Journal of Product Innovation Management

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ORIGINAL ARTICLE OPEN ACCESS

Smart Timing for Smart Products? Complementor Multihoming in Nascent Platform Markets

Senem Aydin Ozden[1] | Fernando F. Suarez[2] | Dirk Libaers[3,4] | Yakov Bart[2]

[1]City St George's, University of London, Bayes Business School, London, UK | [2]Northeastern University, D'Amore McKim School of Business, Boston, Massachusetts, USA | [3]University of South Florida, Muma College of Business, Tampa, Florida, USA | [4]University of Vaasa, Innovation and Entrepreneurship InnoLab, Vaasa, Finland

Correspondence: Senem Aydin Ozden (senem.aydin@citystgeorges.ac.uk)

Received: 10 February 2023 | **Revised:** 13 March 2025 | **Accepted:** 30 July 2025

Associate Editor: Jonathan Bohlmann

Funding: The authors received no specific funding for this work.

Keywords: complementor strategy | multi-platform ecosystem | nascent platform market | smart home | timing of multihoming

ABSTRACT

In multi-platform markets, complementors often choose to offer their products or services across several platforms—a strategy known as complementor multihoming. This approach has gained significant attention from both industry practitioners and management scholars. Building on existing research regarding the factors that influence complementors' decision to multihome and the associated performance implications, this study examines the *timing strategies* involved in complementors' multihoming decisions. Specifically, we investigate the drivers of the timing of complementors' sequential multihoming, focusing on the factors that affect the timing of their first and subsequent multihoming. The empirical context of our research is the ecosystem of platforms and complementors in the nascent smart home market. Our results show that early entrants transition more quickly from single-homing to multihoming (i.e., joining a second platform) than late entrants, suggesting that they adopt a hedging strategy in response to the high uncertainty present in the early stages of the ecosystem. We also find that the drivers of the timing of multihoming may differ for the first and subsequent multihoming. For the first multihoming, the market traction of non-adopted platforms is associated with how quickly complementors multihome. However, this relationship dissipates in subsequent multihoming decisions. Nevertheless, certain factors influence the timing of all multihoming: when joining a second or third platform, complementors are faster to adopt platforms that are technologically similar to those they have already joined. We discuss the managerial implications of these findings for platforms and complementors navigating multi-platform ecosystems.

1 | Introduction

In platform-mediated markets where several platforms compete for dominance, complementors—suppliers of complementary products or services that add value to a platform (Boudreau and Jeppesen 2015)—can join multiple platforms and thereby expand their user base (Corts and Lederman 2009; Rietveld and Eggers 2018). For instance, Spotify, the market leader in music streaming services, launched its iOS app in July 2011, and the Android version of its app became available in May 2014. Often referred to as complementor multihoming, the strategy of offering products or services across platforms has drawn considerable interest from management and innovation scholars, as reflected in the rapid growth of research in this field (e.g., Agarwal and Kapoor 2023; Cennamo et al. 2018; Chen et al. 2022; Chung et al. 2024; Landsman and Stremersch 2011; Li and Zhu 2021; Polidoro and Yang 2024; Srinivasan and Venkatraman 2018; Tavalaei and Cennamo 2021; Tian et al. 2022). Studies have shown that multihoming has several strategic implications for complementor performance and platform competition. For

Summary

- This study argues that fast multihoming increases complementors' chances of survival in nascent platform markets.
- Early entrants to a multi-platform ecosystem are advised to join a second platform quickly to hedge against market uncertainty and reduce the risk of choosing the wrong platform.
- Complementors can also benefit from monitoring which platforms gain early popularity and considering these signals when deciding how fast to multihome.
- Fast adoption of a rising platform can strengthen complementors' market positioning.
- In addition, complementors can multihome faster by targeting platforms that are technologically closer to those they have already adopted.
- To deter early entrants from quickly multihoming, platform owners may provide incentives or exclusive agreements to high-potential complementors.
- Platform owners can also make it harder for complementors to multihome by differentiating their platform architecture.

complementors, multihoming can improve their chances of survival by mitigating the risk of opportunistic behavior by a focal platform (Hagiu 2005) and by shielding against the risk of a platform's market failure (Schilling 2002). For platforms, however, the presence of complementor offerings across multiple platforms reduces differentiation and hinders a platform's unique positioning in the market and its ability to exploit indirect network effects to attract more users (Allen et al. 2021; Bresnahan et al. 2014; Rietveld et al. 2019).

While management research has advanced our understanding of complementor multihoming by exploring topics such as the decision to multihome (Chen et al. 2022), the types of complementors that multihome (Kim et al. 2017), and the learning opportunities provided by multihoming (Polidoro and Yang 2024), it has largely overlooked a key aspect of complementors' multihoming strategies—*when* to multihome. A complementor's strategic actions are not only concerned with whether or not to multihome but also with the *timing* of such a move. In multi-platform markets, complementors may also need to consider when to multihome *again*. The timing of multihoming is an important dimension of complementors' competitive strategies in platform ecosystems, and it can have a substantial impact on their performance. For example, Dropbox, a cloud storage provider, released its iOS app in September 2009 and quickly followed with its Android app in May 2010. In contrast, Box, a competitor offering similar services, introduced its iOS app earlier than Dropbox in October 2008 but delayed the release of its Android app till September 2010.[1] Dropbox's relatively swift multihoming allowed it to reach users on both mobile platforms sooner, enhancing its accessibility and expanding its market reach.[2] Conversely, Box's delay in multihoming to the Android platform limited its ability to tap into the fast-growing Android user base, giving Dropbox a head start in solidifying its position in the mobile cloud storage market.[3] As this example suggests, the timing of multihoming is a key element of complementors' inter-platform strategies since it can have a significant impact on their competitive outcomes. The decision on when to multihome is likely to be influenced by several complementor- and platform-specific factors which might change over time. In this study, we investigate the determinants of complementors' timing of sequential multihoming. Our research question is: what factors influence the timing of a complementor's initial and subsequent multihoming?

An important contingency that is likely to influence the timing strategies of complementors is the stage of the industry lifecycle (Fosfuri et al. 2013). Research shows that the early stage of an industry exhibits high technological and market uncertainty (Anderson and Tushman 1990). This uncertainty is intensified by the power of network effects in platform landscapes (Frattini et al. 2014). In such settings, complementors must consider which of the emerging platforms will survive the initial period, which one(s) will subsequently take off, and, ultimately, which one will dominate the market. Hence, in the nascent stage of a multi-platform market, complementors are expected to make their multihoming timing decisions with the aim of reducing the uncertainty and increasing their chances of survival. Early entrants in such spaces face the highest levels of uncertainty and may seek to mitigate this by rapidly multihoming to a second platform, thereby increasing their chances of success. Additionally, reducing the uncertainty in the market requires complementors to search for indicators that can inform them about the current state of platform competition and the relative position of platforms. Market indicators such as strong traction gained by a non-adopted platform—reflecting its popularity among users—during this early stage can incentivize complementors to quickly multihome to that platform. However, multihoming is a costly endeavor for complementors; it requires compliance with the technical specifications and esthetic standards unique to each platform (Armstrong and Wright 2007). It has been argued that multihoming between technologically closer platforms can be less costly (Chen et al. 2022; Srinivasan and Venkatraman 2018). Consequently, we expect the technological distance between a non-adopted platform and a complementor's current platform(s) to influence how fast a complementor multihomes, implying that complementors will multihome faster to platforms that are technologically closer.

Our empirical setting is the ecosystem of complementors in the smart home market. This market is at an early stage of development (Hilbolling et al. 2021) with several competing platforms and much uncertainty regarding which platform will dominate. This constitutes an ideal setting to explore complementors' multihoming strategies. It allows us to study the drivers of complementors' timing of first and subsequent multihoming, that is, when a complementor decides to join a second and then a third platform, respectively. Our findings reveal unique patterns in complementors' multihoming timing strategies. Specifically, we find a *hedging* strategy by the early entrants of the market: complementors that enter the nascent platform market early tend to multihome to a second platform faster than late entrants, confirming our expectation that early entrants will multihome quickly to alleviate market uncertainty. We also find that complementors multihoming for the first time tend to join non-adopted platforms with stronger market traction more quickly, in an attempt to hedge their position in the market and shield themselves from potential adverse impacts of platform competition. Finally, our results indicate that complementors are faster to multihome to platforms that are technologically closer to the one(s) they have already joined, as they incur lower costs than multihoming to platforms with more distant technologies.

This research contributes to the platform literature on complementor multihoming (Cennamo et al. 2018; Corts and Lederman 2009; Landsman and Stremersch 2011) by providing new evidence on the timing strategies of complementors beyond the dichotomous choice of whether to multihome or not. Identifying timing as an important aspect of multihoming, our study brings focus to a critical dimension of the competitive dynamics of complementors in platform markets. It also draws attention to the complexity of complementor strategies, especially in nascent multi-platform settings. These contexts significantly differ from mature platform markets by exposing the complementors to a higher risk of failure. While much of the platform research is based on a mature platform setting and a single multihoming option (e.g., Srinivasan and Venkatraman 2018; Bresnahan et al. 2014), we extend the theoretical discussion to nascent platform markets and sequential multihomings. Our study also contributes to the entry timing literature by broadening its application to platform markets. Research in this field mostly investigated platform owners' (Zhu and Iansiti 2012) and complementors' (Huang et al. 2013) entry into platform markets. We inform and complement the entry timing literature by highlighting the prominence of timing in other strategic decisions of complementors, such as multihoming.

2 | Theoretical Background

2.1 | Timing Strategies

The extant literature on entry timing emphasizes the importance of timing strategies and discusses how timing decisions can impact an entrant's survival and performance. This literature has identified several isolating mechanisms that favor early movers, such as technological leadership, preemption of scarce resources, and consumer switching costs (Lieberman and Montgomery 1988). While early movers can benefit from these mechanisms, late movers are theorized to take advantage of "(1) the ability to 'free- ride' on first-mover investments, (2) resolution of technological and market uncertainty, (3) technological discontinuities that provide 'gateways' for new entry, and (4) various types of 'incumbent inertia' that make it difficult for the incumbent to adapt to environmental change" (Lieberman and Montgomery 1988, 47). Several attempts have been made to test the relationship between entry timing and firm performance; however, the evidence remains mostly inconclusive. Studying the money market mutual fund industry, Makadok (1998) found that early movers gained both pricing and market share advantages compared to late movers. Similarly, Carpenter and Nakamoto (1989) showed that the formation of consumer preferences created early-mover advantages. In contrast, Golder and Tellis (1993) argued, based on historical data, that nearly half of market pioneers eventually failed. Likewise, Shankar et al. (1998) evidenced that innovative late movers could create a sustainable advantage over both early and non-innovative late movers. The inconclusiveness of the empirical evidence prompted management scholars to investigate further when and how early-mover advantages prevail in various contexts (Bohlmann et al. 2002; Wang and Xie 2014). The pace of market and technological evolution is argued to act as an enabler or disabler of isolating mechanisms. Specifically, in environments with smooth market growth and technological evolution, entrants are more likely to enjoy early-mover advantages (Suarez and Lanzolla 2007), whereas early-mover advantages in highly volatile environments are harder to sustain (Christensen et al. 1998).

More recent studies examined the implications of early versus late entry in markets with network effects. For example, Srinivasan et al. (2004) focused on such a context and observed a negative association between early entry and pioneer survival; however, this effect was reversed for more radical and technologically intense products. Other studies on entry timing strategies in platform markets uncovered evidence for early-mover advantages (Lieberman 2002) but found no support for heavy preemptive investments by early movers in markets with winner-take-all characteristics (Eisenmann 2006). Some scholars argued for an inverted U-shaped relationship between the timing of entry and the likelihood of success in markets with strong network externalities (Schilling 2002). Examining the video game industry, Zhu and Iansiti (2012) concluded that when network effects are not strong, a late entrant with a superior quality offering can increase its market share, even when the early entrant has a large installed base.

While several studies investigated platform settings, most of this work has been conducted at the platform level and from the perspective of the platform owners (Eisenmann 2006; Schilling 2002; Zhu and Iansiti 2012). Research on entry timing strategies of complementors has been scant and mostly focused on the factors that influence their initial platform adoption decisions. For example, Huang et al. (2013) evidenced that complementors' likelihood of adopting a platform increases with the level of intellectual property (IP) protection and their ownership of downstream capabilities. In contrast, studying the appropriability strategies of app developers in Apple's App Store, Miric et al. (2019) showed that complementors more often rely on early-mover advantages than formal mechanisms of protection, such as patents. Lastly, Wen et al. (2016) conducted research on an open-source software community and found that IBM's announcement of a non-assertion policy on its IP incentivized startups to join the community as complementors.

In sum, prior research on entry timing in platform markets has shown varied results, primarily drawing insights from platform owners' entry timing strategies. However, a few pioneering studies have investigated complementor entry, suggesting that timing strategies are also critical for complementors, and further scrutiny of the complementors' timing strategies has the potential to unpack additional insights. This study extends the entry timing theory to platform contexts by highlighting multihoming timing as a key component of complementors' competitive strategies in multi-platform markets. We empirically examine complementors' timing of multihoming, analyzing factors such as the timing of their initial platform entry and platform characteristics that can influence the speed at which complementors multihome. Specifically, we consider the impact of strong market traction, which can accelerate multihoming, and the technological distance between non-adopted and adopted platforms, which can decelerate it.

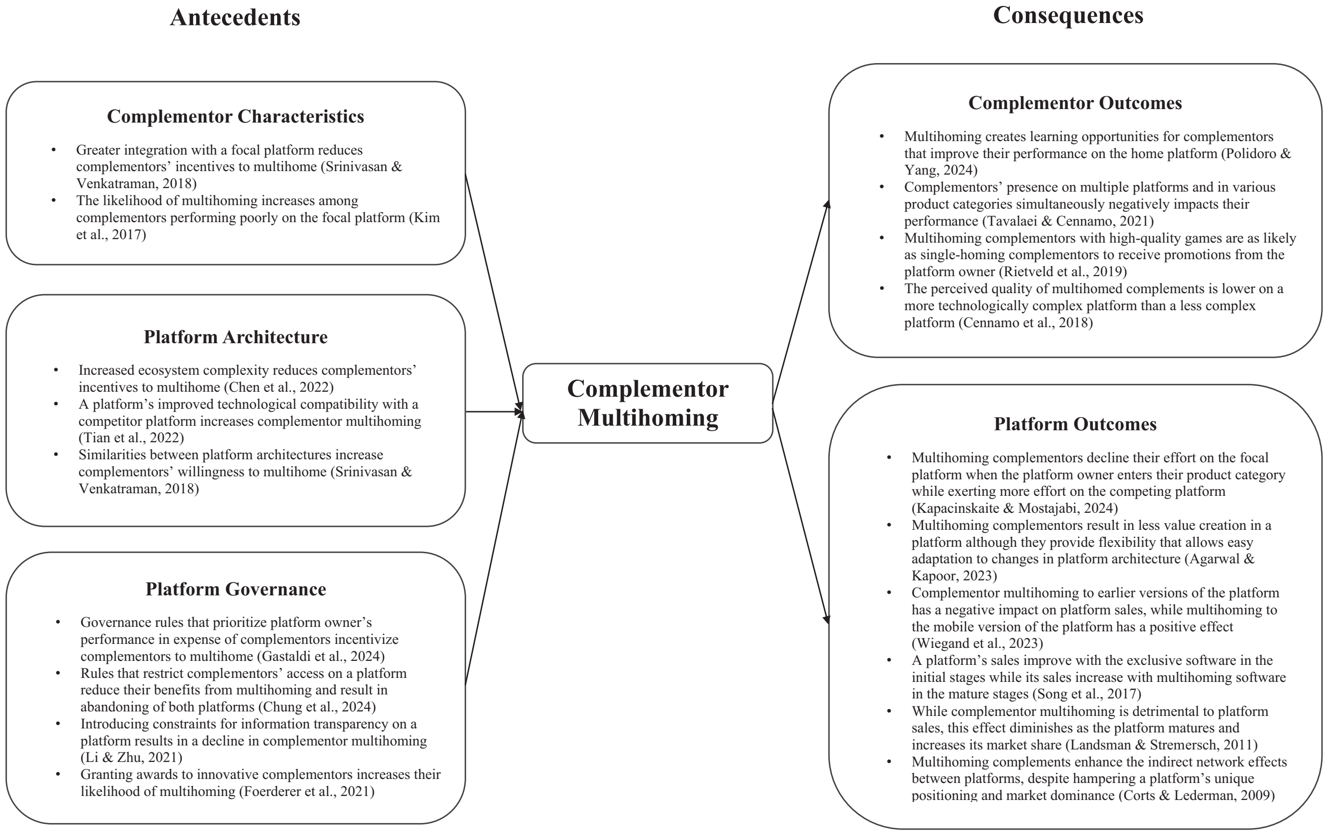
2.2 | Complementor Multihoming

Multihoming is a complementor's strategic decision to offer its products or services on more than one competing platform. Most of the early research on multihoming was theoretical (Rochet and Tirole 2003) and pointed to multihoming as a decision that occurs on one side of the platform (e.g., Armstrong and Wright 2007). Recent research extended this view and studied multihoming on both sides of a platform (Kim et al. 2017; Li and Zhu 2021).

In the last two decades, the scholarly interest and research on complementor multihoming has gradually expanded. A mapping of the empirical literature on complementor multihoming is presented in Table 1. This map indicates that many studies have taken the platform owners' perspective, investigating how a platform's performance is affected when complementors multihome (Agarwal and Kapoor 2023; Corts and Lederman 2009; Landsman and Stremersch 2011; Wiegand et al. 2023). For example, Song et al. (2017) studied the video game industry and found evidence on how a platform's hardware sales are impacted positively by high-quality exclusive software titles in the nascent stages and high-quality multihoming titles in the mature stages of an industry. Likewise, Taeuscher and Rothe (2021) suggested that a moderate presence of exclusive and multihoming complementors in the market for massive open online courses is associated with growth in the installed base. In contrast, Agarwal and Kapoor (2023) showed that multihoming complements restrict value creation in Apple's iPhone ecosystem compared to specialized complements. Wiegand et al. (2023) also found that multihoming to earlier-generation consoles can adversely impact sales on the primary console due to a substitution effect, whereas multihoming to mobile devices demonstrates complementary effects.

As depicted in Table 1, multihoming studies that apply a complementor-centric approach have focused on the decision to multihome or not and have identified several complementor- and platform-related factors that can impact this decision. For instance, Srinivasan and Venkatraman (2018) studied game developers' decision to multihome and found that when a complementor is highly embedded in a single platform, it is less likely to engage in multihoming. Examining the online daily deals market, Kim et al. (2017) argued that complementors performing poorly on a focal platform are more likely to multihome to a competing platform. Other researchers explored how platform characteristics are associated with the complementors' decision

TABLE 1 | A map of the empirical literature on complementor multihoming (Srinivasan and Venkatraman 2018; Kim et al. 2017; Li and Zhu 2021; Agarwal and Kapoor 2023; Corts and Lederman 2009; Wiegand et al. 2023; Cennamo et al. 2018; Chen et al. 2022; Chung et al. 2024; Landsman and Stremersch 2011; Polidoro and Yang 2024; Tavalaei and Cennamo 2021; Tian et al. 2022; Rietveld and Eggers 2018; Song et al. 2017; Gastaldi et al. (2024); Kapacinskaite and Mostajabi 2024; Foerderer et al. 2021).



to multihome and showed that platform architecture and governance rules play an important role. Chen et al. (2022) investigated the smartphone ecosystem and presented that ecosystem complexity leads to less complementor multihoming. Similarly, Tian et al. (2022) showed that a platform's strategy to make its architecture compatible with that of competitors influences the third-party developers' decision to multihome in the web browser market. Expanding the literature on platform governance, Li and Zhu (2021) showed that limiting information transparency reduces complementor multihoming in the online daily deals market. Gastaldi et al. (2024) also observed that as platforms grow, they implement stricter governance rules that prioritize platform control, which results in more complementor multihoming.

Another stream of research on complementor multihoming highlighted its performance implications for the complementors and reported mixed results. In the video game industry, Rietveld and Eggers (2018) found that single-homed video games achieve lower unit sales than multihomed games. In a related study, Rietveld et al. (2019) showed that multihomed, high-quality games are as likely to be promoted by the platform owner as single-homed, high-quality video games. In addition, Cennamo et al. (2018) investigated how complementor multihoming is associated with the differences in the perceived product quality of video game complementors. Their results suggest that the perceived complementor product quality decreases with multihoming. Tavalaei and Cennamo (2021) studied the mobile apps ecosystems and found that complementors' specialization, both in a single product category on a single platform and across multiple platforms and diverse product categories, is associated with an adverse impact on their market performance. Finally, Polidoro and Yang (2024) investigated the learning opportunities available for multihoming complementors on the competing platform and evidenced that seizing these opportunities enhances multihoming complementors' performance on the home platform.

All in all, the reviewed literature on complementor multihoming has advanced around the antecedents and consequences of the decision to multihome. While this literature expanded our knowledge on complementors' decision to multihome, a critical aspect of complementor multihoming—that is *timing*—*has* been mostly overlooked. We identify below the factors influential in complementors' timing of multihoming.

2.3 | Drivers of the Timing of Complementor Multihoming

A nascent market refers to a newly formed market space characterized by high ambiguity, uncertainty, lack of established structures and norms, and rapidly shifting conditions (Santos and Eisenhardt 2009). In nascent platform markets, the fast pace of technological and market change creates a setting of high uncertainty for the participants. Following the extant literature on entry timing in fast-cycle industries (Bohlmann et al. 2002; Suarez and Lanzolla 2007), complementors that enter a platform market at an early stage are likely to face a high risk of failure. In such contexts, early entrants lack the legitimacy and clarity about "the form and function of these organizations [the platforms]" (Dobrev and Gotropoulos 2010, 1153). Moreover, fast-paced technological advancements provide late entrants with the possibility of using superior technology to design products that outperform those of early entrants (Eggers and Kaplan 2009). Rapidly growing market demand also allows late entrants to acquire customers and expand their installed base on a platform without directly competing with the existing complementors (Suarez and Lanzolla 2007).

Another important characteristic of the nascent multi-platform markets stems from the competition among platforms. The existence of multiple competing platforms adds another layer of uncertainty for the complementors; that is, the difficulty of determining a priori which platform(s) will end up failing, surviving, or dominating the market. Complementors that enter early into a multi-platform market must cope with a highly uncertain environment, not only due to the fast-changing technology and uncertain market demand but also because they have very limited information on the future outcomes of platform competition when choosing a platform to join. In these circumstances, we expect early entrants to have the highest incentive to multihome fast to hedge the risks pertaining to their early entry. Early entrants will have a greater urgency to multihome to a second platform compared to late entrants because of the different levels of uncertainty they face when making their decision to multihome. The earlier the entry, the higher the uncertainty in the nascent platform ecosystem. Therefore, a complementor that enters the platform market early joins its first platform under much higher uncertainty than a complementor that enters later. Consequently, the early entrant has a higher probability of choosing the wrong platform compared to the late entrant, which enters the market at a time when the uncertainty is relatively lower.

Hedging by investing in competing alternatives has long been identified as an important strategy for firms that compete in nascent markets characterized by high uncertainty. For instance, Hatfield et al. (2001) showed how firms tend to hedge by investing in competing technologies during the early stages of an industry lifecycle. Hedging strategies have also been studied in uncertain contexts beyond technology. Kogut and Kulatilaka (1994) used the real options framework to investigate how firms hedge the risks associated with uncertainty in new geographic markets they do not know well by entering several markets. Following this line of reasoning, we expect early entrants in nascent platform markets to hedge their risks by rapidly joining a second platform.

Fast adoption of a second platform has several other benefits for the complementors. First, multihoming can enable complementors to access additional user bases, quickly drive up their revenues, and shorten the time to profitability (Bresnahan et al. 2014; Corts and Lederman 2009; Rietveld and Eggers 2018). Second, multihoming can help complementors lower their R&D, production, and marketing costs by achieving scale and scope economies (Venkataraman et al. 2018). While achieving scale is often challenging in nascent markets, fast multihoming to another platform can help complementors expand their market (Kretschmer and Claussen 2016) and spread the fixed costs of production and marketing (Corts and Lederman 2009). Third, rapidly expanding their presence on a competing platform enables complementors to reduce dependency on a single platform and mitigate the risk of holdup

(Hagiu 2005). While these benefits are likely to attract both early and late entrants, early entrants may be more incentivized by the advantages of fast multihoming, as their survival in a nascent market is more reliant on these benefits than that of late entrants. Moreover, the information asymmetry between the early and late entrants also suggests that late entrants are better positioned than early entrants to discern which platform(s) have a better chance to grow and survive, identify the potential holdup risks, and factor these considerations into their decision of which platform to join. We therefore hypothesize the following:

Hypothesis 1. *First multihoming: The earlier a complementor enters a nascent platform market, the faster it multihomes for the first time.*

The prevailing uncertainty in nascent platform markets is at its highest for the earliest entrants, but it decreases in due course as complementors learn more about the platform they join, the competing platforms, and the market demand. Consequently, we expect that the factors influencing a complementor's timing of first multihoming will vary not only based on how early they enter the platform space but also on the extent to which other platforms gain traction in the market—that is, the popularity these platforms achieve among end users.

In nascent multi-platform settings, due to the ongoing battle for market dominance among platforms and the potential for a winner-take-all outcome (Schilling 2002), complementors are likely to seek market signals that help them assess which platform(s) have a higher potential to outperform their rivals. For a complementor, the ideal scenario is selecting the platform with the highest growth potential as their initial choice. If that platform were easy to identify, offering products or services on that platform could be sufficient to achieve success. However, the decision is not simple, as market traction at an early stage of platform development is a noisy signal when predicting how platform competition will evolve. There is high volatility in platform dynamics. A platform gaining traction at an early stage might get overtaken by another platform that deploys more innovative strategies. Due to the difficulties in predicting market evolution, existing market uncertainty makes complementors more likely to multihome rather than stay as single-homing complementors.

When complementors that have already joined a platform decide on the timing of their multihoming to a second platform, they are expected to consider the traction other platforms have achieved in the market. Although it is an imperfect indicator, complementors are likely to factor this information into decision-making, as it might signal platform dominance. Identifying and quickly joining a second platform with strong market traction has the potential to offer complementors protection against the early-stage platform competition.

Complementors on nascent platforms are also incentivized to multihome to avoid a worst-case scenario: namely, realizing at a later stage—when new conditions make it hard to attempt a change—that they have joined the wrong platform, one likely to fail. This scenario can play out if a complementor delays joining a second platform that has recently experienced considerable growth and may overtake rival platforms. Delaying multihoming in this case may have lasting negative consequences for the complementor, particularly if network effects are strong in the platform market. Platform research has highlighted the role of network effects (Rochet and Tirole 2003; Gawer and Cusumano 2014; Parker et al. 2016) and the importance of building up the *N*, that is, the installed base of users, for a firm's survival and performance. Since network effects are present in most platform markets, the nonlinear properties of network effects create a dynamic situation in multi-platform spaces. The momentum enjoyed by a given platform is likely to trickle down to its complementors, allowing them to also grow their user bases, secure external visibility, and achieve customer lock-in (Farrell and Klemperer 2007), giving them an important advantage over the rival complementors that may have chosen platforms with slower traction. If rivals of a complementor benefit from a larger installed base because of having chosen another platform that gains stronger market traction, even success in its first platform may turn inconsequential for the focal complementor. Although a complementor could potentially abandon the initial platform and switch to the one with stronger traction, this is unlikely to be the optimal strategy in the nascent stage of a multi-platform market, due to the substantial uncertainty over whether network effects will lead to a winner-take-all outcome (e.g., Google in web search) or allow for the coexistence of several strong platforms (e.g., iOS and Android mobile ecosystems). Given the uncertainty around the ultimate market structure, complementors are expected to multihome fast to a second platform that shows high traction in the market to enhance their position in the multi-platform space.

The traction a platform gains in the market is expected to be more critical to the timing of complementors' first multihoming than to subsequent ones. As noted earlier, market uncertainty and complementors' motivation to avoid the worst-case scenario of being stranded on a platform that fails lead complementors to quickly join a second platform. Multihoming to a platform that shows high market traction allows complementors to hedge the market risks effectively and increase their chances of survival. Once they secure a safer position in the multi-platform market through this strategic maneuver, and as uncertainty continues to decrease over time, the influence of these imperfect market indicators gradually dissipates.

In sum, due to the heightened risk of being stuck on a low-performing platform and the uncertainty around the ultimate winner(s) in the market, complementors in nascent platform spaces are likely to scout market signals that could indicate which platforms are gaining traction in the market. Despite being a noisy signal, fast multihoming to a second platform that is on the rise increases the chances that a complementor builds a comparative advantage over other complementors that are slower to join that platform. We therefore hypothesize the following:

Hypothesis 2. *First Multihoming: The greater the traction of non-adopted platforms, the faster a complementor will multihome for the first time.*

Another critical factor that influences a complementor's timing of multihoming is the cost of adopting a new platform (Pollock 2009). Multihoming carries substantial costs for the complementors (Armstrong and Wright 2007) which must be weighed against the marginal benefits of joining yet another platform. The cost of participating in a platform, often referred to as homing costs, "represent the aggregate costs of adopting, operating, and the opportunity costs incurred by a complementor to maintain affiliation with a platform" (Tiwana et al. 2010, 681). A significant fraction of these multihoming investments tends to be co-specialized, such that they cannot be easily redeployed or re-used on other platforms (Jacobides et al. 2018), increasing the risk of holdup and the costs of multihoming to a distant platform. Besides, multihoming increases the coordination costs for the complementor, as the envisioned changes and updates in the complementor's products must consider the adopted platforms' technological state and evolution. Multihoming also requires the development of a wider pool of technological capabilities at the complementor firm (Anderson et al. 2014), resulting in a higher cost structure.

Platform owners are aware of these costs and, therefore, offer a variety of technological support to the complementors with the aim of incentivizing them to join their platforms (Parker and Van Alstyne 2016). These are called boundary resources. They have become a standard in platform markets, usually taking the form of technical conferences or seminars, the release of software development kits (SDKs), and application programming interfaces (APIs), and technical support to the developer community (Von Hippel and Katz 2002). Nevertheless, research suggests that homing costs usually arise from the adaptation, coordination, and communication requirements (Kogut and Zander 1992) associated with joining a new platform (Cennamo et al. 2018; Kapoor and Lee 2013). These adaptation and integration costs generally stem from the differences in the technological architecture of the corresponding platforms (Srinivasan and Venkatraman 2018). Studies have shown that the ease with which a complementor multihomes depends on how technologically similar the target platform's architecture is to that of the complementor's current platform(s) (Chen et al. 2022). Multihoming to a platform with a substantially different technological architecture from the platforms a complementor has already joined can strain the complementor's limited development resources and increase coordination costs. Platforms with dissimilar technological architectures lack common APIs and system protocols, forcing multihoming complementors to incur the cost of customizing their products to meet the unique technological requirements of each platform. It can be a time-consuming process to learn the specifications of a new platform architecture and technological idiosyncrasies and update the current design accordingly (Nobeoka and Cusumano 1997). Significant portions of the software code may also need to be overhauled, rewritten, and retested (Cusumano and Yoffie 1998). Thus, multihoming to a platform that is technologically distant from the platform(s) a complementor has already joined is likely to reduce the speed with which it will multihome.

We expect that, in a multi-platform setting where complementors have the option to join multiple platforms, cost considerations will play a significant role in determining how fast complementors will multihome. Unlike market uncertainty, which diminishes over time as complementors learn more about the market dynamics in the nascent platform ecosystem and develop maneuvering strategies to enhance their chances of survival and growth, the technological differences and the associated costs of joining a new platform remain relevant across sequential multihoming. Moreover, each additional platform adoption stretches complementors' resources further. Thus, the cost of joining a new platform is likely to influence complementors' timing of both the first and subsequent multihoming. Consequently, we expect a complementor to multihome faster to target platforms (either as a second and third platform) that are technologically closer to the platform(s) it has already joined, as this will represent a lower-cost and less-complex option to expand their presence in the market and reach a larger user base. We therefore hypothesize the following:

Hypothesis 3a. *First Multihoming: The shorter the technological distance between a complementor's adopted and non-adopted platforms, the faster it will multihome for the first time.*

Hypothesis 3b. *Second Multihoming: The shorter the technological distance between a complementor's adopted and non-adopted platforms, the faster it will multihome for the second time.*

3 | The Smart Home Market

The context of our study is the *smart home market*, also referred to as the connected home or home automation market (Alam et al. 2012). A smart home is defined as a residence "equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security, and entertainment through the management of technology within the home and connections to the world beyond" (Aldrich 2003, 17). The emergence of the smart home market has been enabled by developments in the Internet of Things (IoT) and machine-learning technologies in the last two decades. The Economist (2016) describes the functioning of a smart home as "coffee pots that turn on when the alarm clock rings, lighting and blinds that adjust to the time of the day, and fridges that send an alert when the milk runs out."[4] Although the smart home market was at a ferment stage during our study period, by 2017, it had already reached a worldwide household penetration rate of 2.4% and was expected to grow rapidly.[5]

The concept of a smart home is not new. It was first introduced in 1984 by the US National Association of Home Builders. However, early technologies were largely ineffective due to their closed architecture, which limited the customization capabilities, resulting in fragmented and incompatible systems that did not gain much momentum (Van Berlo et al. 1999). Starting in the 2010s, several technology companies, such as Google-Nest, Samsung-SmartThings, Amazon-Alexa, and Wink, have entered the smart home market by leveraging advances in broadband communication and microprocessors and establishing platforms that connect complementors that produce smart devices with end users. These changes have transformed the traditional home products categories from several independent markets of stand-alone products into a platform-mediated market, where the producers in different product categories now serve as complementors to various platforms.

This context is highly appropriate for testing our hypotheses. First, the smart home market has seen the emergence of several competing platforms, providing complementors with the option of joining more than one platform. The existence of multiple platforms allows for a richer investigation of the complementors' multihoming decisions, such as examining the factors that impact the timing of their first and subsequent multihoming. Second, unlike existing research on multihoming that has focused on mature industries (e.g., video games, mobile phone applications), the smart home market has been at a nascent stage, which allows us to observe complementor strategies in a highly uncertain environment (Anderson and Tushman 1990). Finally, given the recent emergence of this market, it is possible to track the complementors' platform adoption and multihoming strategies from the beginning.

Our study focuses on complementors serving four leading smart home platforms that were available at the start of our study period: Google Nest, Samsung SmartThings, Amazon Alexa, and Wink. In 2011, Nest was the first to enter the market with a programmable, self-learning, and sensor-driven thermostat. In 2013, Nest launched a smoke and carbon monoxide detector, followed by indoor and outdoor cameras in 2014. Its rapid growth drew much industry attention, and Google acquired the startup for US$3.2 billion in January 2014. Soon after, Google launched its Nest platform and allowed complementors to offer their products on the platform by releasing APIs via a program called *Works with Nest*. SmartThings was founded in 2012. Unlike Nest, SmartThings had a platform strategy from the outset, releasing APIs in 2013 to attract complementors. SmartThings quickly became one of the leading platforms in the IoT space. In 2014, Samsung acquired SmartThings. The same year, Amazon entered the smart home market and launched an API to the complementors for its Alexa voice-control service (e.g., “Alexa, ask Roomba to start vacuuming”). Wink was launched as a startup in 2014. Similar to SmartThings, Wink had a platform strategy from the beginning, and its platform offered broad connectivity through several protocols. The company was acquired by Flex (previously, Flextronics) in 2015. These platform owners have established several innovation platforms in the smart home market that create value for their participants by serving as a technological infrastructure upon which complementors can offer new complementary products and innovations (Cusumano et al. 2019; Gawer 2021; Trabucchi and Buganza 2022).

The smart home space is commonly divided into several product categories, such as thermostats, smoke detectors, lighting, appliances (e.g., refrigerators, washing machines, ovens), and security systems (e.g., indoor/outdoor cameras, door locks, and doorbells). Complementors competing in these categories range from incumbents producing stand-alone products dating back to the pre-platform stage (e.g., Philips, Whirlpool, and Honeywell) to diversifying entrants from the electronics industry (e.g., LG, Motorola, and Logitech) to startups with no prior experience in a particular home product category (e.g., ecobee, LIFX, and Canary).

4 | Data and Methods

We tested our hypotheses using a unique dataset of smart device producers competing in the global smart home market. We focused on five large product categories available across all platforms: lights, appliances, smoke detectors, security systems, and thermostats. Our data on global smart device manufacturers were obtained from a market research company (IoT Analytics) that tracks the performance of products in the smart home market. In addition, we manually collected data for each firm in our dataset. For the purposes of our study, a device is considered *smart* if it connects to the Internet, allows for remote control, and has an app-controlled interface. Some smart device producers offer their products on one or more platforms, while others still offer stand-alone products (app-controlled only).

Our unit of analysis is *firm-product category-month*. Our panel dataset consists of 4983 observations (151 firm-product category observations over 33 months) between September 2014 and May 2017 across 136 unique firms, 123 of which are active in a single product category, 11 firms offer products in two categories, and two firms extend their product scope to three categories.

4.1 | Dependent Variable

4.1.1 | Time to Multihome

To exploit the presence of multiple platforms in the smart home market and provide a richer investigation of complementor multihoming, we separately examined the timing of complementors' decision to join two and three platforms (i.e., the timing of their first and subsequent multihoming).[6] The dichotomous variable *time to multihome (second platform)* took the value of 1 if the firm produced for two platforms at month *t* and 0 otherwise. Likewise, the dichotomous variable *time to multihome (third platform)* took the value of 1 if the firm produced for three platforms at month *t* and 0 otherwise.[7]

We gathered data on complementor multihoming events by manually collecting information from each platform's *Works with [Program]* website.[8] Based on news releases, we also identified the date on which each complementor announced its compatibility with a specific platform. The compatibility announcement date was considered as the time of platform adoption.

4.1.2 | Time to First Platform

To provide a broader investigation of the complementors' timing strategies preceding multihoming, we conducted additional analyses that examined the factors that influence firms' timing of joining their first platform. The dependent variable *Time to First Platform* captures the first platform adoption. This dichotomous variable takes the value of 1 if the firm produced for one platform at month *t* and 0 otherwise.

4.2 | Independent Variables

4.2.1 | Time to Market Entry

This variable captured the time elapsed between the emergence of the smart home market, denoted by the launch of the first smart product in the market[9] and the entry of a complementor to the smart home market by adopting its first platform. We counted the number of months between the first product launch date and the date on which a focal firm became a complementor by joining one of the competing platforms.

4.2.2 | Platform Traction

This variable captured the month-to-month growth rates of consumer interest in product categories of non-adopted platforms. To operationalize this variable, we used data derived from Google Trends, a tool that provides normalized indices of search volume over time for specific queries.[10] Our data collection process involved querying Google Trends for terms formatted as "product platform" (e.g., "lights Nest") on a monthly level to reflect all possible combinations of product categories and platforms present in our dataset. By doing so, we ensured comprehensive coverage of the search activity related to these platforms and their associated product categories. The resulting normalized search volume index served as a reliable proxy for gauging the relative popularity and consumer awareness of specific product categories on these platforms. Furthermore, its time-series nature allowed us to track shifts in consumer interest over time. This approach is well-suited to our research goal of capturing the dynamic trends in consumer interest across platform categories on a month-to-month basis.

4.2.3 | Technological Distance

This variable captured the technological distance between a complementor's adopted platform(s) and the non-adopted platforms in the market. Our operationalization of this variable is based on data collected on GitHub, an online collaboration platform widely used by software developers across multiple platforms to store, share, review, or integrate code to advance projects with both business and open-source goals. Developers typically use GitHub forums to discuss specific topics, search for software solutions, and provide feedback, comments, and codes. We identified the sets of software developers (i.e., GitHub usernames) who mentioned each platform in an online post by performing platform-specific search queries on GitHub (e.g., Alexa and API) for each month in our study period. Using these sets, we calculated the monthly technological distances between a complementor's adopted versus non-adopted platforms in the market using Jaccard distance, a commonly used technique to measure the dissimilarity between sample sets (Le Mens et al. 2015).[11] The Jaccard distance ranges from 0 (perfect similarity) to 1 (complete dissimilarity).

4.3 | Control Variables

4.3.1 | Complementor Resources

This variable accounted for the potential impact of a complementor's resources on its timing of multihoming. We measured complementor resources using the cumulative number of smart home technology-related patents that the complementor owned at month *t*. The stock of patents has been used in previous studies to account for a firm's resources (Miller 2004). Data on complementors' patent portfolios were retrieved from the United States Patent and Trademark Office (USPTO) patent database for a period of 20 years preceding our study period, as well as for the 33 months covered by our research timeframe. Patents related to smart home technology were identified through a keyword search for each product category and smart technology combinations (e.g., smart/connected/remote and doorbell). We lagged this variable by 1 month to minimize the potential for reverse causality.[12]

4.3.2 | Complementor Type

This construct was measured using dummy variables for each complementor type, as detailed below. It allowed for controlling the variations in firms' resources not captured by the *Complementor Resources* variable. The de novo variable took the value of 1 if the complementor is a startup (we classified a firm as a startup if it was founded in 2008 or later—that is, not earlier than 10 years before the sample end date—such as LIFX, August, and Netatmo) and 0 otherwise. The *Dealio* variable took the value of 1 if the complementor was an established firm in another industry and diversified into the smart home market (e.g., LG, Motorola, and Logitech) and 0 otherwise. Finally, the *Incumbent* variable took the value of 1 if the complementor was an established company in home devices (e.g., Philips, Whirlpool, and Kwikset) and 0 otherwise.

4.3.3 | Complementor Size

This construct was measured by a categorical variable, with a dummy specification for small firms based on their number of employees. Data on the number of employees were gathered from the Crunchbase website. This variable is aimed at controlling the variations not captured by *Complementor Type* or *Complementor Resources*. *A small firm* took the value of 1 if the number of employees was equal to or below the 50th percentile and 0 otherwise.

4.3.4 | Complementor Product Quality

A smart device's perceived quality may also affect a complementor's ability and timing of multihoming (McIntyre 2011). We accounted for smart device quality using the average app store review scores for a complementor's product, computed monthly for both Apple App Store and Google Play Store. We lagged this variable by 1 month.

4.3.5 | Competition

To account for the potential competition among complementors in non-adopted platforms in each product category, we included the number of within-category complementors in each product category for each platform per month.

4.3.6 | First Adopted Platform

To account for the potential impact of the first platform choice on a complementor's timing of multihoming to a second or third platform, we included a dummy variable for each platform that denoted whether the first adopted platform was Google-Nest, Amazon-Alexa, Samsung-SmartThings, or Wink.

Other controls included the *Smart Device Category*, measured by dummy variables for each product category in our dataset, namely lighting, appliances, smoke detectors, security systems, and thermostats. We also controlled the effect of time by including year dummies.

4.4 | Model Specifications

Our study aims at understanding the determinants of how quickly complementors multihome. Because of the *time-to-event* nature of our dependent variable, we tested our hypotheses using a semi-parametric Cox survival analysis. Following this commonly used methodology (e.g., Leone and Reichstein 2012), we tested the time to multihoming, where the multihoming event was taken as the hazard.

Our Hypotheses 1, 2, 3a, and 3b examine, respectively, the relationship between a complementor's first entry into the platform-mediated market by joining one platform and its hazard to multihome for the first time (Hypothesis 1), the market traction of the non-adopted platforms' product categories and the complementor's hazard to multihome for the first time (Hypothesis 2), and the technological distance between the adopted and non-adopted platforms, and the complementor's hazard to the first and subsequent multihome (Hypotheses 3a and 3b). To test our hypotheses, we considered the timing of a complementor's multihoming decisions (i.e., time elapsed from the beginning of the platform-mediated market to a complementor's first and subsequent multihoming events). Thus, we conducted our survival analyses as a two-step, single event per subject study, where time was measured in months. Let x_i be the row vector of covariates for the time interval $(t_{0i}, t_i]$ for the ith observation in the dataset $i = 1, \ldots, N$. We obtained parameter estimates, $\hat{\beta}$, by maximizing the partial log-likelihood function (Cox 1972):

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

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

In addition to testing our hypotheses, we conducted Cox survival analysis to provide additional empirical evidence on the timing of complementors' initial platform adoption, using *Time to First Platform* as the dependent variable.

The semi-parametric Cox survival model does not make assumptions about the baseline hazard, and it is flexible (Nadolska and Barkema 2014). However, this model assumes proportionality in the hazard model. Our analyses involve covariates whose effects on the hazard can change over time. Therefore, we relaxed the proportional hazards assumption by using time-dependent covariates that include interactions between the covariates and time in our extended Cox model using the tvc function in Stata (Piao and Zajac 2016).

To test the robustness of our analyses, we employed a parametric Weibull regression model, as done in prior studies (e.g., Kapoor and Lee 2013). The hazard function of the Weibull regression model in proportional hazards form is:

$$h(t) = p\lambda t^{p-1}$$

where the concomitant covariates have a multiplicative effect on the hazard function, for $h_0(t) = pt^{p-1}$, and λ is parametrized as $\lambda_j = \exp.(x_j\beta)$. Finally, as part of our additional analyses on complementor multihoming, we estimated the probability of multihoming using a linear probability model (LPM). Due to the time-invariant characteristic of some of our variables, we ran the random effects LPM estimations with robust standard errors clustered at the firm-category level.

5 | Results

Our preliminary analyses showed that 50.3% of smart device manufacturers preferred to remain as a provider of stand-alone smart products, while 49.7% decided to adopt at least one platform. The percentage of complementors that decided to multihome to at least a second platform was 27.2% (i.e., 54.7% of all complementors). Complementors that multihomed to a third platform were 12.6%. Only 3.3% of the complementors were multihomed to all four platforms. Amazon Alexa was the most popular platform among complementors; it was selected by 34 firms as their first platform. The SmartThings platform was the second most popular platform adopted by 23 firms, while Nest was able to attract 16 firms to the smart home market. Lastly, Wink was the first entry point to the smart home market for 14 firms.

Table 2 presents the descriptive statistics of our variables. On average, it took 45.8 months (from the inception of the smart home market) for complementors to join their first platform, 9.4 months to their first multihoming (joining a second platform), and 4.1 months to their subsequent multihoming (joining a third platform). While the average traction gained by the non-adopted platform categories is 0.13, the adopted and non-adopted platforms present an average of 0.856 technological distance on the Jaccard scale of 0 to 1. On average, complementors have 183.9 patents with a minimum of 0 and a maximum of 7653. The average complementor product quality is 2.75 with a 0.1–5 range. The largest categories in our sample are the thermostats and security systems, with 37.7% and 31.8% of the total sample, respectively, followed by the lights category with 17.2% of the firms, and the appliances and smoke detectors categories with 5.3% and 7.9%. While 34.4% of our sample is composed of startups, 43.7% are incumbents, and 21.9% are diversifying firms. In terms of within-category

TABLE 2 | Descriptive statistics.

Variable	Observations	Mean	SD	Min	Max
Time to first platform (dummy)	4983	0.322	0.467	0	1
Time to multihome (second platform) (dummy)	4983	0.151	0.358	0	1
Time to multihome (third platform) (dummy)	4983	0.086	0.281	0	1
Time to market entry (in months)	2475	45.800	11.498	0	65
Platform traction	4983	0.133	6.547	−24.5	32
Technological distance	4983	0.856	0.262	0	1
Complementor resources	4832	183.991	752.353	0	7653
Complementor product quality (on a range of 1–5)	3865	2.746	0.922	0.1	5
Lights	4983	0.172	0.378	0	1
Appliances	4983	0.053	0.224	0	1
Security systems	4983	0.318	0.466	0	1
Thermostats	4983	0.377	0.485	0	1
Smoke detectors	4983	0.079	0.270	0	1
Denovo	4983	0.344	0.475	0	1
Incumbent	4983	0.437	0.496	0	1
Dealio	4983	0.219	0.413	0	1
Competition (Nest)	4983	3.037	3.224	0	11
Competition (Alexa)	4983	4.927	6.913	0	23
Competition (SmartThings)	4983	4.705	4.451	0	17
Competition (Wink)	4983	4.103	3.475	0	14
First adopted platform Nest (dummy)	4983	0.106	0.308	0	1
First adopted platform Alexa (dummy)	4983	0.225	0.418	0	1
First adopted platform SmartThings (dummy)	4983	0.152	0.359	0	1
First adopted platform Wink (dummy)	4983	0.093	0.290	0	1
Small firm (dummy)	4983	0.517	0.500	0	1

competition, the highest competition is in the Alexa platform, with an average of 4.9 competitors, followed by SmartThings (4.7), Wink (4.1), and Nest (3.0). While 51.7% of the firms are categorized as small-size, 48.3% of firms are identified as large firms. The correlation matrix of our variables can be found in Table 3. As shown in the table, none of the explanatory or control variables show high correlation with the dependent variables, that is, the correlations are below the 0.7 threshold, except *Technological Distance*, which has −0.796 correlation with *Time to First Platform* and −0.756 correlation with the *Time to Multihome (second platform)*.

5.1 | Empirical Results

Table 4 presents the results of our empirical analyses. Models 1 and 2 are related to the smart device producers' timing of adopting their first platform. While Model 1 is the baseline model with control variables, Model 2 includes two of our explanatory variables, namely *platform traction* and *technological distance*. Model 1 shows that *complementor product quality* has a positive relationship ($p < 0.01$) with *time to first platform*, yet this effect disappears with the addition of the explanatory variables in Model 2. The estimation in Model 2 on firms' time to first platform shows that *technological distance* ($p < 0.01$) has a negative association with the speed at which firms enter the smart home market by joining their first platform. Models 3 and 4 test the complementors' time to multihome for the first time (to a second platform). While Model 3 is a baseline model that only involves control variables, Model 4 tests our hypotheses. These models also control for the potential impact of the first platform choice on the time to first multihome. Models 3 and 4 indicate that complementors in the *appliances* category are significantly slower ($p < 0.05$ and $p < 0.01$, respectively) to multihome to a second platform, whereas *complementor resources* are positively related ($p < 0.05$) to the complementors' time to multihome.[13] Complementors that joined the Wink platform as their first choice are also fast to join a second platform, likely due to the greater market traction enjoyed by other platforms. Model 4 shows the results for Hypotheses 1, 2, and 3a. The results

TABLE 3 | Correlation matrix.

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Time to first platform (dummy)	1.000												
2	Time to multihome (second platform) (dummy)	0.600*	1.000											
3	Time to multihome (third platform) (dummy)	0.446*	0.727*	1.000										
4	Time to market entry (in months)	−0.516*	−0.399*	−0.353*	1.000									
5	Platform traction	−0.010	−0.002	−0.011	0.005	1.000								
6	Technological distance	−0.796*	−0.756*	−0.676*	0.397*	0.016	1.000							
7	Complementor resources	0.131*	0.123*	0.046*	−0.121*	−0.007	−0.112*	1.000						
8	Complementor product quality (on a range of 1–5)	0.262*	0.148*	0.103*	−0.161*	−0.003	−0.209*	−0.121*	1.000					
9	Lights	0.073*	0.060*	0.110*	−0.185*	−0.004	−0.093*	−0.029*	−0.065*	1.000				
10	Appliances	0.063*	−0.035*	−0.057*	−0.042*	−0.010	0.003	0.673*	−0.153*	−0.108*	1.000			
11	Security systems	0.044*	0.182*	0.125*	0.124*	0.002	−0.108*	−0.088*	0.136*	−0.311*	−0.162*	1.000		
12	Thermostats	−0.151*	−0.190*	−0.130*	0.136*	0.009	0.153*	−0.168*	−0.029	−0.355*	−0.184*	−0.532*	1.000	
13	Smoke detectors	0.041*	−0.027	−0.090*	−0.162*	−0.005	0.039*	−0.064*	0.028	−0.134*	−0.070*	−0.201*	−0.229*	1.000
14	Denovo	−0.033*	−0.042*	0.020	−0.088*	−0.001	−0.024	−0.174*	0.146*	0.113*	−0.171*	0.164*	−0.191*	0.045*
15	Incumbent	0.096*	0.164*	0.087*	−0.039	0.001	−0.077*	0.237*	−0.064*	−0.225*	0.268*	−0.057*	0.168*	−0.111*
16	Dealio	−0.078*	−0.149*	−0.128*	0.154*	0.000	0.120*	−0.085*	−0.087*	0.141*	−0.125*	−0.120*	0.018	0.082*
17	Competition (Nest)	0.005	0.081*	0.054*	0.172*	−0.012	0.012	−0.071*	0.038*	0.056*	−0.148*	0.472*	−0.339*	−0.160*
18	Competition (Alexa)	−0.214*	−0.170*	−0.170*	0.126*	−0.004	0.248*	−0.115*	0.056*	0.009	−0.147*	0.123*	0.044*	−0.179*
19	Competition (SmartThings)	−0.196*	−0.187*	−0.281*	0.351*	−0.002	0.146*	−0.154*	0.105*	−0.021	−0.206*	0.456*	−0.222*	−0.188*
20	Competition (Wink)	−0.130*	−0.159*	−0.229*	0.318*	−0.009	0.054*	−0.167*	0.032*	−0.117*	−0.231*	0.289*	0.079*	−0.286*
21	First adopted platform Nest (dummy)	0.258*	0.128*	0.059*	−0.144*	−0.003	−0.326*	0.033*	0.143*	0.014	0.111*	0.088*	−0.179*	0.058*
22	First adopted platform Alexa (dummy)	0.185*	0.142*	0.109*	0.454*	0.000	−0.225*	−0.078*	0.009	0.048*	−0.128*	0.075*	0.005	−0.100*

(Continues)

TABLE 3 | (Continued)

		1	2	3	4	5	6	7	8	9	10	11	12	13
23	First adopted platform SmartThings (dummy)	0.402*	0.393*	0.314*	−0.303*	−0.001	−0.274*	0.124*	0.081*	0.002	−0.018	0.146*	−0.178*	0.080*
24	First adopted platform Wink (dummy)	0.267*	0.292*	0.289*	−0.075*	0.000	−0.168*	0.090*	0.119*	−0.085*	0.026	0.125*	−0.013	−0.094*
25	Small firm (dummy)	−0.117*	−0.096*	−0.041*	0.139*	0.002	0.088*	−0.246*	0.073*	0.090*	−0.245*	0.006	0.015	0.039*

		14	15	16	17	18	19	20	21	22	23	24	25
14	Denovo	1.000											
15	Incumbent	−0.639*	1.000										
16	Dealio	−0.383*	−0.466*	1.000									
17	Competition (Nest)	0.120*	−0.138*	0.027	1.000								
18	Competition (Alexa)	0.052*	−0.082*	0.038*	0.428*	1.000							
19	Competition (SmartThings)	0.183*	−0.198*	0.027	0.566*	0.561	1.000						
20	Competition (Wink)	0.071*	−0.083*	0.017	0.551*	0.586	0.655*	1.000					
21	First adopted platform Nest (dummy)	0.158*	−0.043*	−0.130*	−0.263*	−0.042	0.033*	−0.052*	1.000				
22	First adopted platform Alexa (dummy)	−0.057*	0.004	0.060*	0.108*	−0.260	0.001	0.035*	−0.134*	1.000			
23	First adopted platform SmartThings (dummy)	−0.036*	0.147*	−0.135*	0.072*	−0.157	−0.351*	−0.116*	−0.146*	0.080*	1.000		
24	First adopted platform Wink (dummy)	−0.040*	0.087*	−0.059*	0.083*	−0.116	−0.092*	−0.301*	−0.110*	0.046*	0.055*	1.000	
25	Small firm (dummy)	0.366*	−0.270*	−0.098*	0.037*	0.059	0.072*	0.130*	−0.011	−0.050*	0.041*	−0.148*	1.000

Note: *$p < 0.05$.

TABLE 4 | Results of the survival analyses.

	Cox hazard model					
	First platform		Second platform		Third platform	
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Time to first platform**	**Time to first platform**	**Time to multihome**	**Time to multihome**	**Time to multihome**	**Time to multihome**
Time to market entry (Hypothesis 1)				−0.002** (0.001)		0.001 (0.001)
Platform traction (Hypothesis 2)		−0.003 (0.002)		0.010*** (0.003)		−0.003 (0.007)
Technological distance (Hypotheses 3a and 3b)		−0.829*** (0.076)		−0.565*** (0.103)		−1.002** (0.494)
Lights	2.684** (1.260)	−0.834 (0.962)	2.649 (1.982)	0.188 (0.796)	34.590*** (3.077)	24.100*** (5.776)
Appliances	1.694 (1.245)	0.734 (0.922)	−6.162** (2.713)	−22.910*** (8.766)	21.600 (0.000)	8.875 (0.000)
Security systems	2.331 (1.681)	−1.195 (0.853)	4.175*** (1.361)	0.132 (0.604)	35.440*** (3.600)	24.100*** (5.706)
Thermostats	0.999 (1.745)	−0.100 (0.713)	1.569 (0.980)	−0.649 (0.930)	29.800*** (2.091)	23.900*** (6.437)
De novo	0.111 (0.371)	−0.304 (0.518)	−0.195 (0.611)	−0.724 (0.641)	2.756*** (0.789)	4.359*** (1.478)
Incumbent	0.208 (0.299)	−0.012 (0.322)	0.451 (0.589)	−0.029 (0.638)	1.304* (0.788)	1.429 (1.396)
Small firm	−0.286 (0.271)	−0.286 (0.417)	−0.385 (0.406)	0.057 (0.635)	−0.418 (0.637)	−0.437 (0.594)
Complementor resources	−1.80e−05 (1.41e−05)	−4.52e−05*** (1.48e−05)	6.31e−05** (2.54e−05)	0.000** (9.10e−05)	2.59e−06 (1.25e−05)	3.64e−05 (4.20e−05)
Complementor product quality	0.032*** (0.008)	0.019 (0.013)	0.022** (0.010)	0.006 (0.015)	0.025 (0.017)	0.016 (0.027)
Competition (Nest)	−0.006 (0.008)	0.012* (0.006)	−0.005 (0.011)	0.008 (0.008)	−0.055*** (0.017)	−0.027*** (0.008)

(Continues)

TABLE 4 | (Continued)

	Cox hazard model					
	First platform		Second platform		Third platform	
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Time to first platform	Time to first platform	Time to multihome	Time to multihome	Time to multihome	Time to multihome
Competition (Alexa)	−0.013***	0.010***	−0.017*	0.002	−0.019*	0.009
	(0.003)	(0.002)	(0.010)	(0.006)	(0.010)	(0.008)
Competition (SmartThings)	−0.006	−0.006	−0.003	−0.005*	−0.047***	−0.047***
	(0.007)	(0.004)	(0.005)	(0.003)	(0.009)	(0.007)
Competition (Wink)	0.015	−0.015**	−0.007	−0.004	−0.043***	−0.038***
	(0.016)	(0.007)	(0.007)	(0.012)	(0.015)	(0.008)
First adopted platform (Nest)			2.021***	−0.697	−2.058*	−6.119***
			(0.758)	(1.146)	(1.084)	(2.362)
First adopted platform (Alexa)			−0.611	−0.216	1.679**	1.233*
			(0.669)	(0.678)	(0.677)	(0.635)
First adopted platform (SmartThings)			2.038**	0.625	0.588	−0.411
			(0.835)	(1.090)	(0.805)	(0.628)
First adopted platform (Wink)			1.653***	1.789**	−1.951	−0.468
			(0.575)	(0.911)	(1.660)	(1.579)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2459	2459	3167	1342	3456	1631

Note: Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

indicate that the *time to market entry* variable has a negative and significant ($p < 0.05$) effect on the hazard to multihome to a second platform, in line with Hypothesis 1. In other words, the faster a complementor enters the smart home market, the more likely it is to switch from single-homing to multihoming in a given period. For each month that a complementor delays entry into the platform market, its hazard of multihoming is decreased by 0.21%. The *platform traction* variable has a positive and significant ($p < 0.01$) relationship with the hazard to first multihome, lending support for Hypothesis 2. Market traction gained by the non-adopted platforms increases a complementor's hazard to multihome for the first time by 1% each month. Finally, we observed that the *technological distance* variable presents a negative and significant ($p < 0.01$) relationship with the hazard to first multihome (in line with Hypothesis 3a). Technological distance between a complementor's adopted and non-adopted platforms decreases the hazard to multihome to a second platform by 43.1% each month. In sum, these results indicate that when a complementor switches from single-homing to multihoming, early entry into the platform-mediated market and platform traction increase the hazard to multihome, while technological distance decreases the hazard to multihome.

In Table 4, Models 5 and 6 test the complementors' time to subsequent multihome (joining a third platform). Model 5 is a baseline model that involves control variables. It shows that the within-category competition in platforms has a negative and significant relationship with the complementors' speed to subsequent multihome. *Denovo* firms have a positive and significant ($p < 0.01$) effect, indicating that they are faster than other firm types to join a third platform. Denovo entrants typically lack the reputation that incumbents enjoy in the market. Therefore, joining a third platform fast can be part of a strategy to solidify their position in the market. Model 6 tests the Hypothesis 3b. The results show that the *technological distance* variable has a negative and significant ($p < 0.05$) relationship with the hazard to subsequent multihome, lending support for Hypothesis 3b. Technological distance between a complementor's adopted and non-adopted platforms decreases the hazard to join a third platform by 63.3% each month. We retested our estimations using an alternative specification of the technological distance variable based on platform updates. This variable captured the difference in the number of platform updates between adopted and non-adopted platforms. The results (not shown) corroborate the finding that the technological distance is negatively associated with the complementors' timing of the first and subsequent multihoming.[14] Overall, the results on technological distance indicate that technological distance impacts a complementor's time to all platform adoptions. The Z-test conducted on the coefficients of technological distance in the first and subsequent multihoming estimations showed no significance (Z-value = 0.87), suggesting that the influence of technological distance on complementors' timing of sequential multihomings is at the same level.

In summary, the results in Models 4 and 6 show that when a complementor multihome for the first time, its early entry into the platform-mediated market and the traction gained by the non-adopted platforms are associated with an increase in the complementor's hazard to multihome, while technological distance is associated with a decrease in its hazard to multihome. As a complementor multihomes again (to a third platform), the technological distance negatively influences the complementor's hazard to multihome. We elaborate on the managerial implications of these findings in the discussion section.

To check the robustness of our survival analyses, we retested our theoretical predictions with Weibull models. The results of these estimations can be found in Table 5. Model 1 tests the complementor's time to first platform, while Models 2 and 3 examine the complementors' time to multihome to a second and third platform, respectively.

In model 1, the results show that *technological distance* has a negative and significant ($p < 0.01$) relationship with the firms' time to enter the smart home market by joining their first platform. In Model 2, we retested Hypotheses 1, 2, and 3a and found support for Hypotheses 1, and 3a. Specifically, the model shows that *time to market entry* has a negative and significant ($p < 0.05$) relationship with the timing of the complementors' first multihome. While *platform traction* presents the expected directionality with a positive coefficient, the *p*-value indicates an insignificant association with the timing of first multihome and rejects Hypothesis 2. *Technological distance* shows a negative and significant ($p < 0.01$) relationship with the timing of complementors' first multihome. Model 3 retests Hypothesis 3b by focusing on the complementors' time to subsequent multihome. The analyses indicate that Hypothesis 3b is supported; *technological distance* has a negative and significant ($p < 0.01$) relationship with the timing of complementors' subsequent multihome. All in all, these estimations lend support to the idea that complementors that enter the smart home market early tend to multihome faster to a second platform. Moreover, technological distance between platforms decelerates not only the complementors' time to enter the smart home market but also their speed to multihome to a second and third platform.

As part of our complementary analyses, we also estimated the firms' probability to enter the smart home market and their probability to multihome to a second and third platform. The results of these estimations are available in Table 6. Models 1, 2, and 3 estimate the probabilities with standard errors in a random effects LPM regression, whereas Models 4, 5, and 6 re-estimate the probabilities by clustering the error terms at the firm-category level in the random effects LPM regression. In Models 1 and 4, it is observed that *technological distance* has a negative and significant ($p < 0.01$) association with the firms' probability of entering the smart home market by adopting their first platform. Likewise, *complementor product quality* is positively associated ($p < 0.01$ and $p < 0.05$) with the firms' probability of adopting their first platform. Models 2 and 5 focus on the complementors' probability of first multihoming (joining a second platform). In both estimations, *time to market entry* shows a negative and significant ($p < 0.01$ and $p < 0.05$) relationship with the probability of multihome for the first time. *Platform traction* presents a positive and significant ($p < 0.01$) association with the probability of first multihome, while *technological distance* presents a negative and significant ($p < 0.01$) relationship with the probability of first multihome. Among the control variables, *complementor resources* appear to have a positive and significant ($p < 0.01$) effect on the complementors' probability of first multihoming. Finally, Models 3 and 6 test the complementors' probability of multihoming

TABLE 5 | Robustness checks.

	Weibull survival model		
	First platform	Second platform	Third platform
	(1)	(2)	(3)
Variables	**Time to first platform**	**Time to multihome**	**Time to multihome**
Time to market entry (Hypothesis 1)		−0.045** (0.021)	−0.017 (0.038)
Platform traction (Hypothesis 2)	−0.005 (0.021)	0.011 (0.021)	−0.085 (0.064)
Technological distance (Hypotheses 3a and 3b)	−10.520*** (0.969)	−5.906*** (1.064)	−6.360*** (1.999)
Lights	−0.834 (1.024)	0.449 (1.015)	19.990*** (2.048)
Appliances	−0.527 (1.676)	−7.618** (3.501)	14.250*** (5.360)
Security systems	−1.307 (1.002)	1.483** (0.629)	21.680*** (1.637)
Thermostats	0.320 (0.905)	−1.413 (0.901)	19.270*** (1.592)
De novo	−0.216 (0.449)	−0.928 (0.844)	4.725*** (1.389)
Incumbent	0.476* (0.283)	0.467 (0.639)	2.124* (1.208)
Small firm	−0.553* (0.297)	−0.363 (0.480)	−0.049 (0.675)
Complementor resources	0.000 (0.000)	0.001** (0.001)	0.000 (0.001)
Complementor product quality	0.150 (0.146)	0.236 (0.264)	0.233 (0.660)
Competition (Nest)	0.240*** (0.082)	−0.159 (0.183)	−0.689*** (0.185)
Competition (Alexa)	−0.023 (0.047)	−0.139 (0.099)	−0.038 (0.205)
Competition (SmartThings)	0.028 (0.085)	−0.109 (0.115)	−0.861*** (0.176)
Competition (Wink)	−0.177 (0.147)	0.002 (0.170)	−0.802** (0.368)
First adopted platform (Nest)		0.178 (0.597)	−5.335*** (1.917)
First adopted platform (Alexa)		−0.089 (0.689)	1.833** (0.804)
First adopted platform (SmartThings)		1.021 (1.202)	−1.592* (0.945)
First adopted platform (Wink)		2.744*** (0.955)	−1.924 (1.468)

(Continues)

TABLE 5 | (Continued)

	Weibull survival model		
	First platform	Second platform	Third platform
	(1)	(2)	(3)
Variables	**Time to first platform**	**Time to multihome**	**Time to multihome**
Constant	1.619	−5.859	−24.880***
	(2.454)	(3.822)	(7.611)
Time FE	Yes	Yes	Yes
Observations	2459	1342	1631

Note: Robust standard errors in parentheses. ***$p<0.01$, **$p<0.05$, *$p<0.1$.

to a third platform. In both models, the *technological distance* coefficient is negative and significant ($p<0.01$), suggesting that *technological distance* also reduces the probability of subsequent multihoming. These findings are consistent with our main results.

6 | Discussion

Nascent platform markets in which several platforms compete for dominance create a setting of high uncertainty. These markets also offer complementors an opportunity to multihome across multiple platforms, which can increase their chances of survival and business growth. Existing platform literature has primarily focused on the determinants and the consequences of complementors' decision to multihome (Agarwal and Kapoor 2023; Gastaldi et al. 2024; Tian et al. 2022). However, this focus has largely overlooked a key strategic dimension of complementors' multihoming decisions: *when* to multihome. By highlighting timing as a critical aspect of multihoming, this study emphasizes that timing strategies are an essential element of complementors' competitive dynamics in multi-platform markets. Using the nascent smart home market as our research context, we studied the factors that influence complementors' timing of sequential multihomings. To our knowledge, our study is the first to investigate the timing of complementors' multihoming, with a specific interest in the timing of their first and subsequent multihoming.

This research contributes to the growing platform literature that takes a complementor-centric perspective (Ceccagnoli et al. 2012; Cennamo et al. 2018; Huang et al. 2013; Kapoor and Agarwal 2017). Most studies in this field have centered around complementors' market entry strategies (Ceccagnoli et al. 2012; Cennamo et al. 2018; Corts and Lederman 2009; Huang et al. 2013; Kapoor and Agarwal 2017), and they have mainly examined single-platform settings (Ceccagnoli et al. 2012; Kapoor and Agarwal 2017). Moreover, research on complementor multihoming has largely been conducted in mature platform contexts where platform dynamics have been reduced to the interactions between two dominant platforms; consequently, complementors face a one-off multihoming decision with only one multihoming option (Cennamo et al. 2018; Corts and Lederman 2009; Landsman and Stremersch 2011; Srinivasan and Venkatraman 2018; Bresnahan et al. 2014). Our research differs from existing research by developing theoretical arguments on complementors' sequential multihomings, demonstrating that complementors can join multiple platforms, and that the factors that influence the timing of each multihoming can vary. This study is also novel in its focus on a nascent platform context, which due to its unique characteristics represents an ideal setting to investigate the drivers of the timing of complementor multihoming under high technological and market uncertainty.

Our research is aimed at bridging the gap between the growing platform literature and the extant entry timing literature to advance our understanding of the complementors' timing strategies, particularly the timing of their multihoming. Findings of our study provide novel insights into complementor strategies. In particular, we observed that early entrants tend to switch from single-homing to multihoming faster than late entrants. This reflects a hedging strategy to mitigate the potential adverse impact of choosing the wrong platform in rapidly changing market conditions and enhance the chances of survival in the early stage of a multi-platform ecosystem. While the emergence of a multi-platform market offers new opportunities for its participants (Polidoro and Yang 2024), it also brings high technological and market uncertainty as several platforms compete and seek ways to leverage the network effects in their favor to achieve market dominance (Frattini et al. 2014). Our results point to the relevance of a hedging strategy specifically when complementors transition from single-homing to multihoming—when joining a second platform. Early entry does not influence the timing of complementors' subsequent multihoming, lending support to the notion that the complementors' entry risk is at its highest early in the industry lifecycle (Cusumano et al. 2019; Eisenmann 2006).

While early entry is a complementor-related factor that has been shown to influence the timing of complementor multihoming, platform-related factors such as the traction a platform achieves in the market, and the technological distance between adopted and non-adopted platform architectures have also been associated with how fast complementors multihome. The significance of these factors can vary with the order of multihoming. For instance, platform traction, that is, the popularity gained in the market by non-adopted platforms, is positively linked with the speed at which a complementor multihomes for the first time. Because complementors adopt their first platform not knowing whether the platform they choose to join will grow faster than its rivals or eventually fall behind, they seek market indicators that might provide information to form predictions about the future success

TABLE 6 | Probability of multihoming.

	Linear probability model					
	First platform	**Second platform**	**Third platform**	**First platform**	**Second platform**	**Third platform**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variables	**Adopt**	**Multihome**	**Multihome**	**Adopt**	**Multihome**	**Multihome**
Time to market entry		−0.006***	−0.001		−0.006**	−0.001
		(0.002)	(0.002)		(0.003)	(0.002)
Platform traction	0.001	0.003***	0.001	0.001**	0.003***	0.001*
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Technological distance	−1.153***	−0.770***	−0.674***	−1.153***	−0.770***	−0.674***
	(0.023)	(0.033)	(0.026)	(0.107)	(0.137)	(0.083)
Lights	−0.095	−0.121	0.319***	−0.095	−0.121	0.319***
	(0.073)	(0.096)	(0.084)	(0.113)	(0.117)	(0.071)
Appliances	0.249**	−0.810***	0.432***	0.249	−0.810***	0.432
	(0.114)	(0.179)	(0.154)	(0.245)	(0.218)	(0.314)
Security systems	−0.172**	0.091	0.445***	−0.172	0.091	0.445***
	(0.069)	(0.092)	(0.080)	(0.110)	(0.119)	(0.078)
Thermostats	−0.140**	−0.084	0.235***	−0.140	−0.084	0.235***
	(0.068)	(0.093)	(0.082)	(0.112)	(0.108)	(0.070)
De novo	−0.017	−0.089	0.063	−0.017	−0.089	0.063
	(0.050)	(0.071)	(0.062)	(0.057)	(0.071)	(0.052)
Incumbent	0.049	0.105*	0.059	0.049	0.105*	0.059
	(0.047)	(0.061)	(0.054)	(0.056)	(0.060)	(0.037)
Small firm	−0.055	0.045	0.073*	−0.055	0.045	0.073*
	(0.038)	(0.049)	(0.044)	(0.040)	(0.046)	(0.042)
Complementor resources	−0.000***	0.000***	−0.000***	−0.000***	0.000***	−0.000*
	(2.42e-05)	(3.47e-05)	(2.92e-05)	(4.14e-05)	(4.31e-05)	(5.96e-05)
Complementor product quality	0.040***	−0.033***	−0.006	0.040**	−0.033	−0.006
	(0.007)	(0.012)	(0.010)	(0.016)	(0.029)	(0.019)
Competition (Nest)	0.007***	0.011***	−0.002	0.007	0.011	−0.002
	(0.002)	(0.003)	(0.002)	(0.008)	(0.011)	(0.008)
Competition (Alexa)	0.002***	0.005***	0.005***	0.002	0.005	0.005
	(0.001)	(0.002)	(0.001)	(0.003)	(0.006)	(0.004)

(Continues)

TABLE 6 | (Continued)

	Linear probability model					
	First platform	Second platform	Third platform	First platform	Second platform	Third platform
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Adopt	Multihome	Multihome	Adopt	Multihome	Multihome
Competition (SmartThings)	0.003* (0.002)	−0.006** (0.002)	−0.034*** (0.002)	0.003 (0.007)	−0.006 (0.010)	−0.034*** (0.008)
Competition (Wink)	−0.006*** (0.002)	−0.024*** (0.003)	−0.033*** (0.002)	−0.006 (0.010)	−0.024** (0.010)	−0.033*** (0.009)
First adopted platform (Nest)		0.142* (0.084)	−0.085 (0.074)		0.142* (0.073)	−0.085 (0.075)
First adopted platform (Alexa)		0.087 (0.061)	0.072 (0.054)		0.087 (0.060)	0.072 (0.055)
First adopted platform (SmartThings)		0.150** (0.068)	−0.023 (0.059)		0.150* (0.079)	−0.023 (0.055)
First adopted platform (Wink)		0.167** (0.068)	0.080 (0.060)		0.167** (0.067)	0.080 (0.068)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.346*** (0.074)	1.202*** (0.149)	0.624*** (0.130)	1.346*** (0.161)	1.202*** (0.190)	0.624*** (0.100)
Clustering stand. errors	No	No	No	Yes	Yes	Yes
Observations	3865	2040	2040	3865	2040	2040

Note: Standard errors in parentheses in Model 1–3, robust standard errors in parentheses in Model 4–6. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

of competing platforms. Although an imperfect signal, platform traction provides complementors with information about the current state of platform competition which they can incorporate into their timing strategies when deciding to multihome for the first time. This effect disappears as the market evolves and uncertainty decreases, particularly for complementors that have already hedged their entry risks by joining two platforms. In contrast, our findings suggest that technological distance plays a crucial role in how fast a firm enters the smart home market and joins its second and third platforms. Complementors are faster to multihome to platforms that are technologically closer to their already-adopted platforms. This result is in line with the prior research conducted in other platform markets (e.g., Srinivasan and Venkatraman 2018; Cennamo et al. 2018) that argues multihoming carries important costs for the complementors (Armstrong and Wright 2007) which tend to increase with the technological distance between platforms and different versions of platform architecture (Cennamo et al. 2018; Chen et al. 2022). Our study complements existing research by presenting evidence on the influence of technological distance in shaping complementors' timing strategies for their first and subsequent multihoming.

Platforms that have emerged in the smart home market are typically considered as innovation platforms that provide the necessary technological architecture upon which the participants create value by offering novel complementary products and services (Cusumano et al. 2019; Gawer 2021; Trabucchi and Buganza 2022). Complementors that join the multi-platform ecosystem are the main *side* of the platform (Parker et al. 2016) that brings innovative products and services to a platform, expanding its functionality and value to the users. While smart home technology has been around since the 1980s, it is the current digital platforms, with their modular approach and exposed interfaces, that have created the appropriate technological infrastructure, allowing extended connectivity and opening the gate to a wide array of highly innovative IoT products (Hoffman and Novak 2025; Raff et al. 2020; Schulz et al. 2023). Research highlights the conditions that favor product innovation in platform ecosystems (Boudreau 2012), and the early stages of innovation platforms are shown to be particularly challenging as they require their participants to engage in complementary innovation (Gawer 2021; Gawer and Cusumano 2014). Our study adds to prior research by studying complementor strategies in nascent innovation platforms. Simultaneously considering complementors' timing of multihoming with their innovative processes during the early stages of ecosystem development can enrich our understanding of complementor strategies in this challenging context.

This research has several managerial implications for both complementors and platform owners. From a complementor perspective, based on our findings, enhancing an early entrant's chances of survival in a nascent multi-platform ecosystem is possible by multihoming fast to a second platform. Complementor firms planning to enter such ecosystems early are, therefore, advised to secure enough resources to multihome quickly. As our research shows, this is particularly important in the early stages of a platform ecosystem when the uncertainty is high and may take some time to resolve. In such situations, complementors might need to engage in sequential multihoming to increase their chances of survival. In anticipation of multihoming, firms can potentially *design for multihoming*, for instance, by choosing modular product designs that make it easier to adapt to various platforms or by using middleware as an interface. While designing for multihoming might have higher upfront product development costs, these can be more than paid off if multihoming one or more times is required. In addition, when choosing which platform to multihome to, our study suggests that complementors must consider two key factors: platform traction and homing costs. While complementor firms have no control over the traction that the competing platforms gain in the market, they can proactively develop organizational skills and a profound understanding of different platform architectures and work on compatible product designs so as to reduce homing costs.

This study also has managerial implications for platform owners since multihoming may hinder a platform's strategy to obtain a unique position in the platform landscape by differentiating its product offerings. Platforms trying to establish a dominant position in the market often negotiate with popular complementors to sign an exclusive contract to attract new users and retain existing ones. For example, Sony negotiated many exclusive titles for its PlayStation 4 game console, such as *Marvel's Spider-Man* and *God of War*. Based on our observation that early entrants in nascent multi-platform spaces tend to multihome faster than late entrants, platform owners should carefully monitor the market response to the offerings of these early entrants and evaluate their growth potential. High-potential early entrants can be singled out and provided with incentives to secure their exclusivity on the platform before they multihome to other platforms. Platform owners can also benefit from developing a distinct platform architecture given that complementors are faster to multihome to platforms that are technologically closer to their already adopted platforms.

Finally, our research points to several boundary conditions that open new areas of future research. Our findings may not necessarily extend to non-platform industries, industries in which only one platform emerges, or mature platform markets where the winning platform(s) is (are) well understood. Given these boundary conditions, future research could disentangle the sources of market and technological uncertainty to explore whether they have differential effects on the timing of complementors' multihoming. Examining the potential second-order effects could be another fruitful area for future research. Moreover, our study only considers the timing of multihoming from the complementors' perspective; future studies may explore situations in which both complementors and users multihome. Scholars could also investigate how complementors align their organizational structure and innovative processes with the timing of their multihoming.

Acknowledgments

The authors would like to thank the editor-in-chief, the associate editor, and the anonymous reviewers of *JPIM* for their constructive comments and suggestions. All remaining errors are our own.

Ethics Statement

The authors have read and agreed to the Committee on Publication Ethics (COPE) international standards for authors.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from IoT Analytics. Restrictions apply to the availability of these data, which were used under license for this study.

Endnotes

[1] *Source:* Sensor Tower (https://sensortower.com/).

[2] Other players in the cloud-based services market, such as Google, Microsoft and Amazon, entered the market later in April 2012 (Drago et al. 2012).

[3] The timing of multihoming is also important in other platform-driven industries, such as video games. 2K Games launched *Bioshock* as an Xbox 360 exclusive title in August 2007, and eventually ported it to PlayStation 3 in October 2008, a little over a year. This multihoming allowed 2K Games to capitalize on a broader audience and extend its reach in the rapidly growing PlayStation market. Conversely, its competitor BioWare's *Mass Effect* was released on Xbox 360 in November 2007, but its PlayStation debut was delayed until 2012, when it became available as part of the *Mass Effect Trilogy*. This delay hindered BioWare's ability to build momentum with PlayStation users early on.

[4] The Economist (June 2016) "Where the smart is" available at: https://www.economist.com/news/business/21700380-connected-homes-will-take-longer-materialize-expected-where-smart.

[5] *Source:* Statista Digital Market Outlook (February 2017).

[6] The analysis of complementors' adoption of a fourth platform could not be conducted as too few complementors multihomed to a fourth platform during our study period.

[7] Starting in 2014, there were four platforms available for complementors to consider. Our data were available from September 2014 onwards.

[8] Works with [Program] is a certification program used by the platform owners to attract complementors to their platforms. Only complementor products that are compatible with a platform's technological architecture appear on the Works with [Program]. All platforms in our sample created such programs.

[9] The first smart product in the market was Nest smart learning thermostat (first generation) that was launched in October 2011.

[10] The addition of Google Trends product queries to sales forecast models has been shown to improve prediction power in a wide variety of contexts (e.g., Boone et al. 2018; Du and Hsieh 2023).

[11] Jaccard distance is formulated as follows: $J(A,B) = 1 - |A \cap B| / |A \cup B|$, 1 minus the size of the intersection divided by the size of the union of the sample sets.

[12] In our robustness checks (not shown), we also used two and three-month lagged control variables. The results remained qualitatively similar.

[13] In our robustness checks, we have winsorized the *complementor resources* variable at the 90% level and achieved qualitatively similar results. Available upon request.

[14] Technological distance is negatively associated with the time to first ($b = -0.01$, $p < 0.01$) and second ($b = -0.07$, $p < 0.01$) multihoming. Available upon request.

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Biographies

Senem Aydin Ozden is an Assistant Professor (Lecturer) of Strategy at Bayes Business School, City St George's, University of London. She received her PhD in Business Administration and Management from Bocconi University, with a major in Strategy and a minor in Technology and Innovation Management. She also holds a Bachelor of Architecture (BArch) and an MBA from Middle East Technical University. Her research interests include competitive dynamics in platform ecosystems, complementor strategies, intellectual property rights, and technology licensing.

Fernando F. Suarez is the Jean C. Tempel Professor of Entrepreneurship and Innovation at the D'Amore-McKim School of Business, Northeastern University, and the former Chair of the Entrepreneurship & Innovation Department (2016–2023). Prior to this, he founded the Strategy and Innovation Department at Boston University and served as its Chair from 2008 to 2013. He has also held faculty positions at the London Business School (UK), MIT Sloan School (USA), Hitotsubashi University (Japan), SKEMA Business School (France), Universidad Adolfo Ibáñez and ESE Business School (Chile). His widely cited research (10,000+ Google Scholar citations) spans the areas of innovation and technology strategy, entry timing strategies, standards and dominant designs, industry evolution, categorical dynamics, platform competition, entrepreneurship, and the role of services in product firms. His publications have appeared in top academic journals as well as in top practitioner-oriented publications. He serves in the Editorial Boards of the Academy of Management Review and Organization Science, and in the Board of Governors of the Academy of Management. Prof. Suarez holds a PhD from the MIT Sloan School of Management, a Master's in Regional Planning from MIT, and a BA in Economics from the University of Chile.

Dirk Libaers is the John and Beverley Grant Endowed Professor of Entrepreneurship and the Director of the Nault Center for Entrepreneurship at the Muma College of Business at the University of South Florida. He is currently a visiting professor at the University of Vaasa in Finland. His research interests include technology and academic entrepreneurship, new product and service development in new ventures and established firms, and issues related to creativity and innovation. His work has been published in the *Strategic Management Journal, Strategic Entrepreneurship Journal, Journal of Product Innovation Management*, *Research Policy*, *Journal of Business Venturing, and Industrial and Corporate Change, among others*.

Yakov Bart is a Professor of Marketing and Thomas E. Moore Faculty Fellow at Northeastern University. His research examining marketing implications of new digital technologies and business models has been funded by NSF, Amazon, Google, MSI, WPP, and published in leading marketing and management journals. Yakov holds a PhD and an MS in Business Administration from the University of California at Berkeley, an SM in Operations Research from MIT, and a Diploma in Mathematics from Moscow State University.