

# **Intra-platform Envelopment: The Coopetitive Dynamics between the Platform Owner and Platform Complementors**

## **ABSTRACT**

Platform owners can exert a substantial level of influence on their complementors, and this influence can have negative consequences for the firms and entrepreneurs offering complementary products. Such competitive influence can vary from indirect actions such as new policies that change the “rule of the game” within the platform, to direct actions such as launching a product that openly competes with some complementors’ products. Despite the fact that these actions are not uncommon, little prior work has explicitly addressed this topic, particularly regarding the coopetitive dynamics that take place when a platform owner directly competes with its platform complementors. This present paper addresses this gap by focusing on intra-platform envelopment, conceptualized as the platform owner’s absorbing the features or functionalities of products offered by its complementors. Our theorizing centers on the consequences that such envelopment has on the affected complementors, and the strategic levers that complementors can use to mitigate or foster the impact. We empirically examine the effect of intra-platform envelopment in two major mobile platforms, Apple iOS and Google Play app stores. We find that the effect of envelopment by the platform owner is heterogeneous and context-specific, and that it also depends on platform governance, specifically how the platform owner implements its envelopment strategy.

**Keywords:** Platform complementors; Mobile (digital) platforms; Coopetitive dynamics

## INTRODUCTION

Digital platforms, such as mobile app stores of Apple iOS and Google Play or online marketplaces like Amazon and Etsy, have become an integral part of today's economy. In particular, they have served as an important enabler for the birth and growth of entrepreneurial firms, which provide complementary products to the platform. Accordingly, strategy and entrepreneurship scholars have devoted an increasing amount of attention to digital platforms. Prior studies have, yet, largely focused on the owner of the platform (Boudreau and Hagiu, 2009; Eisenmann, Parker, and Van Alstyne, 2006, 2011; Gawer and Cusumano, 2002; Gawer and Henderson, 2007; Iansiti and Levien, 2004) and thus, inter-platform competition (that is, competition between different platform owners), in which the relationship with its platform complementors has been primarily considered as cooperative. This is because, in order to win against other competing platform owners, it is critical for the platform owner to have active, committed supports from platform complementors, since a wide variety platform complementors can attract more consumers via indirect network effects (Clements and Ohashi, 2005; Katz and Shapiro, 1994; Rochet and Tirole, 2003). Therefore, to have a large number of complementors on board, the platform owner often provides a diversity of tools and infrastructure, such as APIs (Application Programming Interfaces) and SDKs (Software Development Kits) (Basole and Karla, 2012; Boudreau, 2012; Caillaud and Jullien, 2003). Those offerings from the platform owner, in addition to a large audience, are also beneficial for platform complementors, as they help lower barriers to enter and access.

However, the relationship between the platform owner and its complementors is not always complementary or cooperative. The platform owner sometimes enacts actions that can potentially affect negatively the performance of its complementors, to the point of threatening

their survival. These actions can vary from setting new policies that change the “rule of the game” within the platform to direct intervention in complementor’s markets by launching a product that openly competes with some complementors’ products. In this paper, we focus on the latter, potentially the most damaging action that the platform owner can take from the affected complementors’ point of view. Such situations are not difficult to find, as platforms grow in size and scope.

Despite the fact that coepetitive relationship between the platform owner and its complementors is not uncommon, it has so far not been studied carefully. Although prior research has acknowledged the tension that sometimes exists between the platform owner and its complementors (Gawer and Cusumano, 2002), scholars have little explicitly addressed this issue as we do here (except for a few recent papers – Zhu and Liu, 2016; Li and Agarwal, 2016), presumably because previous studies tend to adopt a static and cross-sectional view (Mcintyre and Srinivasan, 2017) and largely focus on competitive dynamics between different platform owners, as noted. Hence, coepetitive dynamics between the platform owner and complementors has not been fully unpacked yet, and in particular, little is known about the consequences of the platform owner’s entry into the domains of platform complementors. These actions are just largely presumed to negatively affect and thrust out complementors whose products would now compete with the owner’s product. However, this overlooks the complexities and subtleties inherent in the coepetitive dynamics within-the platform settings. Furthermore, in the absence of empirical evidence, we cannot really be sure of the effect and we do not know what complementors can do when facing such situations.

The present paper explores this under-researched topic of the coepetitive dynamics between the platform owner and its complementors by 1) explicitly focusing on the

consequences of the platform owner's competitive entry into its own complementors' space and 2) examining the strategic levers that platform complementors can exploit in order to mitigate or foster the impact of such entry. We extend the notion of envelopment, introduced to refer to an inter-platform competition strategy and defined as "entry by one platform provider into another [platform provider]'s market by bundling its own platform's functionality with that of target's" (Eisenmann *et al.*, 2011:1271). We argue that the concept also applies to intra-platform dynamics and define "intra-platform envelopment" as the launching by the platform owner of a product whose functionality overlaps with the functionalities offered by one or more of its platform complementors and thus, directly compete with them.

The level of granularity in our data allows us to focus on the "features" or "functionalities" of different platform products, providing a more in-depth analysis of the way a platform owner's actions can affect complementors' performance and behavior. This is important when considering a high degree of interdependence that exists between the platform owner and its complementors (Mcintyre and Srinivasan, 2017; Venkatraman and Lee, 2004). The platform owner has to carefully consider the extent to which it will envelop complementors, since it needs a healthy complementor market for the continuing success of the platform. Therefore, we expect the platform owner to be reluctant to fully overlap the functionalities of its complementors. A more likely scenario would come as a more nuanced and subtle manner, such as a partial overlap of the functionalities of some of the complementors' products. This is because a frontal attack against complementors would not only present very difficult challenges to the affected complementors, but also could discourage other complementors from staying in or joining the platform (Gawer and Cusumano, 2002; Gawer and Henderson, 2007).

Empirically, we test for the consequences of intra-platform envelopment in the context of health and fitness apps in two leading mobile platforms, Apple iOS and Google Play app stores. This context offers an ideal setting to explore our research questions. First, the health and fitness category is fairly fragmented, with no single or even few players dominating the market, resulting in a vibrant and competitive platform-complementor dynamics. Second, this is the category that has undergone a fast growth and many changes in its competitive structure in light of the burgeoning attention to how mobile apps might improve health and fitness, which has also attracted the attention of the platform owner. Recent examples of such changes are the release of Apple Health and Google Fit in mid-2014. Apple and Google alike introduced new functionality that overlapped with some of the features offered by third-party apps. They both incorporated “tracking” functionality, a feature that was already present in several third-party apps in the category. Since the introduction of Apple Health and Google Fit did not affect all the apps in health and fitness category equally, this setting allows us the possibility to have control groups in the same category in the analysis.

Using a hand-constructed dataset compiled from multiple sources, we run a panel-data estimation, employing a difference-in-differences approach to investigate the effect of the introduction of Apple Health and Google Fit on the performance of the applications of the affected complementors. In order to further unpack intra-platform envelopment, we also investigate heterogeneous effects, specifically varying by platform-specific and complementary product-specific characteristics. In particular, given that platform governance, such as degree of openness, directly affects the engagement and participation of platform complementors (Boudreau, 2008, 2010; Economides and Katsamakos, 2006; West, 2003), we explore how varying degrees of platform openness intervene in this intra-platform envelopment procedure.

Apple and Google are known to have starkly different approaches in managing their ecosystems, often referred to as “closed” and “open” respectively, which thus results in very different degrees of control over their complementors. We thus expect the effect of intra-platform envelopment to vary accordingly, and our results support this insight. The overall impact of intra-platform envelopment is found to be significantly negative. Yet, in the case of Apple Health alone, we find a more negative and significant effect on the product performance of the affected complementors. In contrast, we find a positive and significant effect of intra-platform envelopment for the complementors in the case of Google Fit. Also, we find that the effect of intra-platform envelopment differs by complementary application-specific and complementor-specific characteristics.

Our study contributes to the three existing bodies of literature. First, we contribute to the platform literature by examining an under-explored topic of within-the platform competitive dynamics and by explicitly taking the perspective of platform complementors. Our research clarifies and dimensions the implications of intra-platform envelopment, and adds to the understanding of the important dynamics that emerge between the platform owner and its complementors within a focal platform. We explicitly acknowledge the cooperative dynamics between the parties within the platform and address their competitive tensions, which has received less attention in prior platform studies that tend to focus on the perspective of the platform owner and competitive battles between those different platform owners. Also, this paper is one of the few attempts to empirically examine the consequences of platform owner’s direct intervention into complementor markets. Second, this paper enhances our understanding of entrepreneurial ecosystems that are enabled by the emergence of digital platforms. The vast majority of platform complementors in digital platforms are either individual developers or small

entrepreneurial firms. A diversity of offerings from the platform owner to induce a larger number of platform complementors are particularly helpful for the entrepreneurial firms, which often suffer from the liabilities of newness and smallness (Stinchcombe, 1965). Extant scholars have highlighted the importance of joining entrepreneurial ecosystems for the survival and success of entrepreneurial businesses (Ceccagnoli *et al.*, 2012). However, less is known about the potential pitfalls or challenges of joining the ecosystem (Nambisan and Baron, 2013). This present study raises awareness about under-recognized risks and threats that the platform ecosystem poses for complementors, and suggests some strategic levers that entrepreneurial firms in these contexts may consider using to neutralize those threats. Third, this study also contributes to the coopetition literature (Brandenburger and Nalebuff, 1996). Previous coopetition studies have largely considered situations where two or more competitors decide at some point to collaborate, so the directionality goes from competition to collaboration. In contrast, intra-platform envelopment settings feature a reverse directionality; players that are first collaborators (the platform owner and its complementors to be enveloped) suddenly become competitors. In addition, in traditional studies, the set of potential partners is rather stable and known in advance, which is in sharp contrast with the situation in platform markets, where hundreds of new complementors enter the market each month and some can become big and powerful in very short periods of time.

The remainder of the paper is structured as follows. First, we begin by laying out the theoretical framework and develop hypothesis. Next, we describe the empirical approach and setting. Third, we present the results, and then, finally we conclude by discussing the implications of the results.

## THEORY AND HYPOTHESES

### **The cooperative dynamics between the platform owner and platform complementors**

Coopetition is defined as simultaneous cooperation and competition between players (Brandenburger and Nalebuff, 1996). The relationship between the platform owner and platform complementors exhibits the characteristics of cooperative dynamics. On the one hand, the active and committed supports from a variety of platform complementors are crucial for the platform owner to win the battle against other rivalry platform owners, given the importance of indirect network effects through which platform complementors can bring more consumers on board (Eisenmann *et al.*, 2006; Rochet and Tirole, 2003). On the other hand, platform complementors depend upon the platform owner for access to a large and growing audience for their products. Platform owners typically offer a range of tools, such as APIs and SDKs, to further help lessen the burden and costs to develop applications for that platform, thereby lowering entry barriers (Basole and Karla, 2012; Boudreau, 2012). This cooperative aspect of the relationship between the platform owner and its complementors has been well acknowledged and emphasized in extant platform studies (Basole and Karla, 2012; Boudreau, 2012; Parker and Van Alstyne, 2005; Rochet and Tirole, 2003).

However, the competitive aspect of the relationship has been little examined in the literature, particularly from the perspective of platform complementors. In particular, a direct form of competition from the standpoint of platform complementors would be the platform owner's entry into their market space. Resource and speed-to-market constraints prevent the platform owner from providing all the complementary products that are needed to ensure that the platform remains competitive vis-à-vis other platforms. The owner of a focal platform may sometimes confront the dilemma of whether and what to develop a particular functionality

internally versus relying on third-party developers (Eisenmann *et al.*, 2008). Given a high level of mutual dependence between the platform owner and platform complementors, direct competition from the platform owner against its complementors is likely to have a very significant effect on the affected complementors. Surprisingly, this topic has little been explicitly addressed before, although extant research has hinted at possible tensions between the platform owner and its complementors (Gawer and Cusumano, 2002). The main insight coming from existing studies is that the platform owner who ventures in complementors' space can produce an unintended consequence: a strong signal to other complementors who may decide not to enter or continue supporting the platform. Thus, prior studies, instead of delving deep into this competitive entry itself, have primarily focused on how the platform owner should orchestrate and manage the participation and engagement of platform complementors (Boudreau and Hagiu, 2009; Gawer and Cusumano, 2002; Gawer and Henderson, 2007). Furthermore, the platform owner's entering into complementors' space tends to be simply perceived as a binary decision between a full cloning of complementor products or no entry at all.

However, we argue that the full cloning of complementors' products by the platform owner is rather unlikely. Such an obvious frontal attack will rattle the entire complementor ecosystem, as suggested by Gawer and Cusumano (2002). More likely, the platform owner will launch or embed "specific" functionalities that are present in some of the complementors' products. In order to capture such subtlety of cooperative dynamics between the platform owner and complementors, we focus on the features or functionalities of products, instead of products *per se*. This approach is aligned with the most recent writings on cooperation that have started to stress the need to conceptualize cooperation as a continuum that allows a varying degree of interplay of the cooperative dynamics (Bengtsson and Kock, 2014; Luo, 2007).

## **Intra-platform envelopment**

Existing literature has studied situations where a platform owner invades the space of competing platform owners. This strategy, labelled platform envelopment, has been defined in the following way; “envelopment entails entry by one platform owner into another [platform provider]’s market by bundling its own platform’s functionality with that of the target’s” (Eisenmann *et al.*, 2011: 1271). For example, LinkedIn added the feature of job listings in order to compete with Monster.com. Platform envelopment is considered a powerful force that shapes platform evolution in inter-platform competition (Eisenmann *et al.*, 2006, 2011; Suarez and Kirtley, 2012).

We extend the notion of inter-platform envelopment to situations where a platform owner invades the space of its own complementors. We define “intra-platform envelopment” as *the platform owner’s action of releasing a product whose functionality overlaps with that of the products already offered by platform complementors.*

In practice, the entry of the platform owner into its own complementors’ space happens fairly often. There are several reasons why the platform owner may decide to pursue an intra-platform envelopment strategy. The platform owner might aspire to replace complementors’ offerings, if the latter is considered to be strategically important or a potentially large source of direct revenue. For example, the platform owner might be incentivized to provide certain functionalities itself, when concerned about the risk of hold-up (Shapiro and Varian, 1999) or coordination problem, all of which are likely to occur when those features or functionalities becoming more important within the platform. Alternatively, the platform owner may decide to enter the complementor market where existing complementors do not perform satisfactorily. For example, Gawer and Cusumano (2002), in their case study of Intel, elucidate that Intel entered

the market space of its complementors, whose offerings did not perform well, thereby as part of the attempts to intensify competition and stimulate innovation within its platform. The precise motivations behind the decision of the platform owner to enter the space of its complementors are out of the scope of this present paper, yet, it is uncontentionous that the entry of the platform owner will have a significant effect on its complementors, considering a high level of the interdependence between two parties, which, therefore, calls for a careful investigation on this topic.

While it is natural to think of additional competition – let alone from the platform owner – as having a negative impact on complementors, in a rapidly evolving market, such as those faced by many digital platforms today, the platform owner’s entry can potentially have some beneficial consequences. One might expect positive consequence for the complementors affected by intra-platform envelopment. For example, the fact that the platform owner enters a particular category may have a signaling effect that can lower the uncertainty in a fast evolving category. The mere fact that the platform owner launches a certain feature or functionality in a focal category can signal to the market that the category is established and of prime importance, prompting platform users to check the offerings in that category. The enhanced visibility of the category derived from the active participation of the owner can bring added legitimacy to the focal category (Rao, 1994), which, in turn, can result in more users. These effects spilled into the focal category are akin to the “rising tide lifts all the boats” effect, and can end up in a situation where platform complementors in that category improve their performance outcomes.

Despite the potential for positive spillovers, we expect negative effects of intra-platform envelopment to be stronger than positive effects. Ultimately, the platform owner that envelops is likely to appropriate value that could have been captured by the affected complementors (Priem,

2007), and since this is a direct effect, we expect it to predominate over any positive spilled-over effect. Moreover, we expect the negative effect of envelopment to be stronger in the case of intra-platform envelopment than envelopment between platform owners, because in addition to asymmetric balance of power that can exist between the players, in the case of intra-platform envelopment, complementors compete within a space and “rules of the game” that are set (and can be changed) by the platform owner itself (Economides and Katsamakos, 2006; Kenney and Pon, 2011). This situation gives the platform owner an increased amount of power over complementors compared to other situations. In addition, consumers are likely to opt for the offerings by the platform owner over those of platform complementors, due to the former’s brand name, visibility, and market prominence. We, hence, expect the entry of the platform owner into complementors’ space to have a negative effect on the product performance of these complementors, and hypothesize as follow.

*Hypothesis 1: Intra-platform envelopment is negatively associated with the product performance of the affected complementors.*

## **DATA AND METHOD**

### **Empirical setting: health and fitness apps in mobile platforms**

We specifically examine intra-platform envelopment in the context of Apple iOS and Google Play app stores, which are salient examples of contemporary digital platforms. Apple iOS and Google Play were launched in July, 2008 and September, 2008 respectively. These two players dominate the mobile platform markets, fiercely competing against each other while

jointly owning over 90 percent of market shares; as of 2016, Google Play had 2.2 million apps while Apple had around 2 million available apps in its respective app store<sup>1</sup>.

We focus on a single category within the U.S. app store, health and fitness category, to mitigate concerns over possible confounding effects of combining different category types. The health and fitness category offers an ideal setting to explore our research questions for several reasons. First, it is an established category, growing 87 percent faster than the overall app market<sup>2</sup>. Second, unlike other app categories dominated by one or a few players, the health and fitness category is fairly fragmented and fiercely contested, which makes it possible to explore the vibrant intra-platform competitive dynamics. Third, the launch of Apple Health and Google Fit, intra-platform envelopment actions that we study, did not affect all health and fitness apps in a homogeneous manner. Health and fitness apps can be further sub-grouped based on their focal area of business, and the extent and timing of Apple Health and Google Fit effect differ by subcategory, enabling us to use some subcategories as control groups.

### **Intra-platform envelopment: the launch of Apple Health and Google Fit**

We focus on major instances of intra-platform envelopment in the health and fitness category: the launch of app by Apple and Google (Apple Health and Google Fit) whose functionality directly overlaps with that of some of the third-party health and fitness apps. This represents an ideal occurrence of intra-platform envelopment for several reasons. First, it happens in both of the major platforms. Apple Health was launched in September, 2014, and Google Fit came in October, 2014. Second, both include a particular functionality of “tracing” of

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<sup>1</sup> <https://www.statista.com/statistics/276623/number-of-apps-available-in-leading-app-stores/>

<sup>2</sup> <http://techcrunch.com/2014/06/19/fitness-app-usage-is-growing-87-faster-than-the-overall-app-market/>

health and fitness data, which is already offered by the health and fitness apps made by independent developers. The new offerings by Apple and Google can work as a stand-alone app, thus potentially acting as a substitute to third-party apps in their respective platforms. That is, consumers can store, record, and keep track of a range of health and fitness related data by directly using Apple Health and Google Fit even without third-party apps. Third, this phenomenon also well shows the subtlety of intra-platform envelopment, when the platform owner attempts against its complementors: co-existence of competition and cooperation. Despite the potential for presenting a substituting threat stemming from the fact that Apple Health and Google Fit can work alone without the support from third-party apps, Apple and Google alike also released APIs to encourage their independent developers to link to and interact with Apple Health and Google Fit. APIs are a set of routines and tools specifying how the components of a software application should interact; they provide guidance to developers in how to engage with the platform. Apple Health and Google Fit claim to serve as a central hub, in which consumers can store, manage, and connect health and fitness related data with ease, a vision that can be truly viable when a wider variety of third-party apps connect to Apple Health and Google Fit and import and export their data to and from Apple Health and Google Fit. As such, the success of Apple Health and Google Fit hinges on the active participation and engagement of third-party apps, and APIs are intended to help those complementary products to better leverage any service or offering presented in Apple Health and Google Fit. This tension in the platform owner-complementor relationship stresses the difference between intra-platform envelopment and inter-platform counterpart. The platform owner that attempts intra-platform envelopment has to be aware of and careful with the effect that such action may have in the overall ecosystem of independent developers that it relies on.

Qualitative evidence, which we gathered from interviews with industry participants and experts as well as business press, hints competing perspectives on the impact of Apple Health and Google Fit on their platform complementors. These indicate the complexities and subtleties surrounding intra-platform envelopment. Table 1 contains quotes that we excerpted from qualitative accounts that illustrate both cooperative and competitive aspects of Apple and Google offerings. These unsettled perspectives further call for a systematic investigation on this topic with a large, quantitative dataset.

– Insert Table 1 here –

### **Types of the apps that are affected by intra-platform envelopment**

The apps in the health and fitness category can be further categorized into subcategories, based upon their primary focus. We distinguish nine subcategories: running/walking/cycling; physical workouts/training; food/nutrition; sleep; women’s health; hydration; medical; body measurements; and others – see Table 2 for a brief description of each subcategory. To identify these subcategories, we follow the classifications used by the app stores, those used by several mobile analytic companies, and insights from a series of iterative discussions with industry experts. We then coded our data assigning each app to the corresponding subcategory. We checked for the accuracy of the classification by drawing a random sample of apps and having a research assistant to do the same job – inter-rater reliability of the classification was over 86 percent.

– Insert Table 2 here –

The impact of Apple Health and Google Fit varies by subcategory. For instance, in their initial release, both Apple Health and Google Fit offered the tracking functionality for running

activities, thereby directly affecting running apps. In contrast, Apple Health and Google Fit did not include a tracking feature for women’s health related activities (e.g., keep track of fertility or ovulation cycle), and therefore, those women health apps were not affected in their initial release. Exploiting this fact that the envelopment effect of Apple Health and Google Fit varies by subcategory, we construct a dataset composed of apps whose focal subcategory experienced envelopment by the platform owner, and those unaffected apps whose primal subcategory was not affected– see Table 3 for the details.

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## **Data sources**

*Quantitative dataset.* We use a large, self-collected dataset to explore the impact of intra-platform envelopment. Our dataset combines the hand-constructed data on health and fitness app and developer characteristics, with the commercial data on app downloads to measure the extent of app demand. Our data comes from three different sources. First, data on app downloads was purchased from a specialized mobile analytic company, *Apptopia*, which tracks and analyzes the mobile app industry. Both Apple iOS and Google Play do not publicly disclose the sales and downloads of their app stores, but instead, they provide ranking data based on the number of downloads. Prior studies have used ranking data as a proxy for app performance (Carare, 2012; Yin, Davis, and Muzyrya, 2014). Although ranking is a reasonable proxy to infer a focal app’s demand and market performance, it is by no means a perfect measure. For example, performance gap between the 1<sup>st</sup> ranked and 2<sup>nd</sup> ranked app is not likely to be the same as the gap between the 100<sup>th</sup> ranked and the 101<sup>st</sup> ranked app. Yet, such difference is treated as equal in an analysis based on ranking data. In this sense, a few scholars (Carare, 2012; Garg and Telang, 2013; Ghose and Han, 2014) have even tried to model the number of downloads from publicly available data.

However, such modeling is also dependent upon ranking data and covers only top ranked apps (e.g., top 200), thereby failing to fully capture the dynamics of the app market (Carare, 2012). To overcome these limitations, we use raw data of app downloads estimated from a respected industry source, which we had acquired access to through months of negotiations and discussions. In addition to app downloads data, we also collected app metadata directly from Apple and Google app stores, and two other mobile analytic sites (*AppAnnie* and *SensorTower*).

Our dataset contains the top 600 health and fitness apps and the top 1,500 health and fitness apps in Google Play and Apple iOS app stores respectively for the periods of July 1, 2014 to December 31, 2015. “Top apps” are measured by the number of downloads, and top 600 and top 1,500 represents the total number of apps that *Apptopia* tracked, which therefore mitigates the concern of selection bias on our part. Our collected data starts before the actual Apple Health and Google Fit release dates in order to make before-and-after intra-platform envelopment comparisons. Some apps were removed from the app stores during the data collection period; when that happens, the platform owner also removes all the historical data related to those apps – We therefore excluded those apps with missing information from our sample. To make the before-and-after comparisons more valid, we restricted our sample to those apps released before July 1, 2014. Our final sample consists of 1,305 apps and 93,960 observations at the app-week level in Google Play, and 3,696 apps and 236,544 observations at the app-week level in Apple iOS app store.

***Qualitative dataset.*** As a supplementary analysis, we conducted more than 20 semi-structured interviews with industry participants, industry experts, and other platform scholars in order to understand the nature and dynamics of mobile platform markets and to validate our findings. These qualitative accounts are important, in that much of the phenomenon in this

market is fast-paced and rapidly emerging, and therefore, it is crucial to use qualitative evidence to triangulate and confirm our analysis.

## **Variables**

*Dependent variable.* We use the number of downloads as our dependent variable. As mobile platform markets are very skewed with long-tailed distribution, downloads are also positively skewed. We took the natural logarithm to address the skew in the distribution of this variable.

*Independent variables. Affected group.* We examine the effect of intra-platform envelopment by comparing the apps whose focal subcategory was affected by the platform owner's intra-platform envelopment with those which was not. As shown in Table 3 above, the apps whose primal subcategory within the health and fitness category falls in the affected subcategories by intra-platform envelopment takes the value of one, while zero if not.

*After intra-platform envelopment.* Apple Health came in September, 2014 and Google Fit did in October, 2014. To exploit differences between before-and-after the launch of Apple Health and Google Fit, we set the value of zero for the weeks before intra-platform envelopment, and one for the weeks after envelopment occurred. To arrive at our variable of interest, *affected group after intra-platform envelopment*, we interact this variable *after intra-platform envelopment* with the above indicator variable of *affected group*.

In order to address any unobservable differences inherent in app-specific characteristics, we employ app-level fixed effects. Also, we include weekly dummies to account for any macro or time-trend differences. We did not include any time-varying app and app-developer level control variables, because most of these time-varying variables can be an endogenous outcome

of intra-platform envelopment (e.g., bad control problems as illustrated in Angrist and Pischke (2008)). Please refer to Table 4 for descriptive statistics for main variables.

– Insert Table 4 here –

## Methodology

We use a difference-in-differences approach, taking advantage of the unaffected subcategories that can act as control groups, together with fixed-effects at the app level and at the platform-week level in order to control for any unobserved app-specific and platform-week-specific differences. Below is our main specification of interest, where  $i$  denotes app,  $j$  denotes subcategory,  $k$  denotes Apple iOS app store,  $z$  denotes Google Play app store, and  $t$  denotes time (weeks). The variables that are constant within observations (e.g., variables of *affected group*, or *after intra-platform envelopment*) are not included in the model, as they are absorbed by fixed-effects.

$$\text{Log}(\text{Downloads}_{ijt}) = f(\varepsilon_{ijt}; \alpha_i + \beta_{kt} + \lambda_{zt} + \delta \text{Affected group}_{ij} * \text{After intra-platform envelopment}_{ijt})$$

## RESULTS

### Main results

Model 1 in Table 5 shows the result for the combined data from Apple iOS and Google Play app stores. The coefficient estimate of *affected group after intra-platform envelopment* suggests that the envelopment effect is negative and significant in the context of pooled data for both stores, lending support to Hypothesis 1. The applications affected by intra-platform

envelopment experience a decrease in downloads by 12 percent, compared to those apps that are unaffected by the platform owner move.

– Insert Table 5 here –

## **Heterogeneous effects and mechanisms**

In order to further unpack intra-platform envelopment and explore the underlying mechanisms, we investigate several factors that can intervene in the process of intra-platform envelopment.

*Platform governance (degree of openness): Apple vs. Google.* We explore whether and how different types of platform governance drive heterogeneity in the process of intra-platform envelopment. Platform governance, in particular degree of openness, is known to directly affect the participation and engagement of platform complementors (Boudreau, 2008, 2010; Economides & Katsamakos, 2006; West, 2003).

Google and Apple are known to have a very different approach in regards to platform openness; Google Play is considered to pursue a more open and less controlling platform governance policy than Apple. Such differences are also reflected in the instances of their intra-platform envelopment, that is, Apple Health and Google Fit release in their respective app ecosystems. While the basic contents, functionalities, and characteristics of Apple Health and Google Fit are similar, there are important differences in how each company implemented it in their app store. Apple Health came as pre-installed in all new iPhones, and for existing iPhones, it was automatically installed (without requiring user permission) when a user upgraded the operating system in his/her smartphone. Google Fit, in contrast, was not pre-installed in Android devices, and required a manual download for those users that wanted to have it. That is, users

had to go to Google Play app store, search for the app, and install it in their smartphone. Moreover, Apple and Google had a different approach when it comes to offering APIs for their released apps of Apple Health and Google Fit. Consistent with their different perspectives on openness, Google provided more options and flexibility for third-party developers, whereas APIs related to Apple Health were more restrictive and offered less discretion to independent developers. For instance, Google Fit is composed of three different APIs, which enable independent developers to mix and match to their interests, while Apple Health APIs are distributed in a rather standardized and monolithic way – see Table 6 for detailed information about the different governance approach of these two companies, which we gathered from interviews with industry experts and business press analysis.

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Given these important considerations, we expect the differences in openness and platform governance between Apple and Google to result in heterogeneity in the effect of intra-platform envelopment when comparing across platforms. Therefore, we run separate models to account for such important differences.

*Apple iOS app store.* Model 2 in Table 5 shows that in the case of Apple iOS, the effect of intra-platform envelopment is negative; the apps affected by the introduction of Apple Health experience a decrease in downloads by 32 percent, compared to unaffected apps.

*Google Play app store.* A similar envelopment action leads to the opposite effect in Google Play app store, as indicated by Model 3 in Table 5. The coefficient estimate of *affected group after intra-platform envelopment* is positive and significant, implying that the introduction of Google Fit has a positive effect on those apps affected by Google’s intra-platform

envelopment. These apps experience an increase in downloads by 35 percent, compared to unaffected apps.

These opposite effects suggest found in the Apple and Google app stores suggest that the effect of intra-platform envelopment is highly contingent upon platform-specific characteristics, in particular the governance structure of each platform and how the specific intra-platform envelopment action is implemented. The way that Google Fit was implemented – giving more discretion and flexibility to platform complementors to leverage the APIs and placing the platform owner app in a levelled-playing ground with others by requiring a manual download – appears to have suppressed the competitive effect. The more open and complementor-friendly governance structure of Google Play app store seems to have produced positive spillover effects that trumped over competitive effects. The case of Apple Health, in contrast, suggests that competitive effects can be strengthened when the platform owner implements more controlling and restrictive governance policies.

*App-specific characteristics.* We further explore the platform-specific differences suggested by the previous analyses, by running separate models for each platform, in which we investigate some of the important app-specific characteristics, such as pricing decisions and existence of in-app purchases capabilities. Our analyses attempt to determine if these differences are associated with heterogeneous effects in the case of intra-platform envelopment.

*Price mechanisms – free vs. paid apps.* One of the most important decisions developers in mobile platform markets have to make is how much to charge for their apps. Given that thousands of apps already exist and more keep constantly coming into (and out of) the market due to low barriers to enter (Boudreau, 2012), consumers' willingness to pay is likely to be low. Distributing products for free has actually become prevalent in mobile platform markets. Free

apps account for nearly 90 percent of the total mobile app store downloads<sup>3</sup>. The variable *app price* takes a value of zero if the app is offered for free, while it becomes one for paid apps.

*Apple iOS app store.* Model 2 in Table 7 shows how the effect of intra-platform envelopment differs by price mechanisms. The difference in performance between free and paid apps is of borderline significance ( $p=0.08$ ), which indicates that the negative impact from the platform owner's envelopment does not appear to be mitigated by pricing. That is, the performance of all third-party apps affected by intra-platform envelopment, regardless of pricing, appear to be reduced by the offerings of the platform owner.

*Google Play app store.* Model 2 in Table 8 shows that the positive impact of Google Fit on the affected apps is enhanced for the case of free apps, while the coefficient for paid apps becomes insignificant. This is likely to be related to the fact that free apps tend to be simpler and stripped of advanced functionality, and thus can benefit greatly by the functionality offered by Google Fit which they can now connect to. Paid apps, in contrast, tend to be more function-rich and therefore are less likely to gain much in functionality by connecting to Google Fit.

*In-app purchase option – apps with basic features vs. apps with advanced features.* App developers' revenue not only comes from charging for the product. App developers can also earn revenue by providing in-app purchase options, which allow consumers to access additional features, contents and resources that make the app experience richer. Often, in-app purchases are used *in lieu of* an upfront charge for the app ( $\text{price} > 0$ ). Hence, apps with in-app purchase capabilities tend to be more feature-rich than those without that capability.

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<sup>3</sup> <http://www.gartner.com/newsroom/id/2153215>

Approximately, 76 percent of U.S. iPhone app revenue comes from in-app purchases as of 2013<sup>4</sup>, which suggests that in-app purchases have become a major revenue source in this market. The variable *in-app purchase options* take a value of one, if the app offers in-app purchases while it becomes zero for the apps without in-app purchases.

*Apple iOS app store.* As shown in Model 3 in Table 7, the negative effect of the Apple Health platform envelopment on the affected apps appears to be mitigated to some extent for those apps that have in-app purchase capability (the coefficient becomes statistically insignificant). In contrast, for those apps that do not have in-app purchase capability – more basic apps – the negative effect of intra-platform envelopment remains significant.

*Google Play app store.* Model 3 in Table 8 shows that *in-app purchases* moderate the effect of the Google Fit intra-platform envelopment on the affected apps ( $p=0.05$ ). Apps that do not have in-app purchase capability seem to benefit more from the launch of Google Fit, while the effect becomes statistically insignificant for those apps that have in-app purchase capabilities, thus already providing feature-rich experiences to consumers.

[Note to Platform Strategy Research Symposium 2017 reviewers: we are currently exploring the effects of other app-specific or developer-specific characteristics to further unpack intra-platform envelopment. The final results are not available yet and thus are not included in this version, but, the completed paper is expected to include those aspects as well].

– Insert Table 7 here –

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<sup>4</sup> <https://techcrunch.com/2013/03/28/in-app-purchase-revenue-hits-record-high-accounts-for-76-of-u-s-iphone-app-revenue-90-in-asian-markets/>

– Insert Table 8 here –

## **DISCUSSIONS AND CONCLUSIONS**

The present paper is one of the few first studies to conceptualize the nuanced competitive and collaborative tension that exists in the relationship between a platform owner and its complementors – a coopetitive relationship. We focus on the effect of intra-platform envelopment on platform complementors and we empirically test hypotheses with a large, hand-collected dataset. We see our primary contribution to the platform literature, which has so far primarily focused on inter-platform competition (Eisenmann *et al.*, 2006; Gawer and Cusumano, 2002; Selander, Henfridsson, and Svahn, 2013), while paying less attention to intra-platform dynamics. Thus, extant literature on platforms typically stresses only the one aspect of the owner-complementor relationship, that is, the complementary or cooperative aspect. However, as our study shows, platform owners not only compete with other platforms but can also compete with their own complementors by launching products that overlap with the functionality of complementor products. By focusing on these intra-platform envelopment actions, we extend the notion of platform envelopment used in platform-to-platform competition, and thus open new avenues for research. Considering the unique characteristics of platform markets, in which the owner and complementors of a focal platform are closely dependent upon each other, the consequences of intra-platform envelopment are complex and nuanced. We expect intra-platform envelopment to take the form of a partial overlap of the complementor features, as opposed to a full overlap of those functionalities, since platform owners must be careful not to annihilate the complementor ecosystem they need to succeed. Moreover, we expect envelopment not to be uniform all across platforms, but instead vary according to specific characteristics of the different

platforms. As shown in our analyses, a similar intra-platform envelopment action can bring about effects that vary with difference in platform governance (openness), and the specific way that envelopment is executed. This stresses the importance of taking a contingent approach when exploring the dynamics within the platform settings.

Our findings suggest that the effect of intra-platform envelopment also varies by app-specific characteristics. This suggests that there is an important role for agency when it comes to how complementors may respond to the challenge of envelopment by the platform owner. Our results point to some strategic levers that complementors can use to mitigate the negative effects (or amplify the positive ones) of intra-platform envelopment. Previous studies on entrepreneurial ecosystems have emphasized the merits and benefits of entrepreneurial ventures to join the entrepreneurial ecosystem. Our paper warns about “the other side of the coin”, that is, the risk of envelopment by the platform owner, and provides estimates of the potential effects of such actions, and possible strategies to cope with them. We thus focus on an underexplored topic of entrepreneurial ecosystems enabled by platforms by contributing to the entrepreneurship literature.

Our results also contribute to the co-opetition literature, which has tended to explore the competitive-collaborative relationship between competitors by examining similar phenomena but that often starting from the other end: former competitors that decide to collaborate (for instance, the Symbian joint-venture created by smartphone competitors wanting to produce a rich mobile operating system). In the case of intra-platform envelopment, the directionality is opposite: collaborators (platform owner and complementors) suddenly become competitors due to the envelopment action by the owner.

However, this paper has also some limitations. First, the study is based on a single context: health and fitness apps in mobile platform markets. Even though it is an established category that has experienced fast growth and attracted the attention of both platform owners and policy makers (e.g., the emergence of mobile health initiatives), caution is needed in claiming generalizability. Second, we cannot claim causality in our intra-platform envelopment analysis, because there is no guarantee that the decision of the platform owner to embark in envelopment comes in a totally unanticipated manner to the complementors. Although exploring the antecedents of intra-platform envelopment is out of the scope of this paper, there could be different motives behind the decision of the platform owner to launch Apple Health and Google Fit (for instance, which features or subcategories to envelop, which in turn is associated with which complementors are affected and which ones are not). Qualitative evidence that we gathered in Table 1, with unsettled perspectives, hints that the release of Apple Health and Google Fit may have been an exogenous shock in the complementors' market. Indeed, some decisions actually turned out to be random; e.g., the reason why the first release of Apple Health did not include women's health seems to be simply due to the fact that the majority of Apple developers are male and just were not aware of the importance of, say, tracking menstrual cycle or ovulation<sup>5</sup>. Yet, given unresolved, lingering uncertainties, still, we only argue that our study should be considered as an early investigation to delve into the dynamic and heterogeneous consequences of intra-platform envelopment, and we hope that this work would spark future research on this important topic.

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<sup>5</sup> <http://www.theverge.com/2014/9/25/6844021/apple-promised-an-expansive-health-app-so-why-cant-i-track>

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**Table 1: Competing perspectives on the impact of Apple Health and Google Fit on health and fitness apps**

Attributes	Excerpts from business press and interviews with industry experts and participants
<b>Direct substitute to existing health and fitness apps</b>	<p><i>"Health and Fit work directly with health and fitness devices."</i></p> <p><i>"Google Fit uses sensors in a user's activity tracker or mobile device to record physical fitness activities"</i></p> <p><i>"In iOS 8.0, the system can automatically save data from compatible Bluetooth LE heart rate monitors"</i></p> <p><i>"The system can also automatically import activity data from M7 motion coprocessor, if available"</i></p> <p><i>"Health is already logging steps (if you have an iPhone 5S or newer) and flights of stairs climbed (if you have iPhone 6 or 6 plus)"</i></p> <p><i>"Health (and Fit) can keep track of your steps without help from an external app or device, like Fitbit"</i></p> <p><i>"Truth be told, you don't even need a wearable or additional smart device to get moderate use from Apple Health, - thanks to the iPhone's own motion sensors, GPS tech, and M-series co-processor"</i></p> <p><i>"Unless you have tech that goes beyond what Apple or Google can offer in a smartphone, you'll be eaten alive"</i></p>
<b>Enabler that facilitates the m (mobile)-health ecosystem</b>	<p><i>"Healthkit allows third-party apps to focus on implementing only the aspects you are most interested in, leaving other tasks to more specialized apps"</i></p> <p><i>"The main aim of Health is to provide a single point of reference for all of your aggregated health and fitness data, - and the more third-party services you can plug into it, the better"</i></p> <p><i>"For a more complete picture, Health works best when synced to another fitness tracker or smartwatch you're always wearing - (or a connected device like a heart rate sensor or smart scale) via that device's companion app"</i></p> <p><i>"Having a company like Apple or Google educating everyone on why this stuff matters can help the whole category become mainstream faster"</i></p> <p><i>"Thanks to Healthkit, developers can spend a lot more time on building our more personalized guidance and incorporating more types of data - into the guidance framework, which can help people get better results across more of the things they care about"</i></p> <p><i>"Apple's Health and Google's Fit can help reach a broader audience and forge partnerships with the traditional health care industry - that would be hard for startups to accomplish alone"</i></p> <p><i>"So, for Apple Health (Google Fit) app to be useful, you'll need other health apps"</i></p>

Source : Business press, including Apple Health and Google Fit official homepage and interviews with industry experts and app developers

**Table 2: Subcategorization within health and fitness category**

Subcategory	Criteria
1 (Fitness) Running/walking/cycling	GPS (sensor) tracking -activities related
2 (Fitness) Physical workouts	Physical class; training; workout-enhancing activities
3 (Health) Food/nutrition	Calories or macro-nutrition related; meal-plan; diet
4 (Health) Sleep	Sleep cycle; sleep inducing related
5 (Health) Women's health	Fertility or ovulation tracking related
6 (Health) Hydration	Water tracking related
7 (Health) Medical	Vital signs (blood pressure, glucose, blood alcohol content, body temperature); medical
8 (Health) Body measurements	Weights; heights; BMI; body-fat measurement related
9 (Health and Fitness) Others	Offline business supports; baby and pregnancy; beauty; mental health; e-magazine and books; smoking and alcohol, etc.

**Table 3: Effect of Apple Health and Google Fit by subcategory in health and fitness apps**

<b>Subcategory</b>	<b>Apple Health (Sep 17, 2014)</b>	<b>Google Fit (Oct 28, 2014)</b>	<b>Apple Health II (Sep 16, 2015)</b>	<b>Google Fit II (Nov 19, 2015)</b>
1 (Fitness) Running/walking/cycling	<i>Affected</i>	<i>Affected</i>	<i>Affected</i>	<i>Affected</i>
2 (Fitness) Physical workouts	<i>Affected</i>		<i>Affected</i>	<i>Affected</i>
3 (Health) Food/nutrition	<i>Affected</i>		<i>Affected</i>	<i>Affected</i>
4 (Health) Sleep	<i>Affected</i>		<i>Affected</i>	<i>Affected</i>
5 (Health) Women health			<i>Affected</i>	
6 (Health) Hydration			<i>Affected</i>	
7 (Health) Medical	<i>Affected</i>		<i>Affected</i>	
8 (Health) Body measurement	<i>Affected</i>	<i>Affected</i>	<i>Affected</i>	<i>Affected</i>
9 (Health and Fitness) Others				

**Table 4: Descriptive statistics for main variables**

<b>Variables</b>	<b>Obs.</b>	<b>Mean</b>	<b>Std. Dev</b>	<b>Min</b>	<b>Max</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>1</b> ( <i>Logged</i> ) <i>Downloads</i>	398,854	2.29	2.37	0	10.78	1			
<b>2</b> <i>Affected group</i>	398,775	0.61	0.48	0	1	-0.01	1		
<b>3</b> <i>After intra-platform envelopment</i>	330,576	0.79	0.4	0	1	-0.03	0.01	1	
<b>4</b> <i>App price</i>	398,854	0.49	0.49	0	1	-0.41	0.12	0.001	1
<b>5</b> <i>In-app purchase option</i>	398,854	0.27	0.44	0	1	0.18	0.02	0.002	-0.35

**Table 5: Regression results**

<b>Dependent variable</b>	<b>Model 1</b> Pooled data <i>log (Downloads)</i>	<b>Model 2</b> Apple iOS only <i>log (Downloads)</i>	<b>Model 3</b> Google Play only <i>log (Downloads)</i>
<i>Affected group * after intra-platform envelopment</i>	-0.12*** (0.04)	-0.32*** (0.05)	0.35*** (0.11)
Platform-Week FE	YES	YES	YES
App FE	YES	YES	YES
Observations	330,504	236,544	93,960
Groups	5,001	3,696	1,305
R-squared	0.74	0.72	0.80

*Notes:* Robust standard errors clustered by the app are in parantheses

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

**Table 6: Comparison between Apple (Health) and Google (Fit)**

	<b>Apple</b> <i>(Controlling, closed, tightly managed, standardized, fixated)</i>	<b>Google</b> <i>(Flexible, open, allowing more discretion, less regulated, embracing)</i>
<b>App</b>	Pre-installed or automatically installed upon upgrading iOS system	Manual download from the app store is required
<b>APIs</b>	Restricted to using only between iOS system and devices Healthkit constrains the types of data and units to a predefined list Developers cannot create custom data types or units	REST APIs - supports across multiple platforms and devices (Android, Web apps, and even iOS) App developers can create custom data (if Google Fit does not provide a similar data type) Using standard units is not mandatory, but choice of apps Offers different sets of APIs, which allows developers to mix and match (e.g., sensors API, recording API, history API, etc)
<b>Platform policy</b>	Vertically integrated, closed system "Walled-garden" strategy to provide a more effective and cohesive user experience Strictly controlling application developers Tight and selective approval process: it takes 6 days on average	More open platform Open, free licensing approach with the goal of building market share as quickly as possible as a late comer Exerts little supports and at the same time, little control over the application community Fewer restrictions and rejections in app approval: 2 hours on average

*Source* : Business press, including Apple Health and Google Fit official homepage , interviews with industry experts and app developers, and literature reviews  
(Eaton *et al.*, 2015; Kenney and Pon, 2011; Muller, Kijl, and Martens, 2011)

**Table 7: Heterogeneous effects in Apple iOS app store**

*Apple iOS app store (Apple Health release)*

	Model 1	Model 2		Model 3	
		<i>Free apps</i> (T-test: $p=0.08^*$ )	<i>Paid apps</i>	<i>No in-app purchase</i>	<i>In-app purchase</i> (T-test: $p=0.00^{***}$ )
<b>Dependent variable:</b> <i>log (Downloads)</i>					
<i>Affected group * after intra-platform envelopment</i>	-0.32*** (0.05)	-0.02 (0.07)	-0.17*** (0.05)	-0.47*** (0.05)	0.08 (0.1)
Time FE	YES	YES	YES	YES	YES
App FE	YES	YES	YES	YES	YES
Observations	236,544	117,248	119,296	169,408	67,136
Groups	3,696	1,832	1,864	2,647	1,049
R-squared	0.72	0.72	0.71	0.71	0.72

*Notes:* Robust standard errors clustered by the app are in parantheses

\*  $p<0.1$ , \*\*  $p<0.05$ , \*\*\* $p<0.01$

**Table 8: Heterogeneous effects in Google Play app store**

*Google Play app store (Google Fit release)*

<b>Dependent variable: <i>log (Downloads)</i></b>	<b>Model 1</b>	<b>Model 2</b>		<b>Model 3</b>	
		<i>Free apps</i> (T-test: $p=0.001$ ***)	<i>Paid apps</i>	<i>No in-app purchase</i>	<i>In-app purchase</i> (T-test: $p=0.05$ *)
<i>Affected group * after intra-platform envelopment</i>	0.35*** (0.11)	0.67*** (0.19)	-0.01 (0.08)	0.46*** (0.13)	0.001 (0.19)
Time FE	YES	YES	YES	YES	YES
App FE	YES	YES	YES	YES	YES
Observations	93,960	49,248	44,712	70,848	23,112
Groups	1,305	684	621	984	321
R-squared	0.80	0.74	0.68	0.80	0.83

*Notes:* Robust standard errors clustered by the app are in parantheses

\*  $p<0.1$ , \*\*  $p<0.05$ , \*\*\* $p<0.01$