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Moving ahead of rivals: Gaining product market advantage through product imitation in the Apple iOS app store

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Abstract

Strategy scholars have paid much attention to imitation deterrence to sustain superior performance. However, mastering imitation can be as important as deterring imitation under some conditions, particularly in high-velocity environments. Despite its potential significance, there is a dearth of scholarly studies on the effect of imitation on performance, and empirical studies on the topic are even rarer. In this paper, I extend our understanding of the role and effects of imitation with an analysis in the context of the Apple iOS app store. I explore the mechanisms by which product imitation leads to product market advantage. I move beyond a dichotomous conceptualization of imitation by focusing on the breadth and the speed of imitation in high-velocity environments. I find an inverted U-shaped relationship between breadth of imitation and product market performance. I also find a moderating effect of an imitator's prior market experience in enhancing the performance effect of breadth of imitation. Moreover, I find imitation speed to be associated with superior product market advantage.

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INTRODUCTION

The notion of imitation has been a central tenet in strategy literature. In particular, scholars have paid much attention to imitation deterrence, taking the perspective of an imitatee – that is, the target of imitation. For example, the resource-based view literature (Barney, 1991; Barney, Wright, & Ketchen, 2001) puts a high emphasis on inimitability as a prerequisite for resources that provides a sustained superior performance. Also, first-mover advantage (Lieberman & Montgomery, 1988, 2013) and intellectual property (DeBrock, 1985; Gallini, 1992) literatures are concerned with establishing barriers to imitation by entering early and preempting resources over imitators, or via legal protection.

I argue that mastering imitation can be as important as deterring imitation in high-velocity environments. Under some conditions, imitation can be strategically used to the advantage of a firm in enhancing performance. While scholarly works taking the perspective of an imitator are not completely new, relative to research on imitation deterrence, studies which examine imitation as a strategic choice are surprisingly scarce. In the past, a few studies scattered across disciplines have attempted to understand what prompts imitation. For instance, on the one hand, neo-institutional theory (DiMaggio & Powell, 1983; Haveman, 1993) posits that organization models itself on those who appear to be successful or legitimate. On the other hand, information-cascades theory (Banerjee, 1992; Barreto & Baden-Fuller, 2006) scholars consider imitation as part of an organization's efficiency-driven actions to access superior information by following others whom are believed to have better information.

These few efforts to explore the antecedents of imitation only highlights the paucity of research that systematically explores the consequences of imitation as a strategic choice, in particular its performance implications (Henisz & Delios, 2001). As I noted above, empirical works on this topic are rare (Ethiraj & Zhu, 2008). Against this backdrop, this study intends to fill this gap by theorizing on and empirically validating the performance effects of imitation. Among the possible types of imitation, I focus on product imitation and its impact on product market performance. A product consists of a multitude of features, and I examine those features when exploring product imitation. Especially in product markets, focusing on products is sensible, since these are the most direct way in which firms compete against rivals.

I have several goals in this paper. The first is to advance our understanding of imitation by moving beyond the dichotomous conceptualization. As I argue later, I rather see imitation as a continuum with imitative activities having at least two important dimensions: *how much (breadth)* and *how fast (speed)* is imitated. Second, I help conceptualize conditions under which imitation can be strategically employed in the interest of a firm. The extant studies on imitation presume the presence of uncertainty as the underlying condition for the emergence of imitative behaviors (DiMaggio & Powell, 1983; Henisz & Delios, 2001; Lieberman & Asaba, 2006). In a similar vein, a few recent studies expect uncertainty to positively moderate the performance effect of imitation (Ross & Sharapov, 2014; Zhou, 2006). Uncertainty comes from different sources and in different forms, depending upon which its effect would vary. Yet, we still know little about how those attributes of uncertainty relate to imitation (except for Henisz and Delios (2001)). By unpacking the attributes of uncertainty, I propose that imitation can be strategically used to enhance performance at least under some conditions. Particularly, I am interested in uncertain environments, driven by speed, especially those in which the pace of environmental dynamism and that of imitation are fast – which I define as high-velocity environments hereafter, following Eisenhardt and colleagues (Bourgeois III & Eisenhardt, 1988; Eisenhardt & Martin, 2000). I argue that imitation can be strategically important under conditions of high-velocity environments. Focusing on high-velocity environments, my third goal is, then, to empirically explore how imitation is related to product market performance by focusing on the breath and the speed of imitation.

I therefore sought an empirical setting that exhibited characteristics of high-velocity environments. The iOS mobile app market that I chose provides an ideal setting. The iOS app store, one of the two dominant app platforms in the U.S., besides being a fast-paced market growing at a CAGR of over 150% since its inception[1], has witnessed a surge of imitation taking place. Also, this setting has several pros to explore the effects of product imitation on product market advantage. First, the most important decision-making metrics center around

[1] http://www.statista.com/statistics/263795/number-of-available-apps-in-the-apple-app-store/

products, including rankings and top charts being measured at the product level. Second, the amount of data available in this context allows me to track in-detail what specific features are imitated and when. Lastly, as the majority of players in this industry tend to be individual developers or very small organizations that concentrate their resources and efforts on developing one or a few products, much of the firm-level strategic implications can also be inferred from a product-level analysis in this app economy. Using hand-collected dataset of health and fitness apps in the U.S. iOS app store during the time period of January to December, 2013, I find a more nuanced and dynamic effect of imitation on product performance than prior conceptualizations. I find that, when breadth of imitation is considered, the effect of imitation is not just binary, either positive or negative, as prior studies imply. Rather, I find an inverted U-shaped relationship between breadth of imitation and product market performance, which is further enhanced in conjunction with an imitator's prior market experience. Along the same lines, I find that speed of imitation is significantly related to product market performance.

THEORETICAL DEVELOPMENT

Prior research on the performance effects of imitation

The perspectives on the performance implications of imitation have developed in a fragmented manner (R. P. Lee & Zhou, 2012; Lieberman & Asaba, 2006). Prior studies tend to look at the effect of imitation from the perspective of an imitatee or the overall industry while indirectly inferring its impact on an imitator. There are few studies focusing on the performance effect on an imitator's firm or product. Given this inconsistency in the level of analysis, the literature has developed conflicting views on the relationship between imitation and the imitator's performance.

On the one hand, some stress the benefits of imitation, arguing that it helps a firm save on prohibitively expensive innovation costs, to avoid risks associated with pioneering markets, and to learn and better improve from first-mover mistakes (Baldwin & Childs, 1969; H. Lee, Smith, Grimm, & Schomburg, 2000; Lieberman & Montgomery, 1988). Often, it is an imitator who reaps most of the profits, taking a larger share of innovation value than an innovator. Shenkar (2010), in a practitioner-oriented book, contends that in some cases, even 97.8% of innovation value goes to imitators. On the other hand, others (Deephouse, 1999; Odagiri, 1994) point out to the devastating implications of imitation in that it can lead to a fiercer market competition by promoting homogeneity, which can eventually impair the profitability of an imitator and that of the overall industry. These authors argue that imitation can also be costly, as there can be irreversible costs if an imitator fails to choose the right path or the right set of imitation targets (Barreto & Baden-Fuller, 2006) or if it lacks the capability of successfully implementing imitation (Lieberman & Asaba, 2006). Basically, these authors argue that, although the lure of imitation is promising, imitation does not actually come easy. Taken together, these competing views as to what the performance implications of imitation are call for a careful analysis to explore theoretical logics behind the direct effects of imitation on performance and empirically validate these positions.

A few studies have started exploring moderators that indirectly intervene in the efficacy of imitation. For instance, Ross and Sharapov (2014), in their analysis of head-to-head boat races from the American Cup World Series, found that imitation effect is moderated by the degree of environmental uncertainty, by the extent of an imitator's initial advantage, and by the difference between imitator and imitatee capabilities. Also, R.P.Lee and Zhou (2012) took a contingent approach in their study of high-tech sectors in China to look at the effect of product imitation on financial performance. They found that an imitator's marketing capabilities and ownership type positively moderate the effect of imitation on financial performance. As such, scholars suggest ample opportunities for future research in exploring contingent factors that moderate direct effects of imitation.

Theoretical scope: High-velocity environments

Imitation does not lead to superior performance all the time, but rather, I claim, at least under some conditions, there is room for imitation to be strategically used to enhance performance. Specifically, I argue that high-velocity environments present conditions that make strategic imitation viable and relevant. A key characteristics of high-velocity environments (Bourgeois III & Eisenhardt, 1988;

Eisenhardt & Martin, 2000) is that market boundaries keep shifting in a dynamic and unpredictable manner. Eisenhardt and Martin (2000) argue that, "High-velocity markets are ones in which market boundaries are blurred, successful models are unclear, and market players are ambiguous and shifting. The overall industry structure is unclear".

Following this definition, I am interested in a particular type of high-velocity environments, in which not just the pace of environmental dynamism is fast, but also that of imitation. On the supply side, fast-moving technological and market environments provide a wealth of imitation sources and possibilities, which imitators can choose from. One of the peculiar attributes of high-velocity environments is that often there is no clearly identifiable success model, as players and product offerings are constantly in flux. In a similar vein, in these environments, the most recent developments or practices do not necessarily make prior ones obsolete, given the lack of consensus, multiplicity of choices and vibrant dynamics in the market. Against this backdrop, a surge of rapid changes in technologies and market tastes results in many different products and offers a wide variety of elements that imitators can play with in a strategic manner. Particularly, in environments in which barriers to imitation are low and thus, imitation can come easy, the value of imitation as a strategic option increases even further. Moreover, in such environments, on the demand side, a majority of consumers and stakeholders are likely not to precisely understand the market situation and the direction in which it is evolving. This makes it difficult to identify what and who are being imitated – that is, distinguishing imitators from imitatees, a situation compounded by the constant entry of a large number of players to the market. In these circumstances, the inherent social bias against imitators (Posen, Lee, & Yi, 2013; Shenkar, 2010) is not salient, leaving imitation as a viable way to create market advantage.

Therefore, presuming high-velocity environments, in which both the pace of environmental dynamism and that of imitation are fast, I develop theoretical frameworks of how imitation can be associated with superior performance.

Gaining market advantage through imitation

Direct effects of imitation

When it comes to imitation strategy, a firm needs to decide *how much (breadth)* and *how fast (speed)* to imitate.

Breadth of imitation

The extant studies on imitation tend to approach imitation as a simple binary decision of whether to imitate or not (Csaszar & Siggelkow, 2010; R. P. Lee & Zhou, 2012). However, even within a single product, a wide range of product features can be imitated, ranging from no imitation at all to a complete cloning of a certain product. How much of previous products is imitated, I argue, would matter for market performance. In this regard, treating imitation just as a binary decision overlooks granular differences and richness of imitation strategies, possibly leading to spurious results. Yet, little has been studied about the impact of varying degrees of imitation on performance (Posen et al., 2013).

In high-velocity environments, firms, whose judgement is blurred by fast-paced environmental and competitive movement, are less likely to identify a correct set of cause-effect relationships. Moreover, their ability to precisely choose a right path and a right target of imitation is likely to be degraded under these circumstances. Considering the inherent risk of making erroneous decisions as to what to imitate, a cherry-picking approach of product features would be risky, making imitators more vulnerable to errors. Confronted with high ambiguity, picking only selective features runs the risks of missing out on what indeed matters. That is, the producers' decreased capability of properly evaluating and managing their surroundings also negatively affects their capacity of discerning a right set of imitation targets, increasing the risk of misselection. I argue that in these high-velocity environments, taking an inclusive approach to imitation by comprehensively adopting the elements that appear to be potentially successful leads to better results. Such attempt to minimize the loss of missing out on potential critical factors is more likely to lead to superior performance than more selective approach to imitation. In high-velocity environments, I expect producers' market performance to increase with breadth of imitation.

However, too much imitation can also have drawbacks. It is acknowledged that imitation costs tend to be lower than innovation costs (Katz & Shapiro, 1987; Lieberman & Montgomery, 1988). This might be particularly true, when it comes to imitating one particular element or feature. In a case where imitation can be reduced to a simple binary choice of whether to imitate vs. innovate, the unit cost of production would be lower when imitating than innovating. However, under conditions under varying degrees of imitation are allowed to emerge from different sources, the total costs of aggregating all the different elements of imitation should be also taken into account. I expect the aggregate costs and efforts of employing imitation to increase with an increase in breadth of imitation. Specifically, when it comes to product imitation, in which a multitude of different feature elements are imitated, the ability of coordinating across elements in one product would significantly matter and impact successful product imitation. I anticipate that the difficulty of coordination would be far more aggravated when imitators strive hard to combine too many elements into one. Particularly, if there is little similarity between each imitation element, the total costs would further increase, even rising exponentially in some cases, mainly because of few economies of scale or scope (Panzar & Willig, 1981). I therefore argue that, after a certain point from which the coordination costs increase substantially, the merits of imitation breadth are expected to decrease. After a certain level of imitation breadth, the (exponentially) added difficulty of integrating across each imitation element in one product would offset the benefit from employing a larger breadth of imitation, subsequently adversely affecting product market performance. Therefore, I hypothesize,

Hypothesis 1: The breadth of product imitation will have an inverted U-shaped relationship with product market performance.

Speed of imitation

Another important decision when considering imitation is how fast to imitate. Some argue that a longer time lag between innovation and imitation is helpful in that it can provide sufficient time for imitators to come up with improved products or produce at lower costs than innovators. Ethiraj and Zhu (2008), in their study of a branded drug industry, find a positive relationship between a greater time lag in imitation and quality improvement in an imitator's products. They contend that this time lapse can be considered as the time spent by the imitator to study more about the innovation which allows it to make progress. Particularly, this strategy of gaining time would be paid off under environments with high uncertainty, in which information on imitation in and of itself might be uncertain and less reliable (Lieberman & Asaba, 2006). In this sense, imitators might be better off by delaying imitation until they obtain more accurate information on what and how to imitate.

However, the flip side of this prudent approach is the risk of losing out on market opportunities and access. For instance, a longer delay could provide enough time for innovators and early entrants to take some actions against subsequent late followers (Ethiraj & Zhu, 2008). Under this scenario, it appears to be an unproductive strategy to just wait for the sake of incremental changes while bearing the risk of losing the whole access to the market or the target of imitation per se. If this would be the case, the price to pay for waiting appears to be too high, making the wait-and-see approach less appealing. Furthermore, waiting would not be that helpful, particularly under conditions of high-velocity environments. A wait-and-see approach would only make sense if waiting helps clear the uncertainty that firms face. For example, in order for waiting to turn into an effective strategy, the target and the element of imitation should be presumed to stay stable enough for imitators to develop a better understanding of the market as they invests more time with the market. However, in a case under which the target of imitation and market boundaries keep moving in unpredictable ways, waiting would not help that much. Rather, in high-velocity environments with discontinuous changes, waiting is more likely to add up the degree of uncertainty and confusion. That is because waiting piles up more collections of imitation elements or imitation targets for imitators to take a look at and compare across, instead of clearing them up, since the longer imitators wait, the further and farther the market moves away (Lévesque, Minniti, & Shepherd, 2013). Therefore, given the likelihood that a longer delay in imitation in high-velocity environments is risky while not being that helpful, I contend that a greater time lag in imitation would be of little value.

Moreover, speedy reaction also appears to better meet the expectations of consumers. In high-velocity environments, not just producers, but consumers are likely to suffer from uncertainty and confusion. Uncertainty intervenes in the way consumers make purchase-decisions. Specifically, under uncertainty, the ability of consumers to precisely discern and identify right products that match their needs is reduced. Confused as to what to buy, consumers are prone to make erroneous decisions of choosing wrong or less satisfying options. Thus, it might be in their interest to wait until the degree of uncertainty goes down so that they can acquire better information which can help their buying decisions (Carpenter & Nakamoto, 1990; Walsh & Yamin, 2005).

However, once again the decision to wait would only make sense if consumers perceive that waiting would help reduce uncertainty and confusion, which may not be the case in high velocity environments. For instance, Walsh and Yamin (2005) suggest that if waiting to arrive at better decisions does not help bring about expected outcomes, the degree of consumer disappointment and dissatisfaction would go even higher since their efforts of suppressing the desire to purchase only ends up being in vain. In such case, consumers' delaying would not predominate – even if initially tried. Consumers are bombarded by a surge of new product introduction and information, the amount of which is likely to exceed their screening capacity. As similarly expected in the case for producers, waiting is likely to further accumulate a great extent of market information that consumers ought to handle and process. Although consumers decide to postpone, they would soon realize that such pains of waiting would turn out to be a vain attempt. They would end up encountering more information to cope with, rather than reduced one, adding to rather than reducing their uncertainty about which products are better. Thereby, consumers would not place high value on waiting in this context.

Rather, I expect consumers to engage in a faster and more determined decision-making. Knowing that there are, and will continue to be, a number of substitutable alternatives in the market which moves with high-velocity, consumers would not hesitate to discard products that do not meet their needs in the first place. Assuming low switching costs, consumers will easily move onto the next available options, instead of staying with products that no longer satisfy them fully. In this context, a slow pace of imitation by producers would rapidly backfire, as they would risk being taken out of consumers' consideration lists.

Therefore, under these circumstances, if imitators fail to adopt potentially successful or key features in a timely manner, the risk of being ruled out in the market increases. I argue that speedy imitation would help minimize the risk of missing out on consumers and market opportunities, increasing the chance of moving ahead of rivals.

Hypothesis2: The speed of imitation will be positively associated with product market performance.

Moderating effects of an imitator's market experience

Organizational learning scholars consider imitation as part of vicarious learning (Baum, Li, & Usher, 2000; Haunschild & Miner, 1997; Levitt & March, 1988). Vicarious learning is an organization's action to better understand the situation by observing others, especially when it lacks its own ability to do so. This concept of drawing on others' knowledge and experience, rather than developing on its own, closely resembles the notion of imitation. Organizational learning literature (Fiol & Lyles, 1985; Levitt & March, 1988) implies that learning can enhance firm performance as accumulated experience obtained from learning enable the firm to better cope with environments and better tackle uncertainty it faces. In order for learning to be truly effective, some scholars further suggest the importance of having both vicarious and experiential learning. Without its own related knowledge to recognize and internalize external opportunities, a firm is not fully able to exploit the efficacy of outside knowledge and external innovation. Cohen and Levinthal (1990) point out the significance of a firm's own prior knowledge in better acknowledging the value of outside information, assimilate it, and apply it to commercial ends.

Following the similar logics, I see the value for a firm's own experience in the context of imitation, particularly in high-velocity environments where a firm may struggle to clearly pin down what to imitate, when, and from whom. Under these circumstances, all other things being constant, a firm with deeper market experience in the field in which it considers imitation would probably be better equipped to sense and discern which elements are more likely to be associated with success, compared to a firm with little or no previous experience in that market. A firm's experience in the market, then, can increase its capability for imitation. In addition, prior market experience could also help an imitator build market-wide networks, from which it can further access market information (Powell, Koput, & Smith-Doerr, 1996; Silverman & Baum, 2002), helping it better identify and leverage imitation sources to its advantages. Therefore, I expect an imitator's own market experience to positively moderate the effects of the level of imitation it pursues.

Additionally, I am also interested in examining which types of experience would be more effective in enhancing the performance effect of imitation. Specifically, I expect that more related experience will serve as a stronger moderator than less related one. Thus, I suggest that the moderating effect of an imitator's own market experience would be higher when these experiences are more directly relevant to the area of imitation than with less relevant ones.

Hypothesis 3: An imitator's own market experience in the field in which it contemplates imitation will positively moderate the effect of the breadth of imitation on product market performance.

DATA AND METHOD

Empirical setting: The Apple iOS app store

I chose a mobile app industry as empirical setting, specifically the Apple iOS app store, which takes 65% of the entire mobile app revenue in 2013[2]. This context provides an ideal setting in which to test hypotheses.

Firstly, this is a high-velocity environment, in which a large number of players keep coming in and out of the market in a fast-paced manner due to low barriers to enter and exit (Basole & Karla, 2012; Boudreau, 2012). In this mobile app industry, a mobile app platform provider, such as Apple, offers a wide array of supports and incentives to encourage app developers to join its platform; i.e., by providing free software development toolkits and by handling of a mobile payment procedure to the advantages of app developers. These resources significantly help reduce efforts and costs for app developers to launch apps, lowering entry and exit barriers and prompting a myriad of entries and exits in the market (Basole & Karla, 2012). Even, individuals with no prior backgrounds can easily, totaling as many as 2.3 million individuals working as app developers worldwide as of 2014[3]. Consequently, this contributes to blurring market boundaries and a mixture of player components in a less predictable manner, exhibiting characteristics of high-velocity environments.

Second, product imitation, a key theoretical construct, is traceable. An app consists of a multitude of features, and app developers can use their strategic discretion as to which features to adopt, how many, or when. As such, app features

[2] http://dazeinfo.com/2013/03/13/tablets-to-generate-8-8-billion-app-revenue-in-2013-64-would-come-from-apple-ios-alone-report/
[3]https://blog.newrelic.com/2014/06/13/mobile-app-development-trends-worldwide-need-know/

can be directly compared across apps. A variety of such discretionary decisions on app features allow me to examine varying degrees of breadth and speed of imitation, providing an excellent context to investigate hypotheses. Particularly, each app developer in the Apple iOS app store specifies app description and a list of newly updated app features. As these are considered as a primary tool to communicate with important stakeholders in this industry, app developers are incentivized to notify their key app features and crucial changes. Thus, these data can serve as a codified source to track in-detail what and when are imitated.

Lastly, this setting enables me to observe changes in a relative product performance in the market, which is an appropriate measure to explore the outcome of imitation as a competitive strategic choice (Ross & Sharapov, 2014). Apple publically releases top ranking charts, which could serve as a proxy to measure an app's market performance relative to competitors (Jung, Baek, & Lee, 2012). As Apple does not make the number of app downloads or revenue open to the public, industry stakeholders rely on top charts to judge an app's success. Prior research on a mobile app industry also uses ranking to measure an app's performance (Jung et al., 2012; Yin, Davis, & Muzyrya, 2014).

Data sources

I used hand-collected dataset from *App Annie Store Stats,* which tracks app market data: i.e., app's ranking history, app metadata of app description and historical updates, app's reviews, and publisher info. As a leader in the mobile app analytics industry, *App Annie* provides extensive database. Also, I supplemented the data with other archival sources, and conducted 10 interviews with industry experts, app developers, and *App Annie* executives to better understand the context and to further validate the data.

Specifically, this paper focuses on a single category, U.S. health and fitness category, to mitigate concerns over confounding effects of combining different categories. I chose the health and fitness category for two reasons. First, this is fast growing, even growing 87% faster than the overall app market as of 2014[4]. Second, this category is fairly fragmented while not being dominated by just a few players, which provides a great context to explore the competitive dynamics among rivals.

As this mobile app industry moves fast, I confirmed that monthly observation (rather than conventional yearly) is appropriate. Apple used to publish iOS top 300 charts in each category. Among apps ranked in top 300 in the U.S. health and fitness category, I focused on free apps which were released in 2013, and examined a 12-month panel data from January to December 2013. Although iOS top charts only went till top 300, an app's detailed ranking history can be traceable till top 1,000 if an app identity is known. Therefore, to capture a granular level of differences in rank performance, I manually gathered additional ranking data that

[4] http://techcrunch.com/2014/06/19/fitness-app-usage-is-growing-87-faster-than-the-overall-app-market/

goes beyond top 300. The final sample contains the panel data, consisting of 227 apps, 168 developers, and 1,615 total observations at the product-month level.

Variables

Dependent variable. Dependent variable is *'ranking in the U.S. iOS health and fitness category'* at the end of every month in 2013, starting from January to December, 2013. Higher rank corresponds to higher performance. Thus, for the convenience of interpretation, I used reverse ranking[5].

Independent variables. *Breadth of imitation.* For hypotheses 1 and 3, breath of imitation is measured as the *'total number of key features that an app has imitated'* at the end of every month. As I expect an inverted U-shaped relationship between imitation breadth and performance, I also included a squared term. To examine breadth of imitation, a full product feature list of potential candidates for imitation should be identified first. Specifically, two conditions should be met for certain product features to be the target of imitation. First is that they do exist before imitators consider imitation. Particularly, to tease apart imitation from the possibility of co-invention or innovation that just slipped the opportunity of coming first, I focused on app features that had already existed in the market before the

[5] As ranking beyond 1,000 is not trackable in the database, all rankings beyond 1,000 are treated as 1,001. Apple, which used to publish top 300 charts, recently changed to publish only top 150. The rationale was that most users are not even interested in app ranked below top 150 and differences in ranking beyond that point would be minimal. Thus, I presume that this treatment would not make substantial differences in estimation.

period of observation. Second is that they are considered as key or important among market players. An organization usually does not imitate anyone, yet rather, tends to follow those who appear to be successful players (Lieberman & Asaba 2006; Barreto & Baden-Fuller 2006;DiMaggio 1983). In this vein, I looked at features adopted by apps which at least made it into top 300 in a given period of time. I used a content analysis of each app's documentation, focusing on app description and what's new section, which contains newly updated features with each update date. I did a very close work by discussing each target element of imitation in detail until reaching an agreement with other scholarly and industrial experts, and went through a series of iterations of coding to ensure the validity and reliability of analysis.

An imitator's prior market experiences. For hypothesis 3 which explores the moderating effect of an imitators' prior market experience, I used the *'total number of apps that an imitator has developed'* at the end of every month. Moreover, to measure potential varying effects of more related vs. less related experience to the area of imitation, I operationalized the former as an imitator's prior app-developing experience in the health and fitness category while the latter as that in other categories in the iOS app store.

Speed of imitation. For hypothesis 2, I measured *speed* of imitation as *'time difference in days between the introduction date of a new feature and the first date being imitated',* following prior studies (Ethiraj & Zhu, 2008; Segerstrom, 1991). It would require extensive efforts and time to precisely trace the first innovation date of each and every key feature, especially given that there were more than 700,000 apps as of late 2012 alone[6]. Therefore, I decided to run a subsample analysis, focusing on a key feature that newly came out during the time period of observation. Clearly, one of the most salient features that newly emerged in 2013 is related to iOS7, a new iOS operating system which was innovated by Apple on September 18, 2013. A well-designed user interface is known as key to app success, and it depends upon the level of compatibility with iOS operating system. Thus, app developers strive hard to adopt key features relevant to new iOS system by paying a closer attention to and actively monitoring the moves of competitors, especially key players, in the market. Thus, I looked at the first date of when a given app made compatible with iOS7, and measured the difference in days between this date and iOS7 release date as a proxy to estimate *the speed of im*itation in the analysis.

Control variables. Several variables are included as controls to rule out alternative explanations. First, first-mover advantage researchers claim that late entry would lead to superior performance than early entry in fast-moving industries (Suarez & Lanzolla 2007). To control for an app's entry-timing effect on performance, I included *app age,* operationalized as the *'number of days elapsed since an app entered the market'* at the end of every month. Also, to account for the effect of app quality on performance, I used *app quality*, measured as an *'averaged monthly review score an app has received'* at the end of every month. Third,

[6] http://www.statista.com/statistics/263795/number-of-available-apps-in-the-apple-app-store/

endorsement from powerful social actors – that is, legitimacy (Deephouse, 1996) – could serve to boost performance (Rao, 1994; Stuart, Hoang, & Hybels, 1999). In particular, this would be pronounced for success in this setting in which the majority of players are entrepreneurs who tend to grapple with liabilities of newness and smallness (Khessina & Carroll, 2008; Mitchell, 1991; Stinchcombe & March, 1965). I included *endorsement* to control for any potential legitimacy effect, operationalized as the *'total number of being featured by Apple'* during a given month of observation. Lastly, to account for changes in macroeconomic condition, I employed monthly dummies. Table 1 provides summary statistics with correlation matrix.

--- Table 1 goes about here ---

Methodology

Breadth of imitation. Even after several controls employed, the central challenge of identifying the causal effect of imitation breadth in performance shift is to parse out the effect of imitation breadth from the unobservables that are correlated with breadth of imitation and performance. As part of the efforts to control such unobservable threats, I employ an app-developer fixed-effects framework. As my dependent variable is ranking, I have options of either treating them as continuous or dichotomous. Particularly, I am interested in exploring how imitation affects an app's competitive position in the market against rivals. In this manner, not to lose the richness of detailed information on a relative app performance to its competing products, I decide to keep the raw value of ranking performance. Given that the dependent variable of ranking has a large number of categories, ranging from 1 to 1,001, treating them as continuous variable is also considered reasonable (Menard, 2002).

Speed of imitation. As mentioned earlier, for the imitation speed analysis, I focus on features related to iOS7 as a subset analysis. As part of the efforts not to confound the effect of imitation speed and that of market entry speed, I focus on apps that had already pre-existed before iOS7 release. The final sample of this sub-analysis contains 185 apps and 139 app developers, totaling 1,517 observations at the product-month level. I use a linear-log model, in which I use a natural logarithm of imitation speed, because I anticipate that the negative impact of imitation delay on performance will increase at a decreasing rate. I use an app-developer random-effects model, mainly because imitation speed, key independent variable, is time-invariant. I am concerned that much evidence of heterogeneity in imitation speed would wash away when employing fixed-effects estimation, especially given a ratio of 1:1.3 between the number of app developers and that of apps.

RESULTS

Regression results

Breadth of imitation. In table 2, I provide results. I first estimated a model which only includes controls in Model 1. Model 2, then, tests Hypothesis 1 by adding the variables of imitation breadth and squared term to a set of explanatory variables. The coefficients of imitation breadth and squared term, both of which are significant, show an inverted U-shaped relationship with product performance. This remains to be significant throughout all the models, providing supports for Hypothesis 1. All other things held constant, imitating one more app feature leads to improvement in app rank by 45. However, reverse effects emerge if trying to employ more than eight product features in one app altogether. To test hypothesis 3, I added an interaction term between breadth of imitation and an app developer's prior market experience in Model 3 and Model 4. To further unpack possible varying effects of experience by the extent of relatedness to the area of imitation, I tested two different types of experience: more related and less related experience. Model 3 focuses on prior app development experience in the iOS health and fitness category to estimate the moderating effect of more related experience. Model 4 includes less related experience of prior app development engagement in other iOS categories. Model 5, as a full model, contains all the explanatory variables. The estimated coefficients of interaction terms are positive and significant in Model 3 and 5. However, the moderating effect of less related experience are found to be positive, yet, insignificant in both Model 4 and 5, as predicted. These findings suggest that more related experience positively moderates the effect of imitation breadth on performance while less related experience does not help significantly.

The coefficients of all experiences themselves are negative, which appears to be counterintuitive, which I discuss later.

--- Table 2 goes about here ---

Speed of imitation. Table 3 summarizes the results. First, I only included controls in Model 1. Then, I tested Hypothesis 2 in Model 2 by adding the variable of imitation speed to a set of control variables. The estimated coefficient is negative and significant, indicating that Hypothesis 2 is supported. Also, in Model 3, I included a dummy variable indicating censoring as part of the efforts to account for a right-censored predictor variable[7]. Still, the coefficient of imitation speed remains to be negative and significant. All other things held equal, 10% delay in imitation would lead to a drop in app rank by 3 on average.

--- Table 3 goes about here ---

Additional analysis and robustness checks

I confirmed that the results still hold when robust and clustered (at the app-developer level) standard errors are employed both for the breadth and speed of imitation analysis.

[7] The information on whether and when an app took any action regarding iOS7 within the period of observation was not observed for some apps. I treated this as right-censored at Jan 01, 2014, based upon the presumption that these apps did not react at least within the period of observation.

Breadth of imitation. I present two extensions to investigate the possibility that the results are driven by model specification. I test alternative specifications of Logit and Tobit model. Overall, the major findings are consistent with that of the main specification, supporting hypotheses.

First, in Table 4, I run an app-developer fixed-effects Logit model to see whether the results are still consistent when treating dependent variable as dichotomous. The value of dependent variable is 1 if an app makes it into top 300 chart while being 0 otherwise. I followed the similar steps taken in the main specification, and the results are still consistent.

--- Table 4 goes about here ---

Additionally, in Table 5, I run a Tobit estimation[8] out of concern that the dependent variable of ranking being right-censored at 1,001 might bias the result. Although this would have little impact on the overall estimation since marginal differences beyond 1,000 would be minimal, as mentioned earlier, I do so as additional robustness checks. The overall implications still hold.

--- Table 5 goes about here ---

[8] Since STATA 13 does not allow parametric conditional fixed-effects Tobit estimation, I employ a random-effects model at least to account for unobserved app-developer-level heterogeneities.

Speed of imitation. I include alternative model specifications in Table 6 as done for the analysis of imitation breadth, running Logit and Tobit in Model 1 and Model 2. The major finding still hold throughout all the models, confirming that speedy imitation is more likely to be associated with superior product performance.

--- Table 6 goes about here ---

DISCUSSION AND CONCLUSION

Despite the fact that imitation has drawn much appeal and substantial attraction from practitioners, there is a dearth of scholarly research examining imitation as a strategic choice in the strategy and innovation literature. Instead, to date, researchers have put an undue emphasis on imitation as a threat to deter, primarily taking the perspective of an imitatee. Against this backdrop, my paper seeks to explore the underexplored topic of imitation as a strategic lever from the perspective of an imitator. Specifically, this paper investigates the performance implications of imitation with an empirical analysis, which has received a scarcer attention.

Mastering imitation can be equally important as preventing imitation under some conditions. Presuming high-velocity environments as one of those conditions, this paper explores the relationship between product imitation and product performance in the market, particularly focusing on the breadth and the speed of imitation. First, my findings suggest an inverted U-shaped effect of breadth of product imitation on product performance. This signals that there is indeed room for imitation to be used strategically to gain market advantage. In particular, the finding of a non-linear relationship deserves some attention. This enables us to understand a more nuanced effect of imitation than prior conceptualization that tended to consider imitation as simply dichotomous. The support found for Hypothesis 1 indicates that the effect of imitation is more nuanced, in that expanding the breadth of imitation would first bring positive results but only until a certain point.

However, precisely identifying the turning point in which the effect of imitation breadth changes from positive to negative is not easy. This is because the total costs of imitation include many different factors that are hard to track; the cost of imitation is not only about the monetary value of implementing and integrating each and every element of imitation, but also about hard-to-observed efforts and pains to coordinate across a multitude of imitation elements in one product. This is likely to be highly case-specific, varying by product-specific and market-specific factors. Therefore, it will be hard to pin down specific points or a range of points that could be universally applicable. This signals that there could be ample opportunities for future research to unravel these dynamic, nuanced effects of imitation on performance, especially combining product-specific micro and market-specific macro aspects. In this regard, my paper could serve as a starting point to ignite a scholarly attention toward imitation studies by firstly acknowledging dynamic, nuanced effects of imitation.

I also highlight the role of an imitator's own market experience as moderator to the effect of imitation breadth on product performance. Scholars have begun to recognize the importance of taking contingencies into account in imitation studies (Csaszar & Siggelkow, 2010; R. P. Lee & Zhou, 2012; Ross & Sharapov, 2014). In this vein, this present paper takes a contingent approach to further unpack a nuanced effect of imitation, particularly combining with organizational learning perspectives, which have not been attempted before. The negative sign of the coefficient of experiential experience is also noteworthy, hinting an inherent risk of going alone in high-velocity environments. Under these environments in which a firm's own ability to identify causal linkages is limited, relying solely on its own experience while ignoring other's moves can be dangerous.

My study also highlights the importance of imitation speed. When everything is moving fast, keeping up the pace with surroundings appears to be critical. This suggest a penalty for not timely aligning with environmental dynamics is high in high-velocity environments. This finding appears to be aligned with some entry-timing scholars' argument (Franco, Sarkar, Agarwal, & Echambadi, 2009; Suarez & Lanzolla, 2007) that the macro aspects should be taken into account with regard to the timing decision of when or how fast to move. Particularly, my results suggest that the degree of dynamism at a macro level can play a role in determining the importance of imitation timing.

Additionally, this paper contributes to extending the platform literature, which has paid much attention to platform providers while there has been little research focusing on platform complementors. By exploring the competitive dynamics and strategic implications from the perspective of app developers – platform complementors in a mobile app platform (Basole & Karla, 2012), I add to our understanding of the competitive dynamics of complementors in a platform market.

Managerial implications

My findings have some implications for practitioners. Often, managers tend to downplay the efficacy of imitation in achieving a competitive advantage. In not a few cases, such bias prevails, not based upon a thorough analysis, but because of taken-for-granted negative imprint against imitators. However, firms can indeed be better off via strategic usage of imitation, as evident in business anecdotes and cases (Markides & Geroski, 2004; Shenkar, 2010). In particular, at least under come conditions, there is room for imitation to be better employed as a strategic choice to lead to a superior outcome. Specifically, under conditions under which a firm's own capacity of handling given environments is constrained and thus, its capability of identifying a right set of cause-effect linkage is dysfunctional, such as in high-velocity environments, following the crowd while swiftly paying a closer attention to what rivals do can be beneficial in enhancing performance. The findings of this paper, which attempts to extricate the mechanisms of how imitation can lead to superior performance, call manager's attention to the importance of imitation as a strategic tool. Furthermore, the insight that imitation breadth has a nonlinear effect on performance can also help managers to approach imitation in a more careful, strategic manner.

Additionally, as we are moving into a totally connected world where the "internet of things" will bring digital technologies to just about every product in the market, we can expect most market to begin to exhibit characteristics of high-velocity environments (Wirtz, Mathieu, & Schilke, 2007). Given a lack of empirical examination exploring the strategies and dynamics in these markets (Vilkamo & Keil, 2003; Wirtz et al., 2007), my study can offer a glimpse of how competition takes shape under these increasingly-common market characteristics.

Limitation and future research

The limitations of this study present avenues for future research. First, future research could investigate the generalizability of my finding in other industries as my study focuses on a single industry. Second, it would be useful to identify different conditions - other than high-velocity environments – under which mastering imitation can be strategically used to the advantages of firms. Third, examining other contingent factors that moderate the effects of imitation on performance could be a potentially fruitful avenue to unravel the dynamic effects of imitation, as suggested by prior studies (Csaszar & Siggelkow, 2010; R. P. Lee & Zhou, 2012; Ross & Sharapov, 2014). Fourth, given the limited data availability, I confined analysis on imitation speed only to one element of imitation. Although this is a reasonable proxy to explore the performance implications of imitation speed in this specific setting, future research can further extend the present work by adding more elements of imitation and gathering more data with which the first innovation date and the date of subsequent imitation can be traceable in a sophisticated manner. Lastly, I examined product market performance, but, it would be also interesting to study the performance implications of imitation with different measures of performance, like financial performance. However, as the majority of players in a mobile app industry are private, entrepreneurial firms, it would not be easy to obtain the traditional sense of financial performance data. Instead, as IPO record or VC funding have often been considered as a proxy to measure the success of entrepreneurs, these measure could also be used in this context.

In conclusion, mastering imitation can be a powerful mechanism to enhance product performance in the market, in particular under conditions of high-velocity environments. My research reveals two distinct, yet, complementary dimensions with which imitators can move ahead of rivals in their given competing market, and identifies an important boundary condition. I look forward to future work that further untangles this dynamic, nuanced effect of imitation on performance.

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TABLE1: Descriptive Statistics

	Variable	Obs.	Mean	SD	Mean	Max	1	2	3	4	5	6	7	8	9
1	Reverse ranking	1479	553.435	323.571	1	1001	1								
2	Breadth of imitation	1615	4.795	3.308	0	15	0.276	1							
3	Breadth of imitation^2	1615	33.929	41.097	0	225	0.252	0.952	1						
4	Endorsement	1446	17.487	40.707	0	333	0.091	-0.065	-0.008	1					
5	Health & Fitness experier	1615	15.349	64.445	0	883	-0.070	-0.037	-0.040	0.045	1				
6	Other iOS experience	1615	18.035	101.651	0	1205	0.047	0.060	0.036	0.0004	-0.027	1			
7	App quality	1608	2.675	2.050	0	5	0.425	0.400	0.338	-0.155	-0.063	0.070	1		
8	App age	1615	126.045	87.068	0	364	-0.137	0.183	0.165	-0.063	0.002	0.030	-0.061	1	
9	Firm - App developer	1615	80.334	49.370	1	168	0.048	0.150	0.139	-0.093	0.034	-0.123	0.117	-0.005	1
10	Log (Imitation lag*)	1350	4.105	1.049	0	5.004	-0.112	-0.288	-0.283	-0.046	0.062	0.086	-0.152	-0.044	0.054

* The value is from a subsample analysis

TABLE2: Breadth of imitation

DV: Reverse ranking	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	552.103***	356.244***	443.147***	356.756***	444.014***
	(62.525)	(78.084)	(80.356)	(78.404)	(80.669)
Endorsement	0.228	0.158	0.329	0.160	0.333
	(0.296)	(0.293)	(0.295)	(0.294)	(0.295)
App quality	29.421***	27.656***	27.833***	27.692***	27.887***
	(4.797)	(4.752)	(4.720)	(4.757)	(4.725)
App age	-0.275	-0.439*	-0.299	-0.443*	-0.304
	(0.203)	(0.205)	(0.210)	(0.206)	(0.210)
Imitation		63.032***	51.784**	62.988***	51.661**
		(17.158)	(17.298)	(17.178)	(17.318)
Imitaion^2		-2.776*	-3.483**	-2.796*	-3.513**
		(1.148)	(1.157)	(1.151)	(1.160)
Health & Fitness exp			-5.472***		-5.489***
			(1.498)		(1.500)
Imitation* Health & Fitness exp			1.054***		1.058***
			(0.254)		(0.255)
Other exp				-0.369	-0.520
				(1.281)	(1.273)
Imitation * Other exp				0.065	0.094
				(0.210)	(0.209)
Month dummy	Yes	Yes	Yes	Yes	Yes
Number of Observations	1,312	1,312	1,312	1,312	1,312
Number of Groups	168	168	168	168	168
R^2	0.591	0.601	0.607	0.601	0.607

Notes: Standard errors are in parentheses.

$^+p < 0.1$

$^*p < 0.05$

$^{**}p < 0.01$

$^{***}p < 0.001$

TABLE3: Speed of imitation

DV: Reverse ranking	Model 1	Model 2	Model 3
Intercept	522.802***	631.356***	693.691***
	(64.718)	(99.852)	(104.023)
Endorsement	0.488+	0.268	0.281
	(0.279)	(0.285)	(0.285)
App quality	40.056***	40.623***	41.641***
	(4.557)	(4.876)	(4.882)
App age	-0.082	-0.139	-0.149
	(0.194)	(0.222)	(0.220)
Log (imitation lag)			-64.673**
		(15.171)	(20.430)
Dummy for censoring			85.352*
			(40.597)
Month dummy	Yes	Yes	Yes
Number of observation	1,228	1,072	1,072
Number of groups	139	127	127
R^2	0.184	0.180	0.177

Notes: Standard errors are in parentheses. Dummy variable for censoring is 1 if data is censored and 0 otherwise.

$^{+}p < 0.1$

$^{*}p < 0.05$

$^{**}p < 0.01$

$^{***}p < 0.001$

TABLE4: Alternative Logit specification

DV: Making it into Top 300	Model 1	Model 2	Model 3	Model 4	Model 5
Endorsement	0.005	0.004	0.009*	0.004	0.009*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
App quality	0.304***	0.299***	0.306***	0.299***	0.306***
	(0.056)	(0.057)	(0.058)	(0.057)	(0.058)
App age	-0.005*	-0.006**	-0.006*	-0.007**	-0.006*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Imitation		0.790***	0.627**	0.786***	0.624**
		(0.206)	(0.217)	(0.207)	(0.218)
$Imitation^2$		-0.038**	-0.048***	-0.038**	-0.048***
		(0.013)	(0.014)	(0.013)	(0.014)
Health & Fitness exp			-0.081**		-0.081**
			(0.026)		(0.026)
Imitation * Health & Fitness exp			0.014**		0.014**
			(0.004)		(0.004)
Other exp				-0.002	-0.001
				(0.016)	(0.016)
Imitation & Other exp				0.0004	0.0003
				(0.003)	(0.003)
Month dummy	Yes	Yes	Yes	Yes	Yes
Number of Observations	1,084	1,084	1,084	1,084	1,084
Number of Groups	115	115	115	115	115
Log likelihood	-410.941	-397.507	-391.315	-397.492	-391.305

Notes: Standard errors are in parentheses.

$^+p < 0.1$

$^*p < 0.05$

$^{**}p < 0.01$

$^{***}p < 0.001$

TABLE5: Alternative Tobit specification

DV: Reverse ranking	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	462.887***	329.317***	363.695***	323.891***	358.525***
	(73.567)	(79.835)	(80.235)	(79.951)	(80.390)
Endorsement	0.549+	0.415	0.510+	0.418	0.511+
	(0.305)	(0.302)	(0.302)	(0.302)	(0.302)
App quality	45.106***	40.263***	40.694***	40.279***	40.700***
	(5.224)	(5.181)	(5.167)	(5.180)	(5.166)
App age	-0.660***	-0.859***	-0.793***	-0.859***	-0.794***
	(0.170)	(0.172)	(0.174)	(0.171)	(0.173)
Imitation		46.412***	44.226***	46.386***	44.127***
		(13.541)	(13.544)	(13.545)	(13.554)
Imitation^2		-1.719+	-2.356*	-1.675+	-2.306*
		(0.964)	(0.983)	(0.964)	(0.983)
Health & Fitness exp			-3.064***		-3.037***
			(0.918)		(0.917)
Imitation * Health & Fitness exp			0.733***		0.727***
			(0.224)		(0.224)
Other exp				0.795	0.703
				(0.780)	(0.802)
Imitation & Other exp				-0.100	-0.086
				(0.109)	(0.109)
Month dummy	Yes	Yes	Yes	Yes	Yes
Number of Observations	1,312	1,312	1,312	1,312	1,312
Number of Groups	168	168	168	168	168
Log likelihood	-8105.133	-8088.438	-8082.581	-8087.915	-8082.144

Notes: Standard errors are in parentheses.

+p < 0.1

*p < 0.05

**p < 0.01

***p < 0.001

***p < 0.001

TABLE6: Alternative specifications (Logit + Tobit)

DV: Making it into Top 300 (Logit) Reverse ranking (Tobit)	Model 1 Logit	Model 2 Tobit
Endoresement	0.006^{+}	0.257
	(0.003)	(0.329)
App quality	0.440***	46.302***
	(0.056)	(5.806)
App age	-0.006**	-0.125
	(0.002)	(0.273)
Log (imitation lag)	-0.407^{+}	-73.975**
	(0.219)	(25.423)
Dummy for censoring	0.574	97.574*
	(0.420)	(48.909)
Month dummy	Yes	Yes
Number of observation	1,072	1,072
Number of groups	127	127
Log likelihood	-564.512	-6622.071

Notes: Standard errors are in parentheses. Dummy variable for censoring is 1 if data is censored and 0 otherwise.

$^{+}p < 0.1$

$^{*}p < 0.05$

$^{**}p < 0.01$

$^{***}p < 0.001$