Performance Implications of Core and Complementary Pre-Entry Experience: The Role of Consumer Heterogeneity in Mobile Telephony

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ABSTRACT

We study how two distinct types of pre-entry experience – core technological experience and market-based complementary experience – affect post-entry performance in a new industry. We focus on the fit between capabilities generated through pre-entry experience and the preferences of heterogeneous consumer segments. Specifically, we suggest that firms with pre-entry experience in the focal technology will attract more valuable consumers, but as these consumers typically make adoption decisions early the firm must enter early to benefit. Conversely, firms with pre-entry experience in the focal market will attract a larger share of less valuable consumers regardless of entry timing. Our empirical analysis of the global 2G mobile telecommunications industry supports our theory and provides important insights for research on experience and entry dynamics in high-technology industries.

Keywords: Pre-Entry Experience; Mobile Telecommunications; Consumer Segments; Complementary Assets; Core Technical Knowledge

1. **INTRODUCTION**

Firms often enter a new industry or market with different experiences (Helfat & Lieberman, 2002). Recent strategy research has focused on pre-entry experience as a driver of post-entry performance in a new industry. The presumption is that pre-entry experience results in the accumulation of resources, capabilities, and knowledge (technical, market and operating) that may affect post-entry performance (Bayus & Agarwal, 2007; Klepper & Simons, 2000).

Not all experience, however, has the same effect on the firm's resources and capabilities (Sosa, forthcoming). Different types of experience lead to different resources, and different pre-entry resources will affect performance with different consumer segments depending on the fit between the resources and consumer preferences. For example, a firm with strong pre-entry technological experience may not generate a post-entry advantage if consumers don't care about technological sophistication. Or, if only a portion of the market values technological sophistication, then the firm will have an advantage only in that segment. This example highlights the need to consider the contingent value of pre-entry experience (Franco, Sarkar, Agarwal & Echambadi, 2009).

We contribute to the understanding of the contingent value of pre-entry experience by building on the classic distinction between core and complementary resources. This distinction was articulated by Teece (1986) and further discussed in Helfat and Lieberman's (2002) consideration of different aspects of pre-entry experience. Core resources "refer to knowledge that fundamentally underlies and is required to create a product or service" (Helfat & Lieberman, 2002: 732), and include technical and consumer knowledge (Helfat & Raubitschek, 2000). Complementary resources are those that facilitate the commercialization of products and services, including marketing, manufacturing and distribution resources (Tripsas, 1997; Rothaermel, 2001; Arora & Ceccagnoli, 2006). In dynamic, technology-intensive markets, we argue that core resources result from previous experience with a focal technological platform, and are likely to drive the ability of the firm to appeal

to technology-friendly consumers (typically early adopters). By contrast, complementary resources spring from previous experience in the focal geographical market, and include brand awareness and distribution capabilities that help firms attract brand-oriented consumers (typically late adopters).

We study pre-entry experience and performance in global 2G mobile telecommunications markets. In line with our theory about the importance of fit between resources and market demands, our results suggest that firms with pre-entry core technical experience can successfully attract high-usage consumers, but only if they enter early enough to claim (and keep) these consumers, who typically are the earliest adopters. Conversely, firms with experience leading to complementary (brand and distribution) resources attract a larger share of comparatively less intensive users, which is especially advantageous for late entering firms that otherwise might have difficulty attracting users. *Post-hoc* analysis suggests that the benefits of core experience flow not from being more innovative, but from learning to target and appeal to the most profitable consumers in the market. Meanwhile, the value of complementary experience is tied to the reuse of a valuable brand name and reputation.

These findings contribute to our understanding of pre-entry experience and firm performance by highlighting the importance of the fit between pre-entry, experience-driven resources and the desires of heterogeneous consumer segments. This study also makes two additional contributions. First, we contribute to a relatively small stream of literature on entry dynamics in mobile telecommunications, which is a vital and sizable global industry. Second, we make a methodological contribution by utilizing a two-step empirical approach that can be fruitful for rigorous study of time-invariant factors such as pre-entry experience and entry timing.

2. THEORY AND HYPOTHESES

There is a small but growing strategy literature on pre-entry experience as it relates to post-entry performance in new industries. Helfat & Lieberman (2002) argue that pre-entry experience is a major source of firm heterogeneity in terms of capabilities, resources, and knowledge. Early research

on pre-entry experience focused on competitive differences between entrants and incumbents (Henderson, 1993). The argument was that incumbents possessed the advantage if the experience-based resources they controlled retained value (Tripsas, 1997; Tushman and Anderson, 1986). More recent research has focused on the pre-entry experience of *de alio* or diversifying entrants. Empirical studies have focused on experience in different industries (Klepper & Simons, 2000), related markets within the same broad industry (de Figueiredo & Silverman, 2007; Mitchell, 1989; Sosa, 2009), or earlier technological generations (Franco et al., 2009; King & Tucci, 2002). Each of these studies studies how experience in the pre-entry market augmented the firm's resource stock and complementary assets in ways that affected post-entry performance in the new market.

We extend this research by carefully distinguishing – both theoretically and empirically – between two different types of pre-entry experience. Firms with different types of pre-entry experience accumulate different types of resources and knowledge (Helfat & Lieberman, 2002; Eggers, 2012), so it is important to consider the implications of heterogeneous experience types among entrants into the same new market space. Building on Teece (1986), we focus on the distinction between experience with the focal technology that leads to "core" resources, and experience in the focal market that leads to "complementary" resources. We expect that these distinct types of pre-entry experience affect firm-level outcomes in different ways.

We investigate the potential impact of different types of pre-entry experience by considering the extent to which the experience fits with the needs and wants of different consumer segments in the new market space (Adner 2002; Adner and Zemsky 2006). Intuitively, for pre-entry experience to be useful in a new market or industry, the resulting capabilities must be valued and applicable in the new market (Danneels 2007; Tripsas 1997). Thus, the fit between pre-entry organizational experience and preferences of heterogeneous consumer segments is key to generating competitive advantage. Research on innovation diffusion suggests that adopters can be divided into categories

based on when they adopt the innovation and what factors they find most relevant in making adoption decisions (Rogers, 1995). We draw on this existing research on consumer heterogeneity and the fit with the firm's pre-entry experience of the firm to generate novel hypotheses about the relationships between different types of pre-entry experience and firm performance.

2.1 The Role of Core Pre-Entry Experience

In line with Teece (1986) and others, we consider core experience and resources as those accumulated within a focal technological paradigm. To be "pre-entry" experience, this core experience must be accumulated in a different market space. Typically, this market space is geographically different, where the firm sequentially rolls out the focal technology in different countries or regions. This is consistent with Helfat & Lieberman's (2002) view of "different geographic location" as a key distinction among types of experience (p. 729). The argument is that pre-entry experience with the focal technology builds core knowledge about technology and consumer needs that can be brought to the new market space. Pre-entry core technical experience could also include moving to an entirely new consumer segment with the focal technology, such as expanding from business-to-business to business-to-consumer sales, or a closely related technology.

Core experience may be related to resources and capabilities that affect post-entry performance in multiple ways.[1] First, core experience involves an understanding of the focal technology, which may make firms more innovative. Klepper & Simons (2000) show that related pre-entry experience leads to increased technological and innovative capabilities by looking at the transition from radio to television. Work in disk drives shows that firms are persistent in their ability to stay at the technological frontier across multiple generations of disk drives, which leads to greater firm performance (Franco, et. al., 2009; King & Tucci, 2002). Sosa (2009) showed how pre-entry

[1] An additional explanation – that firms with core technical experience in another market are simply large multinational firms, and gain advantage based on that status – will be investigated empirically.

experience in other closely related pharmaceutical arenas helped firms entering the anti-cancer drug market be more productive in their R&D. Second, firms with core pre-entry experience accumulate important information about how consumers interact with the new technology. This is important because it results in a better understanding of the needs and wants consumers with respect to the focal technology (Helfat & Raubitschek, 2000). Such an understanding of consumer desires has long been a key aspect of success in the marketing literature (Slater & Narver, 2000; Grossman, 1998). Knowledge of consumer desires and of how consumers interact with the technology can help the firm identify profitable consumer segments and aid in targeting those consumers.

If pre-entry experience drives the types of capabilities and knowledge described above, it is important to consider how these resources fit with the preferences of different consumer segments. First, work on the diffusion of innovation suggests that early adopters are likely to be more technologically sophisticated and technology-oriented (Rogers, 1995; Agarwal & Prasad, 1998), and thus would be drawn to a firm with higher innovative capabilities. Second, the population of early adopters is relatively small in all models of innovation diffusion and adoption decisions. The literature on innovation diffusion (e.g., Rogers, 1995) argues that consumers focused on technological features and being at the leading edge of a new technology will be comparatively small in number, as evidenced by naming later adopting groups "early majority" and "late majority".

Third, early adopters of a technology often place a higher value on the technology, primarily because they use it more intensively. Research on innovation adoption finds that early adopters are willing to purchase before the technology's success is assured (Cabral 1990; Cabral, Salant and Woroch 1999; Farrell and Saloner 1986; Grajek and Kretschmer 2009; Kretschmer 2008). Rogers (1995, pp. 269-270) cites early adopters as having more education, greater social status and mobility – all factors related to wealth (and implicitly willingness to pay). This implies that, from the firm's perspective, early adopters will be *higher quality* users, as the firm can charge more for the initial

purchase or charge for higher usage rates. This aligns with suggestions from marketing practitioners that consumers that have been with the firm longest are generally the most profitable (Reichheld and Sasser 1990; Zeithaml, Rust and Lemon 2001).

Thus we suggest that firms with pre-entry core experience – experience with the focal technology in a different market – possess technical capabilities and knowledge of consumer needs that help them attract a specific consumer segment. This segment is likely to (a) be a comparatively small portion of the long-term market, (b) use the new technology more intensively than other segments, and (c) make adoption decisions earlier in the technology's life cycle than other segments. The first two points paint the picture of a small group of high quality consumers. The third aspect highlights an important choice the firm must make to secure this small group of high quality users – namely entering early to be present when these consumers make adoption decisions. In an industrial context with switching costs such as mobile telephony, late entry means that competing firms have locked up all high quality consumers. Jointly, this leads to our first two hypotheses:

H1: Firms with core pre-entry experience will attract higher quality users than firms without such experience.

H2: Core technical pre-entry experience will benefit firms that enter early more than firms that enter late.

2.2 The Role of Market Pre-Entry Experience

We define complementary pre-entry experience as experience in the focal geographical market and with the same consumers, but a different technology or product. Such experience helps firms accumulate complementary assets, which facilitate the commercialization of products and services created with core technical knowledge (Teece, 1986), and include brand names, marketing and distribution organizations, customer service activities and other competences (Helfat & Lieberman, 2002). There is a wide literature on the accumulation and importance of complementary assets and knowledge. For example, Tripsas (1997) shows how typesetting companies facing technological transitions that destroyed the value of their complementary assets were slow to

transition from the old to the new, while these firms could easily cope with changes that preserved the value of complementary assets. Arora and Ceccagnoli (2006) discuss how the possession or lack of key complementary assets has important implications for decisions about licensing out technological innovations.

Broadly speaking, there are three interrelated ways in which resources accumulated through complementary pre-entry experience may improve performance. First, firms with experience in the focal market possess existing consumer relationships and information. This includes information rents about the details of specific consumers, as well as the ability to bundle existing products with new products (Stremersch & Tellis, 2002; Adams & Yellen, 1976). Second, complementary experience can generate brand names, brand loyalty, and consumer awareness that encourage adoption (Nerkar & Roberts, 2004). This is related to the idea of brand extensions in the marketing literature (Broniarczyk & Alba, 1994; Völckner & Sattler, 2006). Third, complementary pre-entry experience may generate distribution assets that facilitate commercialization (Rothaermel, 2001).

Returning to the differences between early and late adopters of a new technology (Mahajan, Muller and Srivastava 1990; Rogers 1995), later adopters may place less value on the new product than earlier ones, as they are less certain of its benefits to them and more cautious in their adoption decisions (Taylor & Todd, 1995). These consumers are more likely to adopt when offered a familiar and trusted brand name, as comfort and trust in the provider are important adoption determinants (Pavlou, 2003). It is also important to note that, as pointed out earlier, later adopter groups in innovation diffusion models are typically significantly larger than early adopter groups – the "mass" of the market. This is supported by research showing that brand names primarily provide advantages in terms of market share (Urban, Carter, Gaskin and Mucha 1986; Brown and Lattin 1994).

Thus, strong brands and other complementary assets in the context of a new technology are more likely to appeal to a group of adopters that (a) is significantly larger than the early adopter

group, (b) makes their adoption decision later, and (c) may place less value on the technology and therefore use it less. Thus, our hypothesis on complementary pre-entry market experience is:

> *H3: Firms with complementary pre-entry experience will attract a higher quantity of users than firms without such experience.*

Note that we do not hypothesize that complementary experience will benefit late entrants more than early ones. The logic for H2 suggests that in industries with switching costs firms must be active when the consumers that value their specific pre-entry experience make adoption decisions. Given that complementary experience will help firms attract consumers that adopt relatively late, these firms may enter either early or late to be present when their segment adopts. It may be inefficient and unprofitable for these firms to incur the costs associated with entering early, but from a revenue perspective (which is the focus of this study) it should not matter when these firms enter.

The theoretical perspectives offered in this study suggest that the different types of pre-entry experience – core versus complementary – can each provide an advantage, but through nearly opposite processes. Core experience helps firms target a small group of early-entering, high quality consumers, while complementary experience helps firms target a large group of late adopting, low value consumers. This suggests that we have to consider the fit between the pre-entry experiences and resources the firm has accumulated and the needs and wants of the consumer segments available in the new market space. We hence focus on three firm characteristics – core technical pre-entry experience, complementary pre-entry experience, and entry timing – and two market outcomes – average usage intensity and firm market share – to investigate implications for firm performance.

3. THE MOBILE TELECOMMUNICATIONS INDUSTRY

Our empirical investigation of these hypotheses is set in the global second generation (2G) mobile telecommunications industry. Mobile telecommunications, and specifically the launch of 2G networks, has been one of the most successful and economically significant technology introductions in recent decades. This contrasts with 1G (analog) mobile networks, which were

launched in many countries in the 1980s. 1G networks generally targeted business consumers, had very low penetration rates, and did not operate long enough before the emergence of 2G (digital) networks to ever be profitable. The rollout of 2G networks began in Finland in 1991, and continued on a country-by-country basis through the 1990s and early 2000s. These 2G networks often focused on business consumers initially, but quickly grew to include mass-market consumers as well.

For our study, the heterogeneity among 2G operators in various countries is particularly interesting. Our sample features many firms with pre-entry telecommunications experience in the focal country, typically through fixed line (copper and fiber) and 1G (analog) systems. While 2G was technologically different from both (fixed line used ducts instead of wireless towers, while 1G was analog instead of digital and had other important technical differences), experience in in the focal market in prior technological generations provided firms with an established brand name and consumer relationships that they could extend to 2G. In addition, many multinational firms (e.g., Telefonica, British Telecom, NTT DoCoMo) created 2G networks in multiple countries over time, leveraging their core technological experience to move into new geographical markets. As discussed in Section 4, these differences define our measures of core and complementary experience.

From a regulatory perspective, government involvement in the industry allows for a clear definition of early versus late entrants and rules out some potential explanations of performance. Market structure in a given country was typically determined by the government granting licenses to a limited number of operators, with additional entrants sometimes granted subsequent licenses. Moreover, government licenses typically specified technological standards beforehand, and these technologies were made available to operators on a nondiscriminatory basis. Thus, it is unlikely that firms could differentiate through technological innovation because of the standardized nature of the technologies involved, although we discuss this idea in Section 5.3.

In terms of consumers, there are three important points. First, mobile phone users make two decisions: they decide to adopt a mobile phone or not, and they make (more or less) continuous usage decisions. This presents us with at least two channels for firm-level advantages: some firms may be good at attracting a large volume of subscribers, and some firms may be successful at attracting high-quality users (those that use their phones more).

Second, prior research on mobile telephony shows that early adopting consumers tend to be heavy users (Grajek and Kretschmer 2009). This aligns with prior research on the diffusion of innovations, where early adopters place a higher value on the new product. Thus, given significant per-consumer fixed costs in terms of consumer acquisition, billing, and service combined with the fact that consumers run up bills based on minutes used per month, high-usage consumers are a potentially attractive and profitable segment.

Third, switching costs are an important part of the evolution of the 2G mobile industry. Introductory offers (e.g. subsidized handsets), an initial lack of number portability, long-term contracts and network effects created through discounts within-network calls are all key aspects of 2G switching costs (Laffont et al. 1998, Cabral 2011). Prior research on 2G has shown that switching costs were a contributing factor to the higher performance of early entering mobile networks (Gomez and Maicas, 2011). Thus, the notion that firms needed to be present in the industry when their target consumer segment made adoption decisions is clearly relevant.

4. DATA AND DESCRIPTIVE ANALYSIS

We draw our data predominantly from two sources used in previous studies (Genakos and Valletti 2011, 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, average prices, and technological standards. Merrill Lynch provides data on the total number of called minutes per operator, which we

use to construct the average usage per consumer.[2] Both data sources are frequently used by commercial firms for significant decisions, ensuring a high degree of accuracy.

We also 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). As the latter only provides yearly data, we linearly interpolated the variables to arrive at quarterly data.[3] We also gather data on firm structure, ownership, and mobile and fixed brands to assess whether firms had access to knowledge from previous entries or incumbency through major shareholders and if it was using the same brand for fixed and mobile operations. These data were drawn from company histories, news reports, and prior research on the evolution of the 2G industry (Noam & Singhal, 1996). The authors and a 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 the cutoff between financial and strategic investments.

Our final dataset features quarterly data on 90 mobile phone network operators in 30 countries from the fourth quarter of 1998 through the second quarter of 2004. All measurements are at the SBU (i.e., firm-country) level of analysis. Our two main dependent variables are the average usage on each operator's network (Minutes of use, *MoU*) and the number of subscribers as a share of the country's population (*CellSubs*).

To capture pre-entry experience, we construct a set of dummy variables indicating if a firm had prior experience with 2G (digital) in other countries, had prior 1G (analog) experience in the focal country, or was a fixed-line incumbent in the focal country. We code prior 2G experience as

[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.

core technological pre-entry experience (*CoreExp*). Conversely, experience in the focal market in either of the two prior generations of telecommunications technologies (fixed line or 1G) might not generate directly transferrable technological knowledge, but would generate sales resources and brand image in the focal country. We therefore consider these two types of experience (1G and fixed line) complementary pre-entry experience (*ComplExp*). Note that 1G experience could be classified as core or complementary. On the one hand, it is experience in the focal market, but it was largely unsuccessful given the initial investments made and thus may not have generated sufficient complementary assets to provide an advantage. On the other hand, it is wireless communications experience but not in the focal technological generation. Therefore, in our additional analyses (Section 5.3) we test 1G experience independently and show that its classification does not affect our main results. In addition, if the firm was the first to offer service in the country, we tag them as an early entrant (*EarlyEntrant*).[4] Variable definitions for all variables and descriptive statistics are reported in Table 1, and a full correlation matrix is in the Appendix.

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5. ANALYSIS AND RESULTS

We focus on two dependent variables – usage (*MoU*) and penetration (*CellSubs*). However, the decision to subscribe to a network and how many minutes to use are connected, and the endogeneity between the two makes it difficult to cleanly identify the effect of firm-level (time-invariant) variables on these outcomes. Econometric approaches that include both time-varying and time-invariant predictor variables (e.g., standard OLS or panel models with random effects) cannot adequately address both endogeneity and important differences between firms. We therefore utilize a two-step approach. First, we use two simultaneous equations with instrumental variables to build

[4] In some cases, two firms entered at the same time and both were tagged as early entrants. In fact, 22 out of the 41 early entrants in our sample are of this sort. In general, there were only 3-4 firms in each market so finer-grained distinctions on entry timing have not been possible to investigate.

models of penetration and usage that include time-varying predictors as well as time-invariant firm-specific effects. Second, as our core variables of interest (*CoreExp*, *ComplExp* and *EarlyEntrant*) are also time-invariant, we extract the firm-specific effects from the first set of regressions and use them as dependent variables in the second step. This helps us address concerns about endogeneity and simultaneity in the first step, and investigate time-invariant effects in the second step. In fact, the two-step approach is both convenient and necessary, because the coefficients on any time-invariant variables are not identified in the first step of our analysis given our use of firm-specific effects. More detail and the results are given below.

5.1 First Step: A Model of Usage and Subscriptions

In the first step of our analysis (used to derive firm-level effects on usage and penetration for further analysis), we use a simultaneous-equation model to investigate the nature of performance based on pre-entry experience and entry timing:

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

$$CellSubs_{ijt} = \beta_{ij} + \gamma_0 * CellSubs_{ij(t-1)} + \gamma_1 * CellP_{ijt} + \gamma_2 * CellP_{i(-j)t} + \gamma_3 * FixedP_{it} + \gamma_4 * MoU_{ijt} + \gamma_5 * CellSubs_{i(-j)t} + \gamma_6 * FixedSubs_{it} + \gamma_7 * GDP_{it} + \gamma_8 * Prepay_{ijt} + \rho_t + \zeta_{ijt}, \quad (2)$$

where i, j, and t refer to country, mobile network operator, and time, respectively. Equation (1) seeks to explain the average usage intensity of a subscriber to a given operator. In particular, we consider own price ($CellP_{ijt}$), the average price of other mobile network operators in the country ($CellP_{i(-j)t}$), and the price of local fixed-line connection ($FixedP_{it}$) as well as an operator's own network of subscribers ($CellSubs_{ijt}$), subscribers to other mobile network 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 ($Prepay_{ijt}$). We control for global conditions affecting telecommunications (namely technological advances and the telecom recession of the early 2000s) with fixed effects for

each time period (φ_t *and* ρ_t). Finally, we include lagged usage ($MoU_{ij(t-1)}$) to control for consumer inertia and learning and operator-specific effects (α_{ij}), which capture unobserved heterogeneity among operators.[5] Equation (2), which explains the share of subscribers to a given operator of the 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, the subscription and usage of mobile phones by consumers may be a joint decision influenced by the same missing factors in both equations.

Equations (1) and (2) contain lagged dependent variables, which lets us compare carriers at different stages of the diffusion process, and operator-specific fixed effects, which lets us control for unobserved (in this stage) heterogeneity among firms. We use the estimation method 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 models with lagged dependent variables and fixed effects. We instrument for prices, network sizes, and prepay share, as they may be endogenous in both equations, as discussed in more detail in the Appendix. The goal of these equations is to obtain operator-specific effects, which we then regress on our measures of pre-entry experience and entry timing in Section 5.2.[6] Table 2 presents regression results of mobile phone usage and penetration equations (1) and (2). The test statistics for the Arellano-Bond AR(2) and the Hansen J tests of overidentifying restrictions are not significant, giving us confidence in our instruments.

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As discussed before, the results in Table 2 are not the focus of this study, as we use these regressions to obtain operator-specific effects further investigated in Section 5.2. It is however worth

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

[6] Note that because we use the Arellano and Bond (1991) estimation, which involves first-differencing of the estimated equations (1) and (2), we cannot estimate the operator-specific effects or a coefficient on any time-invariant variable including pre-entry experience. We can, however, recover the operator-specific effects by comparing actual values of *MoU* and *CellSubs* with the predicted ones based on the estimates of δ's, γ's, φ's and ρ's in equations (1) and (2).

briefly looking at the results. Lagged dependent variables are strong predictors in both equations confirming inertia in both usage and subscription choices. Own price and network size are negative and significant in the usage equation, as expected. This latter effect can be explained by less heavy users joining as the network grows, consistent with Grajek and Kretschmer (2009). The coefficient on price of other operators (negative and significant at the 10% level) provides some evidence of complementarity in usage of mobile phones across networks. This can be explained by reciprocity: users tend to call back after being called. Prepay share and GDP are also significant and have the expected signs—negative and positive, respectively—in the usage equation. In contrast, own price is not statistically significant in the penetration equation and GDP is actually negative and significant. 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 generate the expected effect. What the GDP variable may capture in the penetration equation is that diffusion in richer countries (with corresponding lower changes in GDP per capita over time) is faster than in poorer countries. Experimentation with other functional forms of the GDP variable does not alter our results. Interestingly, average usage intensity is positive (at the 10% significance level) in the penetration equation suggesting that high-intensity users may be more influential than low-intensity users in fueling mobile phone subscriptions. This is consistent with network effects being important for less technology-savvy subscribers.

5.2 Second Step: How Firm-Level Experience Affects Usage and Subscriptions

To answer our core theoretical questions, we are primarily interested in the operator-specific effects from equations (1) and (2), and the relationships between these effects and our set of firm experience and entry timing variables. Before looking at those regressions, it is helpful to see the distribution of the effects visually. These are shown in Figures 1a (for usage, *MoU*, by core experience, *CoreExp*) and 1b (for penetration, *CellSubs*, by complementary experience, *ComplExp*), in

accordance with our theoretical considerations. From these graphs, we can see that these effects are not highly skewed in either case. We can also see that firms with core experience have higher variance in their persistent usage effects (Figure 1a), suggesting there may be other contingent factors that play a role. Firms with complementary experience appear to have higher subscription effects on average (Figure 1b). Clearly however, these are just descriptive observations that we will subject to a rigorous empirical test in the second part of our analysis.

---------- INSERT FIGURES 1A AND 1B ABOUT HERE ----------

To investigate these observations in more detail, we regress the operator-specific effects on our set of core and complementary experience and entry timing dummies and report the results in Table 3. We also include a dummy for a firm operating in a country that entered 2G early to capture country differences stemming from the timing of the rollout of the technology. We find that this coefficient is positive and significant in the penetration regressions, suggesting that countries that launched 2G first have the highest market potential. The first usage regression (as well as the subsequent ones) shows that *CoreExp* is not significant, suggesting that there is no linear effect of core experience on usage intensity, which does not confirm Hypothesis 1. We find, however, that the interaction term of core experience and early entry (*EarlyEntrant*CoreExp*) is positive and significant in the usage regression (3) and that the linear coefficient on early entry becomes insignificant. This suggests that core experience only benefits firms that enter the market early as suggested by Hypothesis 2. These results suggest that H1 only holds for firms with core pre-entry experience that enter early, while H2 is confirmed through the significant interaction term.

Further, we find that, while the *EarlyEntrant*CoreExp* interaction is positive and significant in regression (3), the interaction is negative and significant in the penetration equation (6). Accordingly, core pre-entry experience only provides a benefit in attracting a smaller segment of more valuable consumers. These results are explored in more detail in Sections 5.3 and 6.

Hypothesis 3 suggests that the effect of complementary experience would appear in the penetration equation. In regression (4), *ComplExp* has a positive and significant effect on penetration, while in regression (1) it has no effect on usage. Complementary pre-entry experience thus increases market share, but does not affect the quality of a firm's user base. This supports H3.

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5.3 Further Analyses: Mechanisms Driving the Results

The results above show that pre-entry experience indeed plays a different role depending on whether it refers to core or complementary experience, and provide support for our hypotheses. Pre-entry experience with 2G networks elsewhere helped firms attract higher-usage consumers if they entered early enough to target these consumers, while pre-entry experience in the same geographical market helped firms attract a larger volume of users. The explanatory variables in our first step regressions let us rule out some explanations for these findings. For example, by controlling for price in equations (1) and (2) we exclude the possibility that the effect of core technical experience simply allows firms to charge a higher price than their competitors. Similarly, we can rule out the argument that strategic decisions about pre-pay services or network size might be the means by which firms with core and complementary experiences achieve higher performance. As outlined when developing the hypotheses, however, there are still multiple mechanisms that might lead to these results. We now exploit in-depth industry information and additional data to investigate these mechanisms. We report additional tests in Table 4.

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5.3.1 Core Technological Experience (Prior 2G Experience)

For core experience, which we proxy with 2G experience in a different country, three mechanisms could lead to the relationship we found. First, our 2G experience variable may simply identify large multinational firms, and their advantage may be based on something unrelated to our

theoretical arguments. Second, such technological knowledge might allow firms to be more innovative (Klepper & Simons, 2000; Franco, et. al., 2009). Third, such experience might help firms identify consumer needs and target attractive consumers (Slater & Narver, 2000).

To address the first issue on multinational firms, we limited our analysis to only the large multinational firms in our sample (e.g., AT&T, T-Mobile, Telefonica). All of these firms enter at least two countries with 2G networks, so they have at least one observation in the data where they possess prior 2G experience and one observation where they do not. The results, shown in regressions (1) and (5) of Table 4, are very similar to the results in the original analysis, suggesting that the benefits of prior 2G experience and entering early exist even for these firms that are similar in their international operations.

The second explanation – that 2G experience makes firms more innovative – is highly unlikely given the realities of 2G networks and the fact that we focus on revenue-based advantages. All rollout of 2G networks was, effectively, after the establishment of the dominant technological paradigm as standards were set before rollout in most countries. Within each country, 2G was fairly homogenous technologically, e.g. call quality, coverage, etc. This limits the ability of firms to differentiate based on innovation in a way that would attract tech-savvy consumers. Also, handsets could generally be used across networks in most countries (the U.S. is an exception), which limited the ability to differentiate based on handsets. Excluding countries like the U.S. where handsets were specific to a given carrier produces similar results (available from the authors). A further possibility is that firms with prior experience in the core technology were especially successful in rolling out attractive packages for high-intensity users. However, as the key technological novel feature of 2G mobile was text messaging, which was a service especially attractive to mass market consumers (and generally a substitute for voice minutes, which we measure), which adopted 2G mobile later, prior experience in marketing SMS technology is unlikely to generate the observed effect of higher usage

for early-entering firms with core experience. Thus, we do not believe that our results are likely driven by prior 2G experience allowing firms to be more innovative.

This leaves the third mechanism – that prior 2G experience helps firms target the best and most attractive consumers and markets. One part of this story is that prior 2G experience in other countries helped firms realize that some consumers would use their phones intensively, while other consumers might use them very little and thus might be much less profitable for the firm to service. When looking at the distribution of the usage fixed effects by country (shown in Figure 2), we observe strong cross-country differences – consumers in some countries (e.g., Portugal, Czech Republic and Hungary) used their phones much more than consumers in others (e.g., Canada, Argentina and Australia). Thus, it could be that prior 2G experience helped firms identify and target countries that were likely to possess high-usage consumers, and that they needed to enter that country early to capture those high-usage consumers. We assess this by comparing countries that experienced early entry by technologically experienced carriers with all other countries. To do this, we construct a dummy variable *EarlyCoreMarket*, which equals one for markets that saw early entry of a carrier with core experience and zero otherwise. Then we regress the firm-specific effects of late entrants on our experience indicators and *EarlyCoreMarket* (regressions (2) and (6) in Table 4). Note that we exclude the firm-specific effects of early entrants to rule out the possibility that firms are good at identifying markets in which they alone do well. The coefficient on *EarlyCoreMarket* is positive and significant in the usage regression (2) suggesting that prior core technological experience helps firms identify the most profitable markets with attractive consumers and to identify opportunities that will allow them to capture those consumers. It also rules out the possibility that firms target culturally or geographically close countries in which they will do particularly well (e.g. Telefonica of Spain in Latin America, or T-Mobile of Germany in Poland).

---------- INSERT FIGURE 2 ABOUT HERE ----------

5.3.2 Complementary Experience (Prior In-Country Fixed Line and 1G Experience)

As with core experience, we outlined multiple ways in Section 2.2 in which complementary experience would affect market penetration. First, firms could bundle or cross-sell the new technology (2G) with their existing technology (fixed line) to increase adoption. Second, firms could leverage their existing brand name to generate 2G sales. Third, firms might possess downstream distribution assets that facilitate sales of 2G. We examine each below.

First, we test in more detail what kind of in-country experience would increase penetration by individually looking for any potential value created by prior 1G experience in the country. To do this, we redefine the *ComplExp* variable to reflect only in-country fixed-line experience and add the 1G experience variable in regressions (3) and (7) of Table 4. 1G was unsuccessful given its modest penetration rates and its relatively short window of opportunity. It also largely targeted business consumers as opposed to mainstream consumer adoption. Regression (7) in Table 4 shows that there is no relationship between 1G experience and 2G market penetration rates, and that even when we control for 1G experience fixed line experience is still positive and significant. Thus, it appears that in-country experience is only helpful if it is successful and large-scale.

Second, we split the firms with fixed line experience into two groups – those that used the same brand name and logo for their 2G and fixed line businesses (e.g., Verizon and AT&T in the U.S., T-Mobile in Germany; coded as *SameBrand* =1) and those that used different brands for each (e.g., Orange in France, Unifon in Argentina; *SameBrand* = 0). If the value of fixed line experience was brand-related, then only firms that used the same brand should receive the benefit. Regression (8) in Table 4 shows exactly that – firms using the same brand receive a significantly higher benefit in terms of market penetration from their prior experience than firms that used different brands (coefficient on *SameBrand* positive and significant), This supports the argument that the benefit of pre-entry fixed line experience in the focal country is tied to the ability to leverage a known brand

name to attract consumers. It also casts doubt on the validity of alternative explanations like bundling or active cross-selling as such benefits would be available to any fixed line provider whether they used the same brand name or not (fixed and mobile operators are still considered under the same ownership in both cases). Further, most fixed line companies did not have the type of retail stores that were required to sell 2G services in existence before they launched 2G networks, diminishing the likelihood that distribution assets played a significant role. It is still possible that bundling, consumer information, and distribution assets are important for driving market share, but any effect is contingent on re-using the same brand name across fixed and mobile telephony.

Our further investigations of both core and complementary experience yield important insights into the sources of these effects. First, pre-entry core experience in the focal technology provides vital information to the firm about which types of consumers are actually profitable and how to target them. This experience leads firms to pursue markets where they can both identify and attract high-quality consumers. This resembles a learning story – learning about different segments of consumers, their desires, and their relative attractiveness. Second, pre-entry complementary experience in the focal market provides a specific resource that attracts a large volume of consumers – an established brand name. Firms using the same brand name for their fixed line and mobile businesses attract more consumers than fixed line firms that do not.[7] These mechanisms for core and complementary experience lend depth to our theoretical and empirical results, and extend our understanding of how exactly pre-entry experience affects post-entry performance.

5.4 Robustness Checks

We implemented a number of robustness checks that we do not report to save space (all are available from the authors), but discuss briefly here. First, we excluded countries with unique

[7] Note that our results cannot distinguish between firms that choose not to re-use the same brand name versus firms whose fixed line brand is not valuable enough to reuse.

characteristics. This meant excluding the U.S. alone (as the country has multiple different technological standards) and then all countries using Receiver Pays Policy (RPP, where the receiver of a call pays for minutes of usage as well). The former produces the same qualitative results, while the latter produces similar results with attenuated significance (as expected with a smaller sample and only 90 observations to begin with). Second, in some instances the same parent company owns or has a significant interest in multiple network operators, such as T-Mobile or Vodafone operating in multiple countries. To address this, we clustered standard errors at the parent company level and obtained nearly identical results. Third, we included additional interaction terms, but they were not statistically significant and had no theoretical basis. Fourth, it is possible that the effects we found decay rapidly within each individual country and are thus unlikely to be long-term effects. To test this, we interacted some of our key variables with a measure of "time on air" for the firm to see if the effects were decaying over time. The results show no decay for usage and actually an increasing effect for penetration. Still, our time window (five years) is relatively limited, and so the effects may decay over a longer period. Indeed, utilizing the dynamic nature of our data and constructing a system in equilibrium (i.e. constant subscriber numbers and constant usage over time) we obtain long-term effects of prior core experience contingent on early entry of and prior market experience.[8] We calculate the long-run usage and penetration effects to be 132.7 minutes and -2.6%, respectively, for early entrants with core experience and -55.2 minutes and 6.2% for firms with complementary experience. That is, an early entrant with core experience enjoys higher per-subscriber usage intensity of over two hours per month, but has a lower network penetration by 2.6%. Interestingly, *ComplExp* yields a usage long-run disadvantage of 55.2 minutes while the short term effect in Table 3 is insignificant. This disadvantage is driven by the penetration advantage of 6.2% which exerts

[8] The derivations of the long-run effects are given in Appendix A.1.

downward pressure on average usage - later adopters are less intensive users, as shown by the negative coefficient on own subscribers in the usage equation in Table 2.

Finally, we explore whether core and complementary experience and entry timing have different effects depending on how entrants were chosen. In other words, if entry is endogenous in the sense that "better" firms with a set of prior experience are able to enter markets early, our results might only hold for a set of countries in which the entry process rewarded such firms. We study this with data on the method of providing mobile licenses, with the idea that entrants chosen through more competitive and efficient processes (auction and comparative selection, or "beauty contest") would be more effective than those chosen by direct award. The results for usage suggest that this is indeed the case; early entrants enjoy a usage advantage if they were awarded the license through a competitive process, but not if the license was awarded directly.[9] Our main results, however, still hold after controlling for this potential source of endogeneity; i.e. early entrants with core experience have significantly higher usage intensity on their networks even after controlling for the license award mechanism. Thus, firms with core pre-entry experience can utilize their strengths better in markets with a more competitive award system, but our main results are not driven by this.

6. DISCUSSION

We theoretically and empirically investigated how different types of pre-entry experience lead to different types of post-entry advantages. We did so by building on the distinction between core and complementary resources (Teece, 1986; Helfat and Lieberman, 2002) and the innovation diffusion literature (Rogers, 1995). Our central argument is that core and complementary pre-entry experience affect post-entry performance in nearly opposite ways (while not being mutually exclusive). Pre-entry experience with the focal technology increases the firm's core resources and knowledge (Klepper and Simons, 2000; Franco, et. al., 2009), which in turn attracts the relatively

[9] Our results for market penetration are unaffected by controlling for the award procedure.

small segment of early adopting, high quality consumers. Our extended analysis shows that this effect is primarily driven by learning – firms learn which consumers are most attractive and how to target them based on their experiences in other markets. Conversely, pre-entry experience in the focal geographical market increases the firm's complementary resources and knowledge (Arora and Ceccagnoli, 2006; Tripsas, 1997), which attracts a larger segment of late adopting and lower value consumers. This is driven largely by leveraging an existing brand and consumer awareness to drive technology adoption. These theoretical and empirical findings contribute to prior work on pre-entry experience, demand-side research in strategy, and international business. We discuss these below.

In recent research, the interest in pre-entry experience has moved beyond entrants-versus-incumbent dynamics to consider the notion that firms may bring relevant experience from related industries that affects post-entry outcomes (Sosa, forthcoming; Ganco & Agarwal, 2009). We push this line of reasoning one step further – depending on the type of pre-entry experience the firm possesses, the implications will be different. We show how distinguishing between core and complementary experience has important implications for firm strategies and performance. More generally, a careful consideration of exactly what resources, knowledge, and capabilities diversifying entrants bring to a new industry would improve our understanding pre-entry experience and its effect on post-entry performance.

While the marketing literature focuses a great deal of attention on consumers and segmentation, there is less attention in strategy on the role played by consumers in creating firm-level advantages. This study adds a different perspective to existing work on consumer heterogeneity and the implications for competitive advantage (Adner & Zemsky, 2006; Adner & Snow, 2010). We emphasize that the degree of fit between the knowledge and resources of the organization and the preferences of distinct consumer segments drives which consumers firms will attract and how successful they will be in profiting from those consumer segments. Future work identifying

heterogeneity in firm-level strategies should more clearly identify heterogeneous consumer segments and their implications for strategy and competitive advantage.

Our results also suggest that prior 2G experience has a *negative* relationship with market share. The most obvious explanation for this effect is the "liability of foreignness" (Zaheer, 1995), as these firms are all multinationals entering a foreign local market. While this is possible, we offer an alternative explanation based on the mechanisms that support our hypotheses about attracting more valuable consumers. We suggested that firms with prior 2G experience might be able to recognize that some potential consumers are less profitable and focus primarily on more profitable consumers (heavy users of the technology). Taken further, this perspective suggests that firms following this strategy might prefer to have a smaller market share, taking on only those consumers they consider profitable. Future research on multinational organizations could investigate the extent to which multinational firms might choose to focus on a limited portion of the population – at least for a period of time after entry – to maximize their performance, creating a perceived liability of foreignness but in fact capturing the firm's strategic decision.

From an empirical perspective, this study also contributes to the emerging literature on the evolving nature of firm-level advantages in the mobile telephony industry (Gomez and Maicas, 2011; Muck and Heimeshoff, 2011). Focusing on this global and economically important industry, our analyses show that different types of experience have helped firms improve their performance, though in different ways, and that entry timing in this industry (given the significantly higher value of early consumers and the presence of switching costs) plays a vital role in understanding firm profitability. This has 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 pre-entry experience, 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. Further, while we offer multiple extended analyses that provide important insights, we do not have enough information to unambiguously identify the true drivers of advantages in this context. Additional research on the specific mechanisms is needed to provide better insights about how (for example) prior experience with the technology in other locations affects subsequent strategic decisions.

This study looks at the role of pre-entry experience. We specifically consider the fact that early adopting consumers will be different from late adopting ones. We suggest that firms with core technological experience entering early will attract higher-quality consumers. Conversely, firms with existing marketing and branding resources in a given country will do better at attracting a high volume of lower-value consumers – late adopters influenced by brand effects and awareness. Our empirical results on the global mobile telecommunications industry confirm our intuition and add depth to the discussion about different type of pre-entry experience.

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Fig. 1a. Histograms of Firm Fixed Effects from Usage Intensity Regression

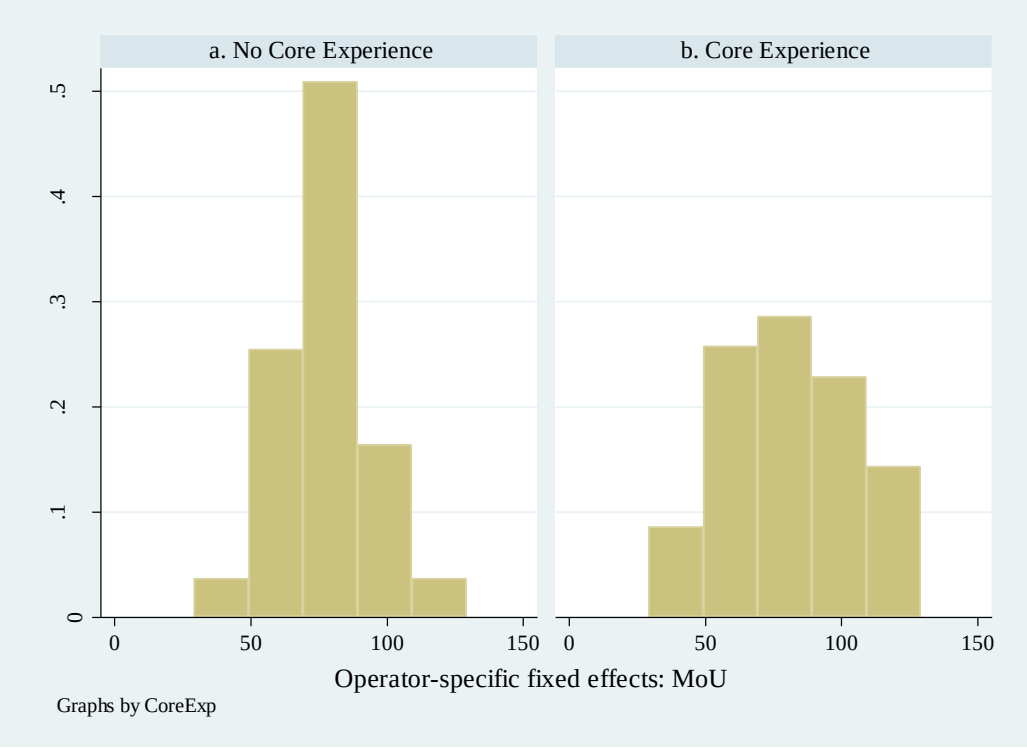


Fig. 1b. Histograms of Firm Fixed Effects from Penetration Regression

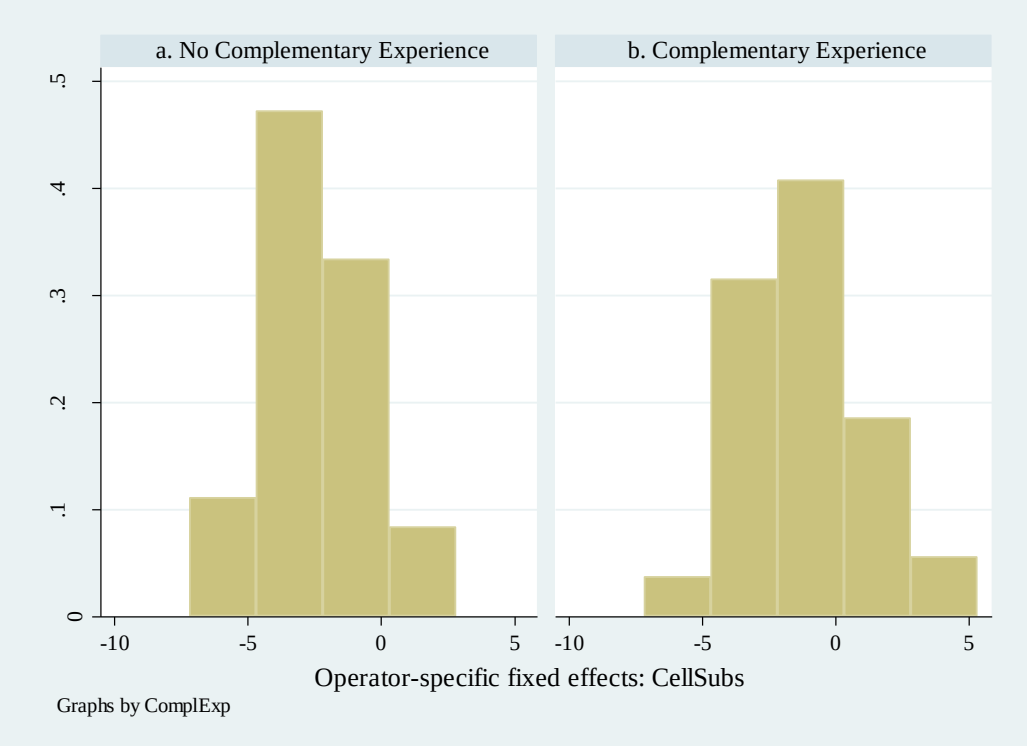
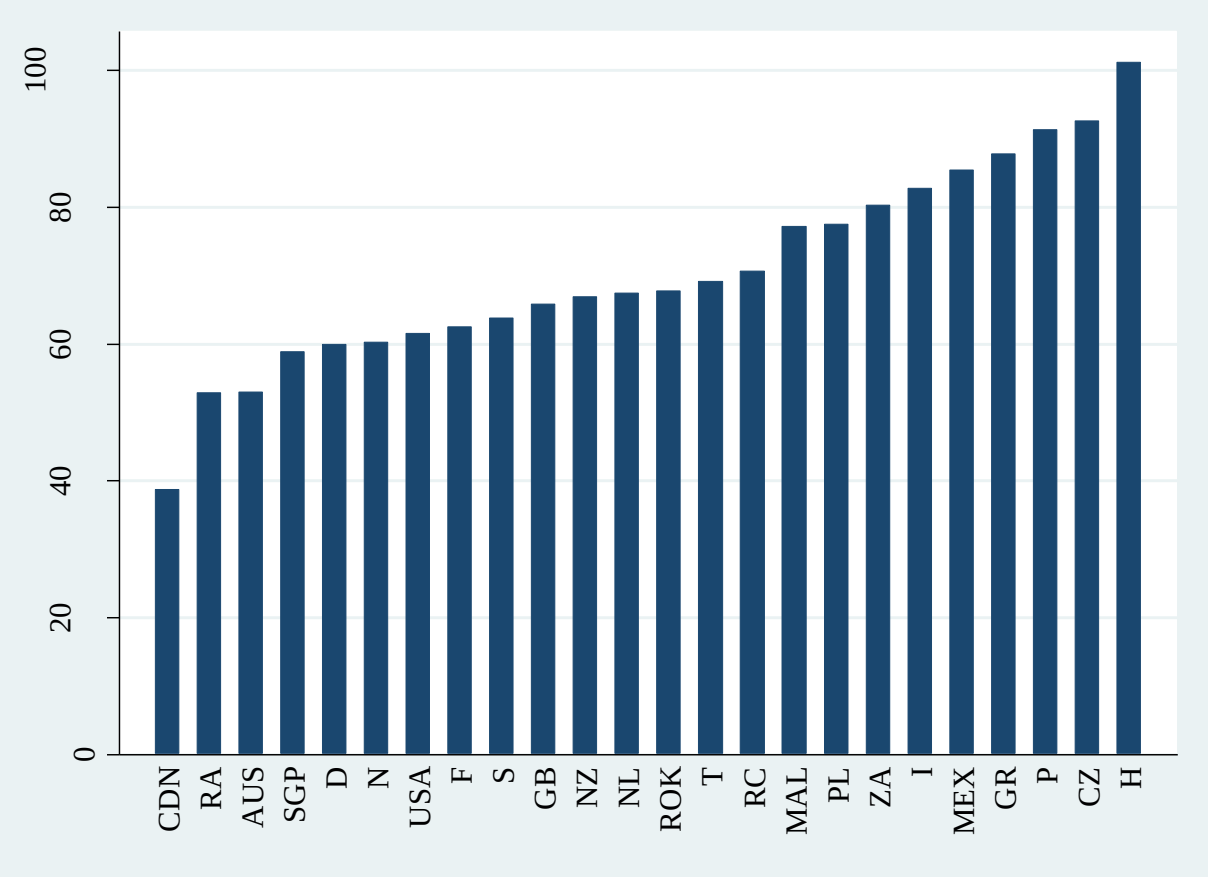


Fig. 2. Distribution of Usage Fixed Effects by Country



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 mobile network operator in a given market (dummy)	1044	0.47	0.50	0	1
ComplExp	Incumbent fixed-line operator or 1G service operator in a given market or both (dummy)	1044	0.59	0.49	0	1
CoreExp	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 mobile telephony before 1995 (dummy)	1044	0.70	0.46	0	1

Tab. 2. Mobile phone usage and penetration regression results

EQUATION:	MoU(t)	CellSubs(j)(t)
	(1)	(2)
MoU(t-1)	0.845***	
	(0.028)	
CellSubs(j)(t-1)		0.858***
		(0.034)
CellP(j)	-1.517***	0.051
	(0.565)	(0.043)
CellP(-j)	-0.743*	0.053
	(0.413)	(0.046)
FixedP	0.456	-0.019
	(1.364)	(0.075)
MoU(t)		0.006*
		(0.003)
CellSubs(j)(t)	-1.239**	
	(0.496)	
CellSubs(-j)(t)	-0.053	0.012
	(0.221)	(0.023)
FixedSubs	0.027	-0.006
	(0.497)	(0.033)
Prepay	-0.325	0.043**
	(0.278)	(0.018)
GDP	1.581***	-0.083***
	(0.447)	(0.030)
AR(2) test	-1.39	-1.41
Hansen J statistic	72.55(178)	63.22(178)
Observations	1044	1013
Clusters	90	90

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

Coefficients on time fixed effects not reported

Tab. 3. Regression of operator-specific effects on experience indicators

EQUATION:	MoU			CellSubs(j)		
	(1)	(2)	(3)	(4)	(5)	(6)
EarlyEntrant	12.298***	19.507***	4.853	0.636	0.933	1.592***
	(3.989)	(6.394)	(5.133)	(0.462)	(0.749)	(0.591)
EarlyCountry	-1.756	-1.356	-0.018	1.490***	1.506***	1.267**
	(4.492)	(4.473)	(4.460)	(0.520)	(0.524)	(0.513)
ComplExp	-0.904	3.965	1.063	1.209**	1.409**	0.957**
	(4.079)	(5.283)	(4.083)	(0.473)	(0.619)	(0.470)
CoreExp	1.891	0.850	-5.423	-1.380***	-1.423***	-0.441
	(4.181)	(4.218)	(5.240)	(0.484)	(0.494)	(0.603)
EarlyEntrant* ComplExp		-11.792			-0.485	
		(8.206)			(0.961)	
EarlyEntrant* CoreExp			17.984**			-2.309**
			(8.063)			(0.928)
Constant	74.866***	72.454***	75.708***	-3.281***	-3.380***	-3.389***
	(5.348)	(5.574)	(5.241)	(0.620)	(0.653)	(0.603)
R^2	0.104	0.125	0.154	0.298	0.300	0.346
Observations	90	90	90	90	90	90

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

Tab. 4. Additional tests of operator-specific effects and experience indicators

EQUATION:	MoU				CellSubs(j)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EarlyEntrant	6.134		11.966***	12.181***	-0.704		0.556	0.658
	(8.107)		(4.093)	(3.961)	(1.115)		(0.459)	(0.450)
EarlyCountry	4.627	11.806*	-1.492	-1.099	1.913*	-0.206	1.452***	1.370***
	(7.517)	(5.948)	(4.509)	(4.481)	(1.034)	(0.686)	(0.506)	(0.509)
ComplExp	-5.472	2.071	1.956	2.569	0.492	1.563***	1.342**	0.577
	(5.473)	(4.439)	(4.609)	(4.661)	(0.753)	(0.512)	(0.517)	(0.529)
1G			-0.325				0.399	
			(4.751)				(0.533)	
SameBrand				-7.654				1.392**
				(5.088)				(0.578)
CoreExp	-8.382	-6.213	2.246	0.851	-2.243**	-0.309	-1.370***	-1.191**
	(7.660)	(4.519)	(4.187)	(4.208)	(1.053)	(0.521)	(0.470)	(0.478)
EarlyEntrant*CoreExp	24.228**				0.029			
	(10.951)				(1.506)			
EarlyCore Market		25.756***				-2.656***		
		(6.121)				(0.706)		
Constant	74.590***	48.927***	73.403***	74.907***	-1.921	-1.158	-3.322***	-3.289***
	(10.517)	(6.548)	(5.138)	(5.309)	(1.446)	(0.755)	(0.576)	(0.603)
R^2	0.404	0.303	0.106	0.127	0.430	0.407	0.343	0.344
Observations	36	49	90	90	36	49	90	90

Table A1. Full correlations between all variables in the analysis (N = 1044)

	MoU	CellSubs(j)	CellSubs(-j)	FixedSubs	CellP(j)	CellP(-j)	FixedP	GDP	Prepay	EarlyEntrant	EarlyCountry	ComplExp	CoreExp
MoU	1.00												
CellSubs(j)	-0.17	1.00											
CellSubs(-j)	-0.01	0.26	1.00										
FixedSubs	0.25	0.22	0.44	1.00									
CellP(j)	-0.55	0.00	-0.05	0.10	1.00								
CellP(-j)	-0.49	-0.05	-0.01	0.09	0.83	1.00							
FixedP	-0.49	0.32	0.37	0.07	0.40	0.44	1.00						
GDP	0.29	0.12	0.25	0.74	0.27	0.26	0.13	1.00					
Prepay	-0.57	0.06	0.01	-0.43	0.09	0.14	0.30	-0.44	1.00				
EarlyEntrant	-0.22	0.39	-0.16	-0.03	0.10	0.06	0.07	-0.08	0.14	1.00			
EarlyCountry	0.04	0.36	0.50	0.59	0.21	0.20	0.32	0.51	-0.09	0.15	1.00		
ComplExp	0.18	0.18	-0.34	0.00	-0.01	-0.04	-0.02	0.19	-0.23	0.18	-0.09	1.00	
CoreExp	-0.33	-0.29	-0.11	-0.37	0.14	0.17	0.00	-0.28	0.34	-0.05	-0.19	-0.21	1.00

Appendix

A1. Instruments used in the estimation of the model

To build the model reported in Table 5, we utilize three sets of instrumental variables. The first group was proposed by Arellano and Bond (1991) to solve concerns about autocorrelation resulting from models with fixed effects and lagged dependent variables. These instruments allow us to consistently estimate the coefficients for those lagged dependent variables.

The second set of instrumental variables tackles possible endogeneity of mobile phone 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 (for a very similar approach, 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 mobile and a fixed-line price index for the rest of Western Europe. To arrive at an operator-specific instrumental variable in the case of mobile telephones, 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.[10] 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, usage 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 Arellano-Bond estimation method involves first-differencing of the estimated equation. Follow-up tests confirm that these are not correlated with the error terms in the regressions.

Finally, it is important to note that the identification of the simultaneous variables in equations (1) and (2) rests on the exclusion restrictions: i) current usage does not depend on lagged penetration (it only depends on current penetration) and ii) current penetration does not depend on lagged usage (it only depends on current usage).

[10] 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:

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

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

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. The differences between a first mover (*k*) and a follower (*l*) in a long-run equilibrium controlling for all other things—i.e. all variables in the vector $\boldsymbol{X}_{ij}$—are then:

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

$$CellSubs^*_{kj} - CellSubs^*_{lj} = \frac{1}{1-\hat{\gamma}_0}\left(\hat{\beta}_{kj} - \hat{\beta}_{lj} + \hat{\gamma}_4\left(MoU^*_{kj} - MoU^*_{lj}\right)\right). \quad (8)$$

Thus, to calculate average long-run differences between the first movers (with technological experience) and the followers in our sample we substitute the estimates from tables 3 and 4 for the respective parameters in (7) and (8) and solve the system of equations. Note that the difference $\hat{\alpha}_{kj} - \hat{\alpha}_J$ in (7) equals to the estimated usage advantage of early entrants with technological experience over late entrants without technological experience (17.984 + 4.853 – 5.423) and the difference $\hat{\beta}_{kj} - \hat{\beta}_J$ in (8) equals to their penetration disadvantage (-2.309 + 1.592 – 0.441). The long-run differences between operators with established brands and the remaining operators can be calculated in an analogous way.