issue in first-mover advantage studies – the endogeneity of entry timing – through multiple methods based on the standardized nature of the industry, measures of pre-entry capabilities, and data on the method of awarding mobile phone licenses.

The remainder of the paper is organized as follows. We first focus on integrating research on capabilities and first-mover advantages with work on the heterogeneity of consumer groups adopting new innovations to frame the specific research questions on the consumer-centric nature of entry order advantages. We then introduce the empirical context and the data we use. We then look first at high-level firm profitability effects of experience and entry timing, and then decompose those advantages into volume, consumer-level profitability, and cost advantages. We then discuss implications of our results for future research.

THEORETICAL FRAMEWORK

Following some inconclusive and conflicting findings on first-mover advantages (Boulding and Christen 2003; Golder and Tellis 1993; Lilien and Yoon 1990), recent research has focused on the role of macro- (Suarez and Lanzolla 2007) and micro- (Franco et al. 2009) contingencies that enable first-mover advantages. The latter perspective suggests that firm level pre-entry capabilities, typically built through prior experience (Helfat and Lieberman 2002; King and Tucci 2002; Klepper and Simons 2000), are important for the ability of firms to create and sustain first-mover advantages. For example, Franco *et al.* (2009) focus on how advanced technological capabilities allow early entrants to be successful in the high-tech disk drive industry. The primary types of capabilities by diversifying firms are marketing and technical capabilities (Sosa 2009). However, for pre-entry capabilities to be useful in a new market or industry, they must be valued and transferable from one market to the next (Danneels 2007; Tripsas 1997). Thus, the fit between the organizational capabilities possessed by a firm and the requirements of the market are of utmost importance to generating competitive advantage. While requirements certainly vary across markets, within any given market they will also vary over time and consumer groups.

Research on innovation diffusion suggests that adopters can be divided into categories based on when they adopt the innovation, and that there are important differences between adopter categories. Rogers (1962/1995), for example, highlights how early adopters are more likely to be technologically savvy and concerned with the functionality offered by a new innovation, while later adopters may be more driven by the behavior of other adopters. Research on the adoption of innovations with network effects points out that the first adopters of a new technology are likely to be those with the highest willingness to pay for the innovation, as they are willing to purchase without the clear benefits of the

network effects (Cabral 1990; Cabral, Salant and Woroch 1999, Farrell and Saloner 1986). Rogers (1962/1995, pp. 269-270) implicitly agrees, citing early adopters as having more education, as well a greater social status and mobility – all factors related to wealth (and implicitly to willingness to pay). Jointly, this suggests that early adopters have the potential to be more profitable for the firms that supply them. This aligns with suggestions from marketing practitioners that some consumers will be much more profitable than others for firms, and that consumers that have been with the firm longest are generally the most profitable (Reichheld and Sasser 1990; Zeithaml, Rust and Lemon 2001).

Taken together, these perspectives on first-mover advantages, firm capabilities and the characteristics of early and late adopters offer three areas for further empirical investigation. First, the point that early adopters will have a higher willingness to pay for the service or product than late adopters suggests a specific avenue for first-mover advantages. Early entrants to a new industry or market will be more profitable if they are able to utilize switching costs to preserve their early consumers (Farrell and Klemperer 2007; Regibeau and Rockett 1996; Schilling 2002), and this profitability advantage will be built on the quality of the consumers the firm serves and not on market share or overall level of penetration. These more profitable consumers will likely be the ones that utilize the firm's services and products more regularly, thus generating more revenue for the firm. In short, we expect early entrants to capture consumers that are more profitable per person.

Second, the quest of early entrants to attract and maintain more profitable consumers will be aided by their possession of capabilities that help them appeal to early adopter consumers. Specifically, technological capabilities and a technology-focused brand will improve the performance of early entrants with highly profitable consumers, as this type of firm will be more likely to offer the product or service they value. This leads to the

expectation that the positive effect of prior technological experience is stronger for early entrants, and that this will primarily help in attracting highly profitable consumers. That is, technologically experienced firms will be able gain more from a window of opportunity.

Finally, later adopting consumers of the new technology will be more driven by the adoption behavior of others and marketing messages such as familiar brand names. These consumers are less technologically savvy than early adopters, and so a trusted brand name is a more comfortable choice. Thus, we expect that an established brand name and distribution network provides a benefit to firms, but the benefit will be largely the opposite of the benefit of early entry discussed above – brand names will help firms attract more consumers overall, but the consumers will be less valuable on average than those attracted by early entrants. Hence, established brand names will have higher market share, but not necessarily more high-value consumers.

These three perspectives combined suggest that taking a consumer-centric perspective and explicitly considering the implications of consumer heterogeneity for entrant firms can help advance research on first-mover advantages. Different consumers drive different paths to profitability, and the ability of firms to attract those consumers is contingent on entry timing, pre-entry experience and the fitness between the two. In this study and based on the theoretical perspectives offered above, we focus on three characteristics of firms – entry timing, technical experience, and existing brand name – and two characteristics of consumers – the extent of their usage of the product or service and the extent to which any given firm captures market share – to investigate the implications for firm profitability.

THE MOBILE TELECOMMUNICATIONS INDUSTRY

Mobile telecommunications, and specifically the launch of second generation (2G) networks,[1] has been one of the most successful technology introductions in the past decades. In addition to its economic significance, it is remarkable that firms went to great lengths to establish an installed base of users, presumably in the hope of recouping revenues later, i.e. through phone calls made and received. Strategies like penetration pricing and handset subsidies were offered in conjunction with long-term contracts, and consumers with identical contracts may differ in their attractiveness to operators as they may be heavy or light users. Prior research shows that early adopting consumers tend to be heavy users (Grajek and Kretschmer 2009, Cabral 2006), so that building an installed base early may increase firm revenues by adding more consumers and attracting more profitable consumers. Studies on first-mover advantages typically only consider the first advantage.

The mobile telecommunications industry is a fruitful setting for our understanding of first-mover advantages for four reasons:

First, the typical industry structure allows for a very clear definition of first movers. Market structure in mobile markets was typically determined by granting licenses to a limited number of operators (*Early Entrants*). Later, additional firms were granted a license to operate, which provides a clear distinction between first-movers and latecomers.

Second, the mobile phone industry has significant switching costs for consumers, especially before some countries mandated that consumers could take their phone numbers with them when they switched. Switching costs are an important source of first-mover

[1] First Generation (1G) networks were generally unsuccessful at attracting adopters compared to their setup costs.

advantages (Lieberman and Montgomery 1989, Mueller 1997; Bijwaard et al. 2008). Early entrants can capture consumers early on and keep them from joining competing networks. With switching costs, it is difficult for new entrants to catch up.

Third, mobile phone users make two decisions: First, they decide to adopt a mobile phone or not, and second, they make (more or less) continuous usage decisions. This opens up at least two channels for first-mover advantages: early movers may be good at attracting subscribers, and/or they may be successful at attracting heavy users. We believe distinguishing between these two dimensions is important for identifying consumer heterogeneity as a driver of first-mover advantages. For example, lock-in of early adopters is likely to manifest via higher penetration coupled with higher usage intensity, while brand recognition is likely to lead to higher penetration, but less likely to higher intensity of use.

Finally, coordination on a standard and licensing as a means of regulating entry into mobile telecoms are important for the discussion on endogeneity of entry timing (Boulding & Christensen, 2003; Bayus & Agarwal, 2007). Most standard-setting organizations grant access to their standard on a non-discriminatory basis, ruling out technology-based differences in efficiency that may affect both entry timing and subsequent success. The main differences between firms in the mobile industry then stem from their capabilities in sales and marketing. For example, if there had been several (commercially) similar mobile generations already, a previous incumbent might have gathered experience and knowledge about the rollout process, enabling incumbents to launch earlier and more efficiently. Firms with previous in-country experience may have strong existing brand names, and firms with 2G mobile experience elsewhere may be seen as technology leaders by consumers. Given fixed-line telephony was rolled out several decades ago and 1G mobile was a niche technology, we believe this to be an unlikely cause for the endogeneity of early movers.

DATA AND DESCRIPTIVE ANALYSIS

We draw our data predominantly from two sources used in previous studies (Genakos and Valletti 2010, Koski and Kretschmer 2005, Grajek and Kretschmer 2009): The Informa Telecoms & Media World Cellular GSM Datapack (Informa T&M) and Merrill Lynch's Global Wireless Matrix. The Informa T&M data covers the number of subscribers for individual mobile operators, average prices and technological standards in considerable detail. Informa T&M is a provider of market and business intelligence to commercial entities in the mobile and media industries. Buyers of this data base commercial decisions on the data, ensuring a high level of accuracy. Merrill Lynch publishes a quarterly report on the development of the global cellular telephony market as a service to clients and industry observers. Merrill Lynch reports, among other data, the total number of called minutes per operator, which we use to construct the average usage per consumer.[2]

To complement our main data, we use IMF's International Financial Statistics (for GDP) and World Bank's World Development Indicators (for population, telephone mainlines, and average cost of a local call). The disadvantage of the WDI database is that it only provides yearly time series. To arrive at quarterly data we linearly interpolated the variables.[3] We also gather data on firm structure and ownership to assess whether firms had access to knowledge from previous entries or incumbency through major shareholders. These data were drawn from company histories, news reports, and prior research on the evolution of the mobile telecommunications industry (e.g. Noam & Singhal, 1996). The authors and a

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[2] We triangulated the above data with available public data sources (OECD's Communications Outlook, ITU's Telecommunications Indicators) and found that the variables common to both private and public data were comparable. We are therefore confident that our data is accurate.

[3] Experimenting with other interpolations does not change the results.

research assistant collected data on firm experience, and resolved any uncertainty by group evaluation. In the case of firms with multiple investors, we considered an investor's prior experience relevant if the investor owned 25% or more of the firm, which is generally considered to the cutoff between a financial versus a strategic investment.

Our sample covers 90 mobile phone network operators in 30 countries from the fourth quarter of 1998 through the second quarter of 2004. We observe average usage on each operator's network (Minutes of use, *MoU*) as well as the number of subscribers (*CellSubs*)—including prepaid card users (*Prepay*)—and the price they pay for the service measured as average revenue per minute (*CellP*). Further, we have information on the number of subscribers to and the price of the fixed-line telephone service in each country (*FixedSubs* and *FixedP*), the country's GDP and whether the country was among the first to adopt the 2G technology (*EarlyCountry*). Finally, we construct a set of dummy variables indicating if a firm had prior experience with 2G in other countries, prior 1G experience in the focal country or if it was a fixed-line incumbent. We expect prior 2G experience to bring technological capabilities (*Tech*), which might enable superior performance directly or via enhancing first-mover advantages. Moreover, prior engagement in fixed-line and 1G mobile services can be expected to give operators sales capabilities and brand image (*Brand*) in the focal country. Variable definitions—including those for additional control variables not discussed in this section—and descriptive statistics are reported in Table 1.

INSERT TABLE 1 ABOUT HERE

A first look descriptive statistics for the data suggests that two of our three primary independent variables – *EarlyEntrant*, *Brand* and *Tech* – are related to firm profitability (as

measured by EBITDA margins). The data in Table 2 indicate that early entrants demonstrate higher margins than later entrants, and that firms with prior in-country brand experience also demonstrate higher margins than those without such experience. Those firms with out-of-country 2G experience before entry show slightly lower profits on average. While these observations are based solely on descriptive statistics, they are at least suggestive that these three measures capture important variation between firms.

INSERT TABLE 2 ABOUT HERE

RESULTS

The observations above about profit differences between different types of firms are based solely on the descriptive statistics. In order to provide a more rigorous analysis of the effects of entry timing and prior experience, we first link these measures to two core measures of performance in the mobile network industry – minutes of usage per user (*MoU*) and overall penetration (*CellSubs*). We then assess the relationship with firm-level profitability in the following subsection.

Entry Timing and Mobile Networks: A Model of Usage and Subscriptions

We propose the following simultaneous-equation model to investigate the nature of performance based on entry timing and pre-entry capabilities:

$$MoU_{ijt} = \alpha_{ij} + \delta_0 * MoU_{ij(t-1)} + \delta_1 * CellP_{ijt} + \delta_2 * CellP_{i(-j)t} + \delta_3 * FixedP_{it} + \delta_4 * CellSubs_{ijt} +$$
$$+ \delta_5 * CellSubs_{i(-j)t} + \delta_6 * FixedSubs_{it} + \delta_7 * GDP_{it} + \delta_8 * Prepay_{ijt} + \varepsilon_{ijt}, \quad (1)$$

$$CellSubs_{ijt} = \beta_{ij} + \gamma_0 * CellSubs_{ij(t-1)} + \gamma_1 * CellP_{ijt} + \gamma_2 * CellP_{i(-j)t} + \gamma_3 * FixedP_{it} + \gamma_4 * MoU_{ijt} +$$

$$+ \gamma_5 * CellSubs_{i(-j)t} + \gamma_6 * FixedSubs_{it} + \gamma_7 * GDP_{it} + \gamma_8 * Prepay_{ijt} + \zeta_{ijt}, \quad (2)$$

where i, j, and t refer to country, cellphone operator, and time, respectively. Equation (1) seeks to explain the average usage intensity of a subscriber to a given operator by a number of factors including cellphone and fixed-line prices, network sizes and other covariates relevant for usage. In particular, we consider own price ($CellP_{ijt}$), the average price of other cellphone operators in the country ($CellP_{i(-j)t}$), and the price of local fixed-line connection ($FixedP_{it}$) as well, as operator's own network of subscribers ($CellSubs_{ijt}$), subscribers to other cellphone operators ($CellSubs_{i(-j)t}$), and fixed-line subscribers ($FixedSubs_{it}$). Moreover, we control for GDP per capita (GDP_{it}) and the share of prepaid consumers in own subscriber base ($Prepay_{ijt}$). Finally, we also include lagged usage ($MoU_{ij(t-1)}$) to control for consumer inertia and learning and operator-specific effects (α_{ij}), which capture the unobserved heterogeneity among operators.[4] Equation (2), which explains the number of subscribers to a given operator as a fraction of total population in the country, is specified analogously. We allow the error terms ε_{ijt} and ζ_{ijt} to be heterogenous and possibly correlated. Thus, we allow the subscription and usage of cellphone by consumers to be a joint decision that may be influenced by the same missing factors in both equations.

Since equations (1) and (2) contain both lagged dependent variables and operator-specific fixed effects we apply the estimation method proposed by Arellano and Bond (1991), which delivers consistent estimates under the assumption of no serial correlation in the error term and is routinely used for this class of models. We use instrumental variables for prices, network sizes, and the prepay share, as they are potentially endogenous in both equations.

[4] These effects are often referred to as fixed effects, as they are invariant across time.

The goal of these equations is to obtain operator-specific effects, which we will then regress on our measures of entry timing and pre-entry experience.

Table 3 presents regression results of mobile phone usage and penetration equations (1) and (2). The test statistics of both the Arellano-Bond AR(2) test and the Hansen J test of overidentifying restrictions are not significant, giving us confidence in the instrumental variables used to estimate the model.[5]

INSERT TABLE 3 ABOUT HERE

While the results in Table 3 are not the focal part of this study, as we use this regression to obtain firm-level operator-specific effects further investigated below, it is worth briefly looking at the results as they largely agree with prior research in this industry. Lagged dependent variables are strong predictors in both equations confirming strong inertia in both usage and subscription choices. Moreover, own price and network size are negative and significant in the usage equation, as expected. This effect can be explained by less heavy users joining in as the network grows, which is consistent with Grajek and Kretschmer (2009). Prepay share and GDP are also significant and have the expected signs—negative and positive, respectively—in the usage equation. In contrast, GDP and own price are not statistically significant in the penetration equation. One explanation is that since the operator-specific effects account for a large part of cross-sectional variation in the data, the time-series variation in GDP and prices is not enough to estimate their effect on top of the strong self-perpetuating penetration growth. Usage is also insignificant in the penetration

[5] A detailed description of instrumental variables used in the estimation is in the Appendix.

equation, which is consistent with our expectations. Interestingly, penetration of other cellphone operators in the market is estimated to be positive suggesting some spillovers across operators. Grajek (2010) reports similar findings and attributes them to network effects operating at the cellphone industry level, which are, however, much weaker than the effects operating at the operator level.

We then regress the operator-specific effects from equations (1) and (2) on our set of first-mover and firm capability variables and report the results in Table 4. In general, the interaction terms testing the contingent nature of first-mover advantages are not significant, so we focus our attention on the baseline regressions (1 and 4) and the one model with a significant interaction (3). The first usage equation (1) shows that *EarlyEntrant* is positive and significant, suggesting that first movers do indeed attract more attractive customers (those that use more minutes) and keep them after entry by later entrants. This agrees with our first hypothesized relationship between entry timing and customer types. Meanwhile, the coefficient on *Tech* is not significant in any of the usage models (1-3), but the interaction between *EarlyEntrant* and *Tech* is positive and significant in Model 3. This supports our second theoretical point, namely that possession of pre-entry technological experience and a reputation for technological ability will accentuate an early entrant's ability to accumulate attractive and technologically savvy early adopters. Our third variable of interest, *Brand*, does not indicate any advantages in terms of usage intensity.

INSERT TABLE 4 ABOUT HERE

In the penetration equation (4), however, we see that "brand operators" enjoy a higher advantage than firms without such important assets. Early entrants also have higher

penetration rates than late entrants *ceteris paribus*, but their advantage is smaller in magnitude than that of brand operators (though the difference is not statistically significant). Additionally, we see that pre-entry technological experience is actually costly in terms of penetration, as these firms attract fewer users than those firms without such pre-entry experience.

The magnitudes of the advantages identified in Table 4 may seem small: they range from null to 19.43 in terms of minutes of use and from 1.204 to 1.469 in terms of penetration rate – approximately 10% of the average values shown in table 1. To fully appreciate the estimated magnitudes, however, one needs to take into account the dynamic structure (i.e. the lagged dependent variables) and the interdependence of the estimated equations. Intuitively, the fixed effects alone do not reflect the fact that first-mover advantages are carried over from one period to the next by the lagged dependent variables and accumulate as a result. One way to do it is to calculate the usage and penetration advantages in the long run when the system of equations (1) and (2) reaches a steady state, i.e. $MoU_{ij(t)} = MoU_{ij(t-1)}$ and $CellSubs_{ij(t)} = CellSubs_{ij(t-1)}$. Calculated this way, the usage and the penetration advantages associated with EarlyEntrant (Brand) amount to 48.9 minutes (-75.8 minutes) and 7.5% (9.1%), respectively, all else equal.[6] The magnitudes are thus much larger in the long run. Moreover, Brand yields a usage disadvantage of 75.8 minutes in the long run while the short term effect in Table 8 is insignificant. This disadvantage is driven by high penetration advantage of 9.1%, which puts a downward pressure on average usage - later adopters are

[6] We show the derivation of long-run advantages in the Appendix.

less intensive users, as indicated by the negative coefficient on own subscribers in the usage equation in Table 3.[7]

Taken together, the results of our usage and penetration regressions suggest multi-faceted first-mover advantages in the cellphone industry: whereas being first to the market allows operators to secure a higher quality installed base, established brand and sales channels (*Brand*) secure the highest penetration and hence market share.[8] Additionally, while prior technological experience allows early entrants to increase their ability to attract high-value customers, such experience actually decreases overall market penetration. In the following section, we investigate these effects more closely by linking entry timing and pre-entry experience with firm profits, both directly and through usage and penetration.

Entry Timing and Mobile Networks: From Usage and Subscriptions to Profits

The models above link entry timing and pre-entry experience with usage and penetration. In this section, we investigate the ties between all of these factors and profits in the mobile network industry. To do this, Table 5 shows the results of a series of regressions with EBITDA as the dependent variable. In Table 5, the control variables generally perform as expected – profits go up as the operator has more time on air (*OnAir*), go down as more competitors enter the market (*Operators Count*), and increase as the firm attracts more prepaid customers (*Prepay*). Interestingly, firms in countries who adopted 2G technology earlier (*EarlyCountry*) generate fewer profits than those in countries that adopted the technology

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[7] This is also evident in the discussion on stagnant or even falling voice ARPU (Average Revenue per User) for most mature economies. See http://www.3g.co.uk/PR/Sept2007/5122.htm.

[8] Note that the two categories *Brand* and *Early entrant* are not mutually exclusive in these models. Consequently, incumbent operators that were first to enter the market enjoy the benefits of both categories, i.e. the relevant coefficient equals to the sum of the coefficients on the variables *Brand* and *Early entrant*.

later. This may indicate the existence of learning spillovers, which help firms to learn from the mistakes of the technology's pioneers. Another explanation is that early adopting countries tend to imply cost disadvantage through higher costs of labor and real estate.

INSERT TABLE 5 ABOUT HERE

In terms of entry timing in a specific market, the *EarlyEntrant* variable in Model (1) clearly shows that early entrants are more profitable than later entrants. Interestingly, while we demonstrated earlier that early entry is associated with both more and more attractive customers (in the subsection above), the inclusion of *MoU* and *CellSubs* in Models (2) and (3) had a minimal impact on the size of the coefficient for *EarlyEntrant*. This shows that while early entrants do gain advantages in usage and penetration, and these two factors drive profitability, early entrants possess additional advantages. As usage and penetration (as well as price, which is controlled for with *CellP*) explain practically all revenues for the firm, the advantage must lie on the cost side of the ledger. While our data do not allow us to clearly state the source of this advantage, possible ideas include first-mover real estate advantages (both for cell towers and retail operations) and going down the technology-specific learning curve. Thus, early entry appears to have both a direct effect on costs and an indirect on revenues through usage and penetration rates.

The effect of entry timing is augmented when considering the role of pre-entry technological experience (*Tech*). Model (1) suggests that *Tech* has, if anything, a negative effect on profitability when considered alone. This is in line with the negative relationship between *Tech* and penetration shown earlier, and the negative effect of *Tech* disappears in Model (2) when *CellSubs* is added to the profitability model. When *Tech* is interacted with *EarlyEntrant*

in Model (5), the results again show that early entrant firms with prior 2G experience show significantly greater profits than early entrants without this experience. Thus, as we discussed earlier, the fit between the needs of early adopting customers (who are mainly businesses and technologically savvy individuals) and the firm (based on its prior technological experience and its perception as a technological leader) increases the profitability of the firms. This supports the idea that early entry can provide a contingent advantage, in this case contingent on the fit between the firm and its customers.

Finally, *Brand* captures the effect of prior in-country marketing experience. This variable is positive and significant in the initial model (1) but the effect diminishes as *CellSubs* is added in Model (2) and disappears once *MoU* is added in Model (3). This suggests that the advantage of having an existing telecommunications brand is fully mediated by the market share of the firm. Brands help firms attract a large volume of customers, but do not appear to provide any cost advantages (as discussed earlier for *EarlyEntrant*). Additionally, in Model (4) we add the interaction between *Brand* and *EarlyEntrant*. This interaction is negative and significant, and is approximately the same size as the *Brand* dummy alone in that model. The suggestion is that, for early entrant firms, the possession of a pre-existing telecommunications brand has little impact on profitability. But for later entering firms, the effect of a brand name is still positive and significant. Thus, the brand name helps late entering firms compensate for coming late, specifically (as shown earlier) by helping them attract a higher volume of (admittedly less attractive) customers.

DISCUSSION

Our results suggest intricate patterns of first-mover advantages in the global mobile telephony industry. The theoretical framing of this study focuses on three types of firms –

those that enter the industry (2G mobile network service) earlier than other firms, those that enter with pre-entry experience in 2G in another country, and those that enter with prior in-country experience (either in 1G or fixed wire line). Each of these three types of firms exhibits some form of advantage in this industry, and these advantages can be tied to our consumer-centric view of entry timing and firm advantage. We discuss the results in greater detail below, with a focus on the underlying drivers of advantage.

We start with firms with in-country experience, modeled as firms that were either fixed-line incumbents and/or were active in 1G mobile telephony. Our regressions show that potential adopters across all consumer groups are more likely to choose an in-country incumbent as mobile operator, other things remaining equal (Table 8). This points at two sources of first-mover advantages across technological generations: First, there is the possibility that existing fixed-line and 1G consumers are encouraged to subscribe to 2G services from the same supplier through direct advertising, discounts, etc. Specifically thinking about firms with 1G experience, these firms could easily transfer 1G subscribers to their 2G networks, for instance by allowing for exiting the long-term 1G contract without penalties. A second possible explanation is that incumbents enjoy higher reputation or awareness across all consumer groups, leading to a higher proportion of subscriptions even without pricing or other incentives. While it is difficult to unambiguously disentangle these two drivers, our evidence suggests that firms with previous in-country experience gain an advantage because they are able to attract a larger mass of low- to moderate-usage consumers, which increases profits in a fixed-cost business like mobile telephone networks.

For early-entrants into the current generation (2G), the nature of first-mover advantages differs. Our results show that entering a market early leads to a subscriber base that consists of relatively more heavy users (Table 8). This suggests a “time window” argument: Early

entry grants operators some time to build up an installed base. In the early phases, most adopters consist of pioneers or early adopters (Rogers 2005) who tend to use their phones more intensively (Cabral 2006, Grajek and Kretschmer 2009). Consequently, this time window is especially valuable as firms can sign up heavy users on long-term contracts, which creates significant switching costs. Indeed, preliminary results on the longevity of first-mover advantages (available from the authors) suggest that churn is fairly low and that on top of the monetary switching costs of breaking a long-term contract or waiting until it runs out, there are also significant non-pecuniary switching cost that extend beyond the average duration of a contract. In any case, early entrants appear to benefit from "classical" first-mover advantages created by switching costs within a single technological generation. The novelty of this study with respect to early entry and switching costs is to show how early entry advantage is driven primarily by the ability to attract the most profitable consumers.

The third class of firms is those with prior (2G) technological experience in another country. Our expectation was that firms would be able to use both their technological experience and their perceived technological superiority to make their offerings even more attractive to technology-oriented early adopting consumers. Our results show that there is no universal advantage of technological experience (Table 6), but that early entrants, i.e. firms that enter in the time window to lock up technology-savvy consumers, benefit from their external technological experience, especially in terms of attracting more profitable users (Table 9). This finding aligns with recent work on the conditional nature of first-mover advantages (Franco et al, 2009). The better the fit between the capabilities (or perceived capabilities) of the firm and the preferences of the relevant consumer group at the time of entry, the greater the advantage. Interestingly, while this advantage clearly manifests in terms of usage intensity, the profit advantage of being a technologically-experience early entrant does not

disappear in the profit regressions even after we control for usage and penetration. This suggests that there may be an additional, cost-based advantage for these firms, but additional work is needed to assess and understand this claim.

There is one additional class of "early entrants" to consider based on the models, namely firms in early adopting countries for 2G. These operators display significant disadvantages in terms of profitability, which is not driven by subscriptions and usage patterns. This is consistent with Eggers (2010), who shows that early technological commitment may be detrimental to firm performance. Later entrants can learn from the experience of the early ones and avoid mistakes in the commercialization of technology. Another explanation of the lower profitability of operators in early-adopting nations is higher costs due to features of early-entering countries, for instance low population density in the Nordic countries.

CONCLUSION

In this paper, we take a consumer-centric perspective towards first-mover advantages in the global mobile telephony industry. Our data allow us to distinguish between different firm types based on their pre-entry experience and entry timing, and to investigate their profitability and the characteristics of their subscriber base. We find that first-mover advantages exist for early entrants through their ability to capture the most attractive (i.e. highest-usage) consumers, that this advantage is amplified if the firm possesses pre-entry experience that fits with the presumed preferences of early adopters, and that early country entrants (those with experience in prior telephone technologies) have an advantage based on the ability to attract a broad swath of adopters.

The primary contribution for our study is to the strategy, marketing and economics literatures on first-mover advantages by emphasizing the importance consumer

heterogeneity for studying entry timing advantages. Focusing on consumers allows us to show that first-mover advantages are multifaceted and that researchers should take into account different measures of success, as our initial analysis of first-mover advantages in profits show. This implies that measuring first-mover advantages in terms of (persistent) market share differences or profits may be incomplete for complex technologies. The theory and data allow us to refine our understanding of the underlying mechanisms for first-mover advantages (Lieberman & Montgomery, 1988), and we suggest that future research on first-mover advantages would benefit from incorporating consumers more explicitly.

This research also contributes to research on first-mover advantage by extending the view firm-level heterogeneity tied to firm-level capabilities. These pre-entry capabilities can both drive organizational advantage directly (Helfat & Lieberman, 2002; Klepper & Simmons, 2000) and in terms of conditionally affecting first-mover advantages (Franco et al, 2009). Our finding that incumbents of a previous technological generation may enjoy an advantage even if they do not enter the new generation straightaway suggests that future work on early-mover (or entry order) effects has to consider market positions in earlier generations. Distinguishing between previous- and current generation market positions may also help differentiate between sources of first-mover advantages: If they accrue mainly from being first in for the current generation, a competitive advantage would erode with technological change, and resources are technology-specific. On the other hand, if advantages accrue from having held a prominent position in previous product generations, competitive advantage may be built on reputation that is largely independent of the active technology at any time.

We also contribute to the limited literature on the evolving nature of firm-level advantages in the mobile telephony industry. Focusing on this global and economically important industry, our analyses show that different types of experience have helped firms improve

their profitability, though in different ways, and that entry timing in this industry (given the significantly higher profitability of early adopting consumers and the presence of switching costs) plays a vital role in understanding firm profitability. These findings have important implications for managers in this industry specifically, but also for other technology-driven and complex industries. Specifically, maximizing market share by entering early may involve a tradeoff as adopters attracted through introductory offers may not be commercially attractive as they are less intensive users of the secondary good or service.

Our study has several limitations and could be extended in several ways. First, we study a specific industry at a specific time. While we believe that the global telecommunications industry is a useful testing ground for more refined concepts of first-mover advantage, the validity of usage intensity as a measure of success as well as the differences between previous-generation incumbents and early current-generation entrants have to be identified in other industries. However, we believe that industries with similar product characteristics (i.e. a durable baseline product or service and repeated purchases of auxiliary services) and similar technological dynamism and the associated generation changes would benefit from a similarly extended analysis of first-mover advantages.

Further, we do not have enough information to unambiguously identify true drivers of first-mover advantages. Our different definitions of early movers, however, can be helpful in identifying the likely sources of first-mover advantages, and in particular their longevity in technologically dynamic markets. Our results suggest that within a technological generation the early stages determine firm success for this generation, but that there is also a degree of transferability of advantages across generations, as indicated by the positive effect of previous-generation incumbents. This is consistent with at least two distinct drivers of first-mover advantages. First, early movers benefit most from consumer inertia due to switching

costs. Combined with the finding that the first consumers to subscribe to the technology tend to be heavy users, it allows early entrants to lock in the most profitable consumer group. Second, incumbents, i.e. early entrants in the previous generation of the technology, seem to benefit from transferring subscribers across technological generations or reputation effects. This is consistent with our finding that incumbents' advantage manifests in market penetration rather than consumer profile because both reputation and transferring subscribers across generations are likely to affect all consumer groups. Finally, our results also suggest that early technological commitment may be detrimental to performance, as evidenced by lower profitability of operators in the early-adopting nations. This gives some indicative evidence of where to search for further information on the nature of first-mover advantages in future research.

This study offers a consumer-centric view of entry order advantages and the role of firm-level capabilities. We specifically consider the fact that early adopting consumers will be different from late adopting ones. We suggest that early entering firms will attract higher-profitability customers, which will be a key source of first-mover advantages. Additionally, this effect will be stronger for firms with strong technological capabilities as early adopters are generally more technology-oriented than late adopters. Conversely, firms with existing marketing and branding resources in a particular country will do better at attracting a high volume of less-profitable customers – standard late adopters influenced by brand effects and awareness. Our empirical results on the global mobile telecommunications industry confirm our expectations and help us offer important depth to the discussion about first-mover advantages and the contingent role of firm capabilities.

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Tab. 1. Variable definitions and descriptive statistics

Variable	Definition	Obs.	Mean	Std. Dev.	Min	Max
MoU	Average monthly minutes of use (number of minutes)	1044	172.82	102.91	56	660
CellSubs(j)	Subscribers to a given operator as population's share (%)	1044	16.80	11.89	0.10	51.90
CellSubs(-j)	Subscribers to competing operators as population's share (%)	1044	34.11	17.61	1.10	83.41
FixedSubs	Fixed-line subscribers as population's share (%)	1044	48.05	16.56	10.49	75.67
CellP(j)	Average revenue per minute of a given operator (US cents)	1044	20.87	8.59	0	53.68
CellP(-j)	Average revenue per minute of competing operators (US cents)	1044	20.72	7.96	3.38	53.68
FixedP	Price of a local fixed-line connection (US cents)	1044	8.46	5.45	0	19
GDP	GDP per capita (000's US dollars)	1044	20.37	10.53	0.89	47.84
Prepay	Share of prepay users among given operator's subscribers (%)	1044	43.11	28.07	0	95.20
EarlyEntrant	First 2G cellphone operator in a given market (dummy)	1044	0.47	0.50	0	1
Brand	Incumbent fixed-line operator or or 1G service operator in a given market or both (dummy)	1044	0.59	0.49	0	1
Tech	Operator that have prior experience in rolling out 2G service in another market (dummy)	1044	0.36	0.48	0	1
EarlyCountry	Country that launched 2G cellular telephony before 1995 (dummy)	1044	0.70	0.46	0	1

Tab. 2. Descriptive statistics of EBITDA by key independent variables

Variable	Variable = 1			Variable = 0		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
EarlyEntrant	472	0.37	0.09	528	0.23	0.22
Brand	588	0.33	0.14	412	0.25	0.23
Tech	347	0.26	0.22	653	0.31	0.16

Tab. 3. Cellphone usage and penetration regression results

EQUATION:	MoU(t)	CellSubs(j)(t)
	(1)	(2)
MoU(t-1)	0.825***	
	(0.029)	
CellSubs(j)(t-1)		0.839***
		(0.034)
CellP(j)	-1.512***	0.025
	(0.483)	(0.035)
CellP(-j)	-0.457	0.037
	(0.327)	(0.041)
FixedP	-0.581	0.046
	(1.156)	(0.055)
MoU(t)		0.003
		(0.003)
CellSubs(j)(t)	-1.454***	
	(0.486)	
CellSubs(-j)(t)	0.196	0.039**
	(0.222)	(0.015)
FixedSubs	-0.373	0.012
	(0.558)	(0.033)
Prepay	-0.526**	0.049***
	(0.250)	(0.016)
GDP	2.095***	-0.018
	(0.470)	(0.024)
AR(2) test	-1.18	-1.34
Hansen J statistic	87.03(195)	74.59(195)
Observations	1044	1013
Clusters	90	90

* p<0.1, ** p<0.05, *** p<0.01; robust standard errors in parentheses

Tab. 4. Regression of operator-specific effects on capability indicators

EQUATION:	MoU			CellSubs(j)		
	(1)	(2)	(3)	(4)	(5)	(6)
EarlyEntrant	19.430***	24.273***	11.465	1.204***	1.687**	1.662***
	(5.355)	(8.661)	(6.964)	(0.428)	(0.692)	(0.562)
EarlyCountry	0.329	0.597	2.188	0.096	0.123	-0.011
	(6.030)	(6.060)	(6.050)	(0.482)	(0.484)	(0.488)
Brand	-2.653	0.618	-0.549	1.469***	1.795***	1.348***
	(5.476)	(7.157)	(5.540)	(0.438)	(0.571)	(0.447)
Tech	2.129	1.430	-5.696	-1.182**	-1.252***	-0.732
	(5.613)	(5.714)	(7.109)	(0.449)	(0.456)	(0.574)
EarlyEntrant* Brand		-7.922			-0.791	
		(11.116)			(0.888)	
EarlyEntrant* Tech			19.241*			-1.106
			(10.939)			(0.883)
Constant	84.519***	82.898***	85.420***	-3.863***	-4.024***	-3.915***
	(7.179)	(7.551)	(7.111)	(0.574)	(0.603)	(0.574)
R^2	0.139	0.145	0.170	0.292	0.299	0.305
Observations	90	90	90	90	90	90

* p<0.1, ** p<0.05, *** p<0.01

Tab. 5. Results of simple profit regressions with interaction terms

Dependent variable: EBITDA

	(1)	(2)	(3)	(4)	(5)
Early entrant	0.034***	0.031***	0.033***	0.058***	0.003
	(0.012)	(0.011)	(0.011)	(0.017)	(0.014)
Early country	-0.144***	-0.167***	-0.175***	-0.169***	-0.167***
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)
Brand	0.047***	0.020*	0.015	0.034**	0.020*
	(0.011)	(0.010)	(0.011)	(0.014)	(0.011)
Tech	-0.018*	0.004	0.011	0.007	-0.020
	(0.011)	(0.010)	(0.011)	(0.011)	(0.014)
OnAir	0.009***	0.006***	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Operators count	-0.027***	-0.003	-0.006	-0.007	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Prepay	0.003***	0.004***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CellP	0.000	0.001	0.001*	0.001	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CellSubs		0.006***	0.006***	0.006***	0.007***
		(0.001)	(0.001)	(0.001)	(0.001)
MoU			0.000**	0.000	0.000*
			(0.000)	(0.000)	(0.000)
EarlyEntrant*Brand				-0.040**	
				(0.020)	
EarlyEntrant*Tech					0.077***
					(0.020)
Constant	0.212***	0.116***	0.083**	0.092***	0.074**
	(0.027)	(0.027)	(0.032)	(0.032)	(0.032)
r2	0.376	0.440	0.442	0.445	0.450
N	1000	1000	1000	1000	1000

Appendix

A1. Instruments used in the estimation of the model

One set of instrumental variables that we use was proposed in Arellano and Bond (1991) and allows us to consistently estimate coefficients on the lagged dependent variables.

The second set of instrumental variables tackles possible endogeneity of cellphone and fixed-line prices in equations (1) and (2). Making use of the panel nature of the data, we construct these instrumental variables based on the geographical proximity between countries (see Hausman, 1997). To the extent that there are some common cost elements in the telephone service provision across regions (e,g, costs of equipment and materials), we can instrument for prices in a given country by average prices in all other countries of the region. For instance, prices in the UK can be instrumented for with a cellular and a fixed-line price index for the rest of Western Europe. To arrive at an operator-specific instrumental variable in the case of cellphones, we further condition it on the technological standards deployed by each operator. For instance, we instrument for price of a Chinese operator using the GSM standard with prices of GSM operators from other Asian-Pacific countries; the price of a Chinese CDMA with prices of CDMA operators from other Asian-Pacific countries; and so on.[9] To gain on efficiency, we additionally include lagged values of these geography-based instruments.

The third set of instrumental variables addresses possible endogeneity of the prepay share and the penetration variables. For these variables we used values lagged by two and three periods. Note that we cannot use the values lagged by one period, because the Arrelano-Bond estimation method involves first-differencing of the estimated equation.

[9] The classification of countries into regions we apply follows the Informa T&M classification and includes: USA/Canada, Western Europe, Eastern Europe, Asia/Pacific, Africa, and Americas.

A2. Derivation of the long-run advantages

We start by defining the expected long-run equilibrium levels of penetration and usage of an operator j as:

$MoU^*_{ij(t)} = MoU^*_{ij(t-1)}$ and (3)

$CellSubs^*_{ij(t)} = CellSubs^*_{ij(t-1)}$, (4)

respectively. Since the long-run equilibrium is by definition time invariant, we can omit the time subscripts and rewrite (1) and (2) using the definitions (3) and (4) to obtain formulas for the expected long-run values of usage and penetration:

$$MoU^*_{ij} = \frac{1}{1-\hat{\delta}_0}\left(\hat{\alpha}_{ij} + \hat{\delta}_4 CellSubs^*_{ij} + \boldsymbol{X}_{ij}\hat{\boldsymbol{\delta}}\right), \quad (5)$$

$$CellSubs^*_{ij} = \frac{1}{1-\hat{\gamma}_0}\left(\hat{\beta}_{ij} + \hat{\gamma}_4 MoU^*_{ij} + \boldsymbol{X}_{ij}\hat{\boldsymbol{\gamma}}\right), \quad (6)$$

where the hat stands for estimated value, the vector $\boldsymbol{X}_{ij}$ contains all other explanatory variables in equations (1) and (2) besides own usage and penetration, and $\hat{\boldsymbol{\delta}}$ and $\hat{\boldsymbol{\gamma}}$ are vectors of the associated parameter estimates. Because $\hat{\gamma}_4$ in table 4 is small (0.003) and not statistically significant, we set it equal to zero in the calculations. The differences between a first mover (*k*) and a follower (*l*) in the expected long-run equlibria controlling for all other things—i.e. all variables in the vector $\boldsymbol{X}_{ij}$—are then:

$$MoU^*_{kj} - MoU^*_{lj} = \frac{1}{1-\hat{\delta}_0}\left(\hat{\alpha}_{kj} - \hat{\alpha}_{lj} + \hat{\delta}_4\left(CellSubs^*_{kj} - CellSubs^*_{lj}\right)\right) \text{ and} \quad (7)$$

$$CellSubs^*_{kj} - CellSubs^*_{lj} = \frac{1}{1-\hat{\gamma}_0}\left(\hat{\beta}_{kj} - \hat{\beta}_{lj}\right). \quad (8)$$

Thus, to calculate average long-run differences between the first movers and the followers in our sample we substitute the estimates from tables 4 and 5 for the the respective parameters in (7) and (8) and solve the equations. For instance, to arrive at the difference between early movers' and followers' usage of 53.7 minutes and penetration of 6.7%, as reported in the text, we substitute 0.825, -1.454 (table 4) and 19.094 (table 5) for $\hat{\delta}_0$, $\hat{\delta}_4$, and $\hat{\alpha}_{kj} - \hat{\alpha}_{lj}$ in (7), respectively. Then we substitute 0.839 (table 4) and 1.074 (table 5) for $\hat{\gamma}_0$ and $\hat{\beta}_{kj} - \hat{\beta}_{lj}$ in (8), respectively, and jointly solve (7) and (8).