SMART TIMING FOR SMART PRODUCTS?
COMPLEMENTOR MULTIHOMING IN NASCENT PLATFORM MARKETS

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ABSTRACT

In a study of the nascent "smart home" industry, we examine platform complementor strategies regarding entry timing and multihoming timing, with their corresponding performance implications. We find that early entrants multihome faster than later entrants. Also, multihoming scope (number of platforms a complementor joins) is associated with higher complementor performance.

INTRODUCTION

Research on platform-mediated markets has proliferated over the past decade. Many of today's products and services, such as video games, social media, or smartphones, are organized around platforms that facilitate interactions and transactions among firms and individuals (Eisenmann, Parker and Van Alstyne, 2006: Gawer, 2014; Hagiu, 2005; McIntyre and Srinivasan, 2017; Rochet and Tirole, 2006). Platform scholars use the term "sides of the platform" to indicate the types of actors in a given platform. Platforms typically serve different sides: for example, Facebook serves end users, complementors and advertisers. Complementors are actors that provide complementary products or services that run on a platform (Bresnahan, Orsini and Yin, 2015; Gawer and Cusumano, 2002). They have been shown to be crucial to a platform's success because complementors are the source of "indirect network effects" (Rochet and Tirole, 2006).

Despite the importance of complementors, much of the platform literature has adopted the perspective of the platform owner, concerned with how owners can create or maintain competitive advantage in the market against competing platforms (Armstrong, 2006; Gawer and Henderson, 2007; Kapoor and Lee, 2013; Schilling, 2002). This literature focuses on the role of complementors as a source of indirect network effects that help a platform attract more users (Evans, 2003; Rochet and Tirole, 2003). The lack of attention to complementors' competitive dynamics is rather surprising given the size and importance of many complementor markets today; these entrepreneurial ecosystems have a significant impact on economic growth and

employment (Audretsch, Keilbach and Lehmann, 2006; Baumol and Strom, 2007; Jacobides, Cennamo and Gawer, 2016).

Our study builds upon an emerging body of work focusing on the competitive strategies of platform complementors (Ceccagnoli *et al.*, 2012; Cennamo, Ozalp and Kretschmer, forthcoming; Kapoor and Agarwal, 2017; Venkataraman, Ceccagnoli and Forman, 2017). For instance, authors have studied the conditions under which participation in a platform is most favorable for complementors (Venkatraman and Lee, 2004), and examined the impact of complementors' possession of intellectual property (IP) protection and downstream capabilities on their platform adoption decisions (Huang *et al.*, 2013). Other authors have investigated how participation in a platform affects complementor performance (Ceccagnoli *et al.*, 2012) and studied complementors' market entry strategies (Corts and Lederman, 2009; Landsman and Stremersch, 2011).

We contribute to and expand on this literature by focusing on key strategies available to complementors competing in industries transformed by the emergence of platforms. Such transformations have challenged incumbents used to compete in traditional product industries (Parker, Van Alstyne and Choudary, 2016) that must now compete in platform-mediated markets (Bresnahan *et al.*, 2015; Hagiu and Altman, 2017). This transformation comes with great uncertainty for incumbents, not only for the novelty of the new business model, but also because typically several platforms compete for dominance in the new space. Complementors in industries with multiple platforms face several critical entry decisions: when to enter the new platform-mediated space (i.e. join a first platform) and when to "multihome" to other platforms. Multihoming occurs when a complementor offers its product or service in more than one competing platform – a strategy that has become common as platforms proliferate. Complementors multihome to access non-overlapping user bases, spread fixed costs, or reduce dependence on any one platform (Clements and Ohashi, 2005; Kretschmer and Claussen, 2016; Corts and Lederman, 2009).

Multihoming has been comprehensively examined through formal models (Armstrong, 2006; Rochet and Tirole, 2003, 2006; Armstrong and Wright, 2007) but empirical research on the topic has been scant. A recent review of the platform literature lamented the lack of attention paid to complementors' strategies, particularly whether and when they should adopt multiple platforms (McIntyre and Srinivasan, 2017). We argue that multihoming can be an effective hedging strategy for complementors, particularly in the early stage of a platform-mediated market characterized by high technological and market uncertainty.

We first study the relationship between a complementor's strategic decision to enter a new platform-mediated market (by joining any one of the competing platforms) and time to multihome (i.e. time to join a second platform after having joined the first one). Specifically, we examine whether early entrants to the new platform-mediated market will also tend to multihome fast. Second, we explore the relationship between multihoming scope (number of platforms a complementor has joined) and the time it takes to multihome again. Third, we investigate whether multihoming scope is related to complementor performance. Fourth, we test how entry timing, and the average time that complementors take to join existing platforms, interact to influence complementor performance. We found that early entry in a platform-mediated market is associated with shorter time to multihome. Further, our results suggest that multihoming scope is correlated with shorter time to the next multihoming event and better complementor performance. We also found that the risk of early-entry disadvantage, common in fast-moving

industries (Suarez and Lanzolla, 2007), can be mitigated by multihoming faster, a result that lends support to our argument that multihoming can be used as a hedging strategy.

The empirical setting for our study is the ecosystem of complementors that has emerged around several competing "smart home" platforms, a market still in its infancy and therefore rife with technological and market uncertainty (Balta-Ozkan *et al.*, 2013). The entry of large technology firms, such as Google (Nest), Amazon (Alexa), and Samsung (SmartThings), which espouse platform strategies, has rapidly changed the landscape of what only a few years ago was a traditional industry with stand-alone products. With the emergence of these new platform firms, traditional producers of home products, such as thermostats, lighting, locks, and smoke detectors, must decide whether to join the new platforms, how many to join, and how fast. The smart home market has been experiencing considerable and accelerating growth (Begovic, 2013), making our study timely and relevant.

HYPOTHESES

Hypothesis 1: The earlier a complementor enters a platform-mediated market, the faster it will multihome.

Hypothesis 2: The more a complementor multihomes, the shorter the time to the next multihoming event.

Hypothesis 3: The more a complementor multihomes, the higher its performance.

Hypothesis 4: The negative performance effect of a complementor's early entry into a platform-mediated market is mitigated by fast complementor multihoming.

DATA AND METHODS

We created a unique dataset of complementors in the global smart home market that captures the industry from its inception. We focus on five large product categories that are common to all four platforms: lights, appliances, smoke detectors, security systems, and thermostats. We gathered data on global smart device manufacturers. A device is considered "smart" if it has an app-controlled interface. Some of these products are offered in one or more platforms, while others still operate as stand-alone products (only app-controlled). Our panel dataset includes 151 firm-category observations over 33 months, between September 2014 and May 2017. There are 136 unique firms (some firms produce for more than one category) in our dataset. Our unit of analysis is complementor-category-month, and the total number of firm-category-month observations is 4,983.

Variables

Dependent Variables. *Time to First Multihome*: This dichotomous variable takes the value of 1 if the smart device firm produces for two or more platforms at month t and 0 otherwise. We gathered the data on complementor multihoming event by collecting it directly from each platform's "works with" program website. Through news releases, we identified the date when a complementor joined a platform by announcing its compatibility with that platform.

Complementor Performance: Prior research uses different measures of complementor performance such as the rate of consumer demand for the complementor's products (e.g. the number of times each product is acquired by consumers, as in Ozer, 2017), sales (Ceccagnoli, *et al*., 2012) and number of transactions (e.g. downloads, as in Wen, Ceccagnoli and Forman, 2015). Following Ceccagnoli *et al.* (2012), we measure complementor performance using monthly product sales revenue. We log-transform this variable to address skewness in the data.

Independent Variables. *Multihoming Scope*: This variable counts the number of platforms that a complementor produces for at time *t*. *Entry Timing*: This variable captures the time of entry of complementor firms to the nascent platform-mediated markets that began with the entry of Nest, measured as the number of months elapsed from the Nest entry to the date in which a focal firm becomes a complementor of any of the competing platforms. *Average Multihoming Time*: This variable counts the average time (in months) between consecutive platform adoptions for a given complementor. Since the hedging strategy argument relies on the speed of multiple platform adoptions, we consider the average time between consecutive platform adoptions as the measure of multihoming time.

Control Variables. We also control for several factors such as *complementor product quality, complementor market share, number of within-category complementors, complementor type, and smart device category*.

Model Specifications

We use two types of model specifications in the analysis to examine our research questions. The first type focuses on the determinants of how fast complementors multihome (time to multihome). Because of the "time to event" nature of our dependent variable, we test our first two hypotheses (Hypothesis-1 and Hypothesis-2) using Cox survival analysis. To test Hypothesis-1, which links the timing of entry to the platform-mediated market with time to multihome, we only consider a complementor's first multihoming decision (time elapsed from the beginning of the platform-mediated market to a complementor's first multihoming event). Thus, we conduct our survival analysis as a single event per subject study. The failure event in our study is the complementor's multihoming event and the time is measured in months. Letting x_i be the row vector of covariates for the time interval $(t_{0i}, t_i]$ for the *i*th observation in the dataset $i = 1, \ldots, N$. We obtain parameter estimates, $\hat{\beta}$, by maximizing the partial log-likelihood function (Cox, 1972):

$$\log L = \sum_{j=1}^{D} \left[\sum_{i \in D_j} x_i \beta - d_j \log \left\{ \sum_{k \in R_j} exp(x_k \beta) \right\} \right]$$

where j indexes the ordered failure times $t_{(j)}$, $j = 1, \ldots, D$; D_j is the set of d_j observations that fail at $t_{(j)}$; d_j is the number of failures at $t_{(j)}$; and R_j is the set of observations k that are at risk at time $t_{(j)}$ (that is, all k such that $t_{0k} < t_{(j)} \leq t_k$).

In testing Hypothesis-2, we allow for multiple multihoming events per subject, i.e. the time elapsed between the last platform that a complementor adopted and the next. We use ordered failure event method with Efron ties; in particular, the conditional risk set model on "time from the previous event" (Prentice, Williams and Peterson, 1981), which is considered an appropriate model for recurrent event data analysis (Kelly and Lim, 2000).

The second model specification type tests how multihoming-related strategies affect complementor performance. We examine (a) the relationship between *multihoming scope* and

complementor performance, and (b) how the interaction of *entry timing* and *average multihoming time* affect *complementor performance*. The dependent variable *complementor performance* is specified as a continuous variable. Given that some of our explanatory variables are time-invariant, we use random-effects generalized least squares (GLS) regression model for testing Hypothesis-3 and Hypothesis-4 as done in previous studies (Jiang, Tao and Santoro, 2010; Kor and Mahoney, 2005).

$$Y_{it} = \alpha + x_{it}\,\beta_1 + (K)_{it}\beta_k + \varepsilon_{it}$$

$i = 1,\ldots, N$ and $t = 1,\ldots,T_i$ where K is the vector of control variables and x is *multihoming scope* variable for complementor i at time t, β_1 is the coefficient we are interested in for testing Hypothesis-3.

$$Y_{it} = \alpha + y_{it}\,\beta_1 + z_{it}\,\beta_2 + (y_{it} * z_{it})\,\beta_3 + (K)_{it}\beta_k + \varepsilon_{it}$$

where K is the vector of control variables and y is *entry timing* variable for complementor i at time t, z is *average multihoming time* variable for complementor i at time t, β_3 is the coefficient of the interaction term that we are interested in for testing Hypothesis-4.

RESULTS

Our empirical analysis of Hypothesis-1suggests that *entry timing* has a negative and significant effect (effect size = -0.0834, p-value = 0.000) on the hazard to multihome. In other words, the longer it takes a complementor to enter the platform-mediated smart home market, the less likely it will switch from single-homing to multihoming[1]. For each month that a complementor delays entry into the platform-mediated market, its hazard of multihoming decreased by 8%. This provides support for Hypothesis-1. Shorter time to multihome was also associated with firms that have higher product quality (effect size = 0.439, p-value = 0.045). We tested for the proportional hazard assumption in our models by running the test based on Schoenfeld residuals using the estat phtest command in Stata. The results of the test suggest that the proportional hazard assumption was not violated in our analyses.

Regarding Hypothesis-2, in the analysis of the conditional risk set model that takes "time from the previous event," our interest is on the *multihoming scope* variable. We found its coefficient to be positively and significantly associated with the hazard to multihome (effect size = 1.783, p-value = 0.000), suggesting that a complementor that has multihomed before is likely to be faster to multihome again than complementors that have multihomed less. Specifically, for each unit increase in multihoming scope, a focal complementor was six times more likely to multihome again. This result lends support to Hypothesis-2. We also tested for the proportional hazards assumption for these models and found no violation.

Hypothesis-3 suggests that the greater the number of platforms adopted, the higher the complementor performance. The coefficient for complementor's *multihoming scope* was found to have a positive and significant relationship with *complementor performance* (effect size = 0.370, p-value = 0.000). One unit increase in multihoming scope increased complementor performance by 37%, thus providing support for Hypothesis-3. As for the control variables, *complementor product quality* had a positive and significant relationship (effect size = 0.299, p-value = 0.001) with complementor performance. The lagged variable of complementor's *market*

share also had a positive and significant relationship with complementor performance (effect size = 5.457, p-value = 0.000).

Lastly, we analyzed how *entry timing* and *average multihoming time* interact to affect complementor performance. While the direct effects of *average multihoming time* and *entry timing* were not significant in our analyses, we found a negative and significant effect for the interaction term (effect size = -0.00279, p-value = 0.004). This suggests that companies that enter the platform-mediated industry early and multihome fast tend to be better off than those that enter early but do not multihome fast. This result lends support to Hypothesis-4. The marginal effects analysis indicated that the negative performance effect of entry timing can be mitigated if a complementor multihomes, on average, in less than ten months.

DISCUSSION

Our research contributes to the literatures on entry timing strategies and platform-mediated markets. We test and extend entry-timing arguments by considering them in the context of a nascent platform-mediated market fraught by uncertainty. Moreover, we theorize on the importance of the time to multihome decision, and its relationship with entry timing. Entry timing scholars have argued that early entrants in fast-moving markets are likely to be displaced by later entrants (Franco *et al*., 2009, Christensen *et al.*, 1998). Our results suggest that early entrants can use fast multihoming as a hedging strategy to minimize the disadvantages of early entry into these fast-moving markets. Multihoming helps complementors cope with the uncertainty of nascent markets by providing them with the ability to hedge their bets into different, non-overlapping markets, much in the same way as early venture capitalists invest across several promising startups in a context of high market and technological uncertainty (Sahlman, 1990).

We also contribute to the platform literature (Eisenmann *et al.*, 2006; Boudreau, 2012; Boudreau and Jeppesen, 2015; Venkatraman and Lee, 2004), particularly to the small but growing body of literature that takes a complementor-centric perspective (Ceccagnoli *et al.*, 2012; Cennamo *et al.*, forthcoming; Huang *et al.*, 2013; Kapoor and Agarwal, 2017). While few studies have focused on complementor market entry strategies (Ceccagnoli *et al.*, 2012; Cennamo *et al.*, forthcoming; Corts and Lederman, 2009; Hung *et al.*, 2013; Kapoor and Agarwal, 2017), they have considered only single-platform settings (Ceccagnoli *et al.*, 2012; Kapoor and Agarwal, 2017). Studies in multi-platform settings are scant, and empirical studies on these settings are even rarer (e.g. Cennamo *et al.*, forthcoming; Venkataraman *et al.*, 2017). To our knowledge, we provide the first empirical evidence of the performance implications of complementor multihoming. Our article is also breaking ground by investigating the relationship between time to multihome and entry timing in platform-mediated markets.

ENDNOTES

1. We also tested the probability of multihoming with a logit model and found that the longer it takes for a complementor to enter the platform-mediated smart home market, the less likely it is to multihome (effect size = -0.006, p-value = 0.000).

REFERENCES AVAILABLE FROM THE AUTHORS