THE PERFORMANCE IMPLICATIONS OF ALLIANCE AND INTEGRATION GOVERNANCE MODES IN PLATFORM ECOSYSTEMS

ABSTRACT

We investigate the performance consequences of alliance versus vertical integration choices of platform participants. We apply insights from transaction cost economics to platform ecosystems by highlighting the importance of ecosystem positioning for the performance outcomes of this ally versus integrate choice. Analyzing 16,656 video game releases by 1,775 developers, 476 publishers, and 4 platform owners across 21 video game platforms between 1989 and 2017, we find that alliances outperform vertical integration, alliances with an owner outperforms alliances between two (non-owner) complementor firms. Despite positive product performance advantages of alliances in platform ecosystems, we found that these benefits diminish with platform diffusion. Our results confirm our conjecture that the coordination benefits of platform ecosystems are more salient for the participants during the early stages of the platform. As platforms matures, the significant performance differences among difference governance forms diminish.

INTRODUCTION

Technological platforms – that is, a system of interdependent components that are designed to function compatibly with each other – are increasingly prevalent with the growing importance of the digital economy. A central yet under-attended strategic concern of both theoretical and practical importance surrounds firm boundaries among the producers of the complementary goods within a platform. While there has been considerable platform research on the integration into complementary goods markets, surprisingly little research in this domain has examined alliances. This is surprising given that alliances are commonly observed in platforms. For example, prominent video game platform owners like Nintendo and Sony frequently assume the role of publishers in a collaborative partnership with game development companies. Similarly, Amazon engages in the "Fulfillment by Amazon" (FBA) program, cooperating with third-party sellers to manage shipping and customer interactions on their behalf. Moreover, it is not at all self-evident that the vast body of research on the firm boundary decision, much of it grounded transaction-cost economics, can be applied to platforms as-is, given that platforms embody incentives and structures that potentially confound transaction cost logic. To amend this lacuna, we ask: how does governance mode choice – alliance vs. integration – when firms diversify across a platform's ecosystem of complements affect firm performance?

A key challenge to answering this question is that extant theories of "make versus ally" might be difficult to apply to technology platforms. Williamson's Nobel prize-winning work on transaction cost economics provides a theory of discriminating alignment that speaks directly to this issue but has been developed within a framework of traditional firms in traditional value chains. In contrast, platforms are, by definition, embedded within inter-organizational structures that strongly circumscribe technological and economic activity. Such structures typically comprise multi-lateral interdependence among platform firms rather than the bilateral interdependence that

characterizes traditional industries (Jacobides et al., 2018; Kretschmer et al., 2022), which makes it challenging for platform firms to jointly realize a focal value proposition (Adner, 2017). Since incentives-based mechanisms that undergird transaction-cost economics are likely to be altered by platform structure, new theory is needed that considers both recent theoretical advances in our understanding of platforms and longstanding transaction cost logics. In this study, we seek to make headway in this direction.

Our central claim is that the main structural characteristics of a platform, as highlighted in the extant platform literature, mitigate alliance transaction costs. Three such structural characteristics important to our discussion are rules, modularity, and non-generic complementarities (Chen et al., 2022; Jacobides et al., 2018; Kretschmer et al., 2022). Rules are specifications that define how a platform's components are to operate and communicate with one another. Modularity is the extent to which a "system's [e.g., a platform's] components can be separated and recombined, and it refers both to the tightness of coupling between components and the degree to which the 'rules' of the system architecture enable (or prohibit) the mixing and matching of components" (Schilling, 2000). Non-generic complementarities are those that do not arise automatically between components, but rather are enabled by a well-conceived platform structure (i.e., a highly modular platform with complementarity-enhancing rules) (Jacobides et al., 2018). These structural characteristics shift incentives towards cooperative behavior (as our ensuing discussion will clarify), thereby mitigating alliance transaction costs.

Several important implications of our claims emerge. First, and most basically, alliances will tend to outperform acquisitions among a platform's firms. Second, alliances between a platform owner (a firm that has a special measure of control over platform structure) and (non-owner) complementor firm will tend to outperform alliances between complementor firms,

because, as we will argue, platform owners are better positioned within the ecosystem to leverage the structural features of a platform to create greater value. Third, platform maturity weakens the benefits of alliances over acquisition and weakens the relative alliance advantage of platform owners over complementors because firms become more proficient at internalizing prior synergies with alliance partners through integrations in mature platforms and have shifts in strategic incentives and intentions as the platform matures.

Our empirical research context is the global video game industry. As a platform-mediated industry (Shankar & Bayus, 2003), the video game industry fits well to test our hypotheses because firms – platform owners (e.g., Microsoft, Nintendo, and Sony) as well as complementors (i.e., firms that only produce games) engage in both vertical integration and alliances. Following recent studies (K. J. Boudreau & Jeppesen, 2015; Kapoor & Agarwal, 2017; Rietveld & Eggers, 2018), we measure complementor performance based on product-level performance. To see the performance consequences of alliance vs. integration behaviors among platform firms (participants), we gather a unique dataset, which consists of 16,656 video game releases by 1,775 developers, 476 publishers, and 4 platform owners across 21 video game platforms between 1989 and 2017

The study makes several contributions. First, our study complements an increasing body of research on the entry decision of platform owners into the complementors' zone (Foerderer et al., 2018; Wen & Zhu, 2019; Zhu, 2019; Zhu & Liu, 2018). These studies mainly focus on the intentions of the platform owners while entering into the complementors' zone and the effects of therein on the general health of an ecosystem, installed user base, and complementor innovation. By contrast, our paper theorizes and offers empirical evidence about the efficacy of different collaborative modes – that is, governance choices – between platform participants and how

platform considerations affect their efficacy. Moreover, we build upon recent studies that investigate the exploitative behaviors of platform owners in complementors' zone (Beattie et al., 2021; Kim & Luca, 2019) and provide insights on how and when different governance choices may be more beneficial for platform owners and complementors.

Second, we build upon the newly emerging ecosystem theory that suggests "ecosystems allow for some degree of coordination without requiring hierarchical governance" (Jacobides et al., 2018, p. 2263). Our results add nuance to and are broadly consistent with this observation. In particular, we find that, compared to vertical integration, alliances between platform participants are positively associated with product performance, which indicates that platform ecosystems supply a coordinative mechanism that may be augmented by alliances. Interestingly, we also find that the coordinative synergies between platforms and alliances weaken with platform maturity, one intuition being that as a platform matures, some of the learning gained in prior alliances may become incorporated into the platform. Thus, as mutual dependence between platform participants decreases over time, positive performance advantages of alliance over vertical integrations may diminish in mature platforms.

Finally, an increasing number of studies focus on platform evolution and the changing composition of platform ecosystems over time (Cennamo, 2018; Daymond et al., 2023; Rietveld & Eggers, 2018). These studies offer insights on the changing value propositions of platforms from a demand side perspective. Our study complements these emerging body of research by offering insights on the supply side heterogeneity and showing the differential effects of governance modes on product performance.

THEORETICAL BACKGROUND

To provide conceptual backdrop to our theoretical claims and consequent hypotheses, we review two key domains important to this study. First, we examine the relevant literature on transaction cost economics and specifically how it helps predict organizational governance. We then turn attention to pertinent features of platform ecosystems, including rules, modularity, and non-generic complementarities (Chen et al., 2022; Jacobides et al., 2018; Kretschmer et al., 2022) as well as changing dynamics in platforms (Cennamo, 2018; Daymond et al., 2023; Rietveld & Eggers, 2018) that require us develop a new theory for the performance implications of alternative governance modes in this context.

Organizational Governance Modes

A governance mode in our study denotes a specific configuration of governance mechanisms that help organizational actors coordinate and control economic transactions (Ebers & Oerlemans, 2016; Hennart, 1993). Building upon early behavioral assumptions of bounded rationality and opportunism (Cyert & March, 1963; March & Simon, 1958), transaction cost economics (TCE) argues that opportunism and uncertainty are likely to lead firms to internalize asset-specific transactions and prefer vertical integration over alternative modes of governance (O. E. Williamson, 1975, 1985). Focusing on transaction characteristics – asset specificity, uncertainty, and frequency – TCE also predicts that greater asset specificity (transaction-specific investments) increases the likelihood of transactional hazards and stymies the ability of court mechanisms to solve these hazards (Cuypers et al., 2021; Tadelis & Williamson, 2012). Thus, vertical integration may be required when assets are highly specific to a given investment.

A stream of literature grounded in the TCE tradition has focused on vertical integration, optimal governance mode, and performance outcomes (Capron & Mitchell, 2012; Castañer et al., 2014; Leiblein et al., 2002; Rothaermel et al., 2006). Early studies have investigated the role of

make, buy, or ally decisions in mitigating concerns regarding opportunism and incomplete contracts (Mahoney, 1992; Poppo & Zenger, 2002; O. E. Williamson, 1975, 1985), the performance outcomes of governance decisions (Leiblein et al., 2002; Nickerson & Silverman, 2003), with some work focused specifically on such decisions in horizontal collaborations (Castañer et al., 2014) that are commonplace between incumbents of the same industry (Kogut, 1988). Given that a platform consists of member firms who must jointly work towards a collective value proposition (Adner, 2017), one might expect that TCE would be highly relevant to informing platform theory. Nonetheless, little research to date has systematically incorporated transaction-cost logic to theorizing on platform performance, which is important because it is not if and to what extent TCE's predictions would apply to platforms and the coordinative structures they embody.

Platform Ecosystems

We define a platform ecosystem as the alignment structure of various transacting and interacting parties to create and appropriate value (Adner, 2017; Jacobides et al., 2018). Scholars conceptualize platform ecosystems as "meta-organizations" that are less formal and hierarchically structured than firms yet more closely coupled than markets (Kretschmer et al., 2022; Tajedin et al., 2019). As such, coordination is accomplished through "standards or base requirements" (Jacobides et al., 2018, p. 9) – what we call "rules" – to ensure that the coherence across the disparate components of the platform is adequate to realize a focal value proposition (Adner, 2017).

Multilateral interdependence. Van Alstyne et al. (2016, p. 4) observe that "[p]ipeline businesses create value by controlling a linear series of activities—the classic value-chain model." In contrast, platform ecosystems create value by effectively coordinating myriad non-linear supplier and

consumer relationships that work together compatibly and synergistically – this is the essence of what Adner (2017) describes as attaining "structural alignment." As such, platforms are marked not by the bilateral interdependence that typifies traditional value chains but rather by multilateral independence among various platform components such that platforms have an underlying technological network topology of interconnections (Adner and Kapoor 2010; Adner 2017; Ranganathan, Chen & Ghosh 2023). Similarly, platforms partition their underlying components into "loosely-coupled" modular organizational systems with defined interfaces that create a specific structure of relationships among participants and bind them together to function as a whole with fewer formal governance mechanisms than in pipeline-based industries (Baldwin & Clark, 2000a; Kretschmer et al., 2022; Schilling, 2000). Modularity, properly designed, facilitates the creation of value-enhancing "non-generic" complementarities within the platform (Jacobides et al., 2018).

Economics of platforms. One of the most prominent theoretical considerations informing early research on technology ecosystems is network effects in which the utility of an ecosystem, to either consumers (direct network effects) or producers (indirect network effects), increases with the size of the ecosystem (Farrell & Saloner, 1985, 1986; Katz & Shapiro, 1986). Early research in this domain were in commonplace examples such as typewriters and the QWERTY keyboard configuration (David, 1985; Suarez & Utterback, 1995), buttressed by mathematical formalism on the phenomenon (Arthur, 1989; Artur et al., 1983). A core insight across this research is that "lock-in" to one platform may be heavily path dependent and affected by early choices or even chance events in the process of competitive platform evolution (Adner et al., 2020; Cennamo & Santalo, 2013).

Another major topic of recent platform research is two-sided markets (Rochet & Tirole, 2003, 2006; Seamans & Zhu, 2017; Zhu & Iansiti, 2019). Network effects are central to our understanding of two-sided markets since they potentially create pricing implications across the two market sides, meaning that it may be optimal to price low on one side of the market to spur network effects on that side and in turn increase willingness to pay on the other side. Therefore, it is not surprising that a growing literature has investigated the pricing and standard-setting decisions of platform owners(Hagiu, 2006; Miller & Toh, 2020; Rochet & Tirole, 2003; Seamans & Zhu, 2017) and the timing decisions of platform owners' entry into platform ecosystems (Zhu & Iansiti, 2012).

Cooperation and competition within platforms.

A tension at the core of platforms is one between value creation and capture. The aforementioned rules and modularity increase the potential for realizing non-generic complementarities in a platform and thereby create value. Cooperation may be necessary to achieve these potential complementarities (Gawer & Cusumano, 2002; Zhang et al., 2022), due in part to the multilateral interdependence of technology platforms (Adner & Kapoor, 2010; Baldwin & Clark, 2000b; Teece, 2018).

Yet a firm can only cooperate so much before it risks not capturing enough value to survive (Hannah & Eisenhardt, 2018). Indeed, a stream of recent platform research, focused primarily on platform-owner strategies, has examined the extent to which the owner should enter the "complementor's zone" and compete in the complementary goods markets of its own platform. The underlying tradeoff at play is that owners may enhance platform value by entering its complementary goods markets, perhaps even increasing the visibility of that market to the benefit other firms in it (Foerderer et al., 2018), but, on the other hand, the owner's entry may pose a

competitive threat to existing firms in that market (Boudreau, 2010; Zhu & Liu, 2018), particularly when the owner has tight control over the rules of the platform (Kang & Suarez, 2023). The potential value-creation upsides of an owner participating in complements markets are multiplex – it may stimulate network effects, exercise better quality control, and expand the installed user base (Foerderer et al., 2018; Wen & Zhu, 2019; Zhu, 2019; Zhu & Liu, 2018). For instance, Li and Agarwal (2017) found that Facebook's integration of Instagram had positive spillovers for other similar third-party complementors, and Foerderer et al. (2018) found a similar effect with Google's integration of photography apps.

Despite such incentives for cooperative behavior, platforms provide rationales for competitive tactics as well. Consistent with this claim, an increasing number of studies report abusive and opportunistic behaviors of platform owners towards complementors. This may be in part due to power asymmetries among platform owners and participants that decrease mutual dependence between platform owners and complementors over time (Curchod et al., 2020). For example, Zhu and Liu (2018) and Wen and Zhu (2019) found negative effects of Amazon's and Google's integration into complementors' markets. Kim and Luca (2019) show that companies such as Microsoft or Google may abuse their position to highlight their own lower-quality products. Beattie et al (2021) suggest that platform owners may bias content to appease preferred advertisers.

Governance in Platforms.

Even though most studies focusing on traditional pipeline organizations investigate horizontal alliances (e.g., Castañer et al. 2014), platform-specific mechanisms make vertical alliances a popular governance mode in platform ecosystems. Hence, in this paper, we study the vertical alliance vs. vertical integration behaviors among platform participants. In platform-mediated

industries, alliances can happen in two ways: (1) alliances between platform owners and complementor firms, and (2) alliances between complementor firms specialized in distinct domains (e.g., in the context of game developers and publishers). Distinct from alliances among pipeline organizations, platform alliances occur between parties who occupy possibly different positions within an ecosystem (Adner, 2017; Adner & Kapoor, 2010).

In our study, the performance gap between different governance modes is contingent on the relative balance between the benefits and costs of these governance modes. We develop Hypotheses 1 and 2 based on platform specific mechanisms such as the existence of some degree of coordination among participants, the co-existence of "loosely-coupled" modular organizational systems and "non-generic complementarities," and the domain specialization among platform participants. We discuss that these platform specific mechanisms make diminish the transaction-cost advantages of vertical integrations while preserving, or even enhancing, the benefits of alliances. Similarly, we posited that alliances with an owner would be more likely to have a positive impact on product performance due to the owner's ability to implicitly endorse the alliance's output, offer valuable insights and technical guidance, and leverage its power within the ecosystem to maximize its own profits. Finally, we focus on the changing composition and strategic incentives in hypotheses 3 and 4 and discuss that as platforms matures, benefits of alliances will diminish in platform ecosystems.

In sum, the core insight from the extant literatures on cooperation and competition in platforms, as applied to this study, is that platforms define a structure that shapes cooperative and competitive dynamics. As a result, a platform's structure likely influences the tradeoffs inherent in the logics of transaction cost economics. A classic example to illustrate these points is Intel's pivotal role within PC ecosystem (Gawer & Cusumano, 2002). Since Intel's microprocessor

innovations are not standalone but rather require a platform of computing-related technologies to codevelop around them, so Intel stands to benefit greatly from a rich set of complementors emerging to support their processor technology. At the same time, complementors should remain wary of Intel competing and potentially coming to dominate their technology space, and in turn, Intel must be careful not to drive away complementors out of such appropriation concerns. As such, the numerous realized and potential partnerships that Intel has with complementors are undergirded by the issues created by the technological architecture of personal computing and Intel's position within it. The Intel example highlights how a platform's structure indeed adds important conceptual considerations to transaction cost logics. This intersection of platform structure and transaction cost economics is the overarching framework from which we theorize the effects of alliances on platform firms' performance.

HYPOTHESES

Alliance vs. integration Considerations Within a Platform Ecosystem

At the heart of Williamson's seminal transaction cost theory is the notion of discriminating alignment, whose core premise is that "transactions, which differ in their attributes, are aligned with governance structures, which differ in their costs and competencies, in a discriminating (mainly, transaction-cost-economizing) way" (O. E. Williamson, 1991, p. 277). A key implication for our purposes is that transaction costs are an important driver in the relative advantages of alliances versus vertical integration as governance mode choices.

With discriminating alignment in mind, integration holds certain advantages over alliances. Integration may mitigate the "external" transaction costs of alliances by decreasing the risk of hold-up or opportunism through hierarchical control (Castañer et al., 2014; Gulati & Singh, 1998; White & Lui, 2005). Vertical integration may also reduce the "internal" costs of coordination (

compared to alliances) by providing more effective interpersonal communication mechanism. In particular, vertical integration enables a firm to develop an "unstructured technical dialog" – that is, a firm-specific dialect or "common language" of technical exchange to facilitate product development, which is particularly useful in contexts where problem-solving is integrated across functions rather than purely sequential (Monteverde, 1995). The greater ease with which unstructured technical dialog may be applied to systems-level integrated problem-solving enables vertical integrations to attain a "synergistic specificity" wherein the interconnected components of a technological product are jointly optimized to attain high overall performance.

On the other hand, alliances also have advantages over integration. For instance, alliances have a "synergistic combination advantage" of pooling resources held by multiple firms (Castañer et al., 2014; Kogut, 1988; Mitchell et al., 2002; Zajac & Olsen, 1993). Such synergies might in principle also exist in integrations through acquisition but in practice are elusive due to challenges in integrating processes and cultures across different groups in an organization. Other potential advantages of alliances over integration are that they retain a greater degree of high-powered market incentives and potentially harbor lower bureaucratic costs (Hoetker, 2006; Makadok & Coff, 2009; O. E. Williamson, 1985).

A basic rationale for why alliances tend to outperform integration in platforms is that platforms serve as (partial) substitutes for the mechanisms integration offers for mitigating transaction costs. First, platforms provide "rules" – that is, a common set of standards or base requirements" (Jacobides et al., 2018; Kretschmer et al., 2022) to ensure compatibility across platform components and enhance performance – that facilitates coordination among complementors. Recent research has argued that ecosystems (platforms) do more than just coordinate, that in fact they facilitate the creation of non-generic, multilateral complementarities

(Jacobides et al., 2018; Kretschmer et al., 2022). Rules potentially align many interdependent components of an ecosystem to function together and achieve ecosystem-specific complementarities not achievable through bilateral coordination (Adner, 2017). As such, ecosystem rules may match or even exceed the benefits of "synergistic specificity" obtained through integrated problem-solving that vertical integration enables.

Second, while vertical integration, as discussed above, decreases the risk of hold-up/opportunism that is inherent in alliances, so too does a platform's rules (to a degree). In particular, rules bring a common set of assumptions and information about the platform (e.g., functional attributes and interfaces between components) that reduce the space with which firms are able to engage in the behaviors associated with high transaction costs. To illustrate, suppose a publisher and video game developer hold complementary capabilities in sports-related games and form an alliance. Suppose further that the publisher has an idea to add a novel advertising scheme embedded into the games. A potential hold-up situation emerges where the publisher believes this feature is in the scope of the original alliance but the developer disagrees and feels that the amount of additional development work is way outside the bounds of their alliance. However, if the videogame platform had a strong alignment structure in that it had a feature-rich API to facilitate adding this advertising feature, this potential alliance hold-up problem might not be an issue.

In sum, our arguments indicate that platforms reduce the transaction-cost related advantages of vertical integration while preserving, or even increasing, the advantages of alliances, which tilts the balance of governance mode efficacy towards alliances, all else being equal. We therefore hypothesize:

> *Hypothesis 1:* In a platform, alliances are more likely to be positively associated with product performance than are integrations between platform firms.

Alliance with a platform owner vs. Alliance between complementors

The prior section developed arguments that alliances hold advantages over integration in platforms due to transaction cost considerations in these settings. We now examine the role of platform owners and contend that alliances between platform owners and complementors tend to outperform alliances between two complementors. The overarching logics of our thesis are the leading role of platform owners (Williamson & De Meyer, 2012) and the power asymmetries between platform owners and complementors (Curchod et al., 2020). In particular, platform owners may have decision rights on, for instance, future technology choices in the evolution of the platform. Platform owners also typically play a central role in the architecture of the ecosystem (i.e., defining the ecosystem's rules) and usually exert some level of control over access to the inner workings of this architecture (Boudreau, 2010; Parker & Van Alstyne, 2017). As a result, owners are uniquely positioned to accumulate expertise to deal with technical challenges surrounding alliances. Therefore, compared to alliances among complementors, alliances between platform owners and complementors benefit from decision rights and informational advantages of platform owners. For example, either explicit or implicit endorsement by platform owners for their own products can increase sales and yield to a higher performance.

In contrast, the lack of endorsement, insights and technical knowledge of platform owners can make it more difficult for products produced by complementor-only alliances to break the noise. Moreover, whereas allying with platform owners can enhance a complementor firm's own status (Hitt et al., 2000; Lin et al., 2009) and increase attention to its products (Li & Agarwal, 2017), alliances among complementors are likely to lack this attention. As complementors allying with platform owners become more visible to consumers, they will likely face competitive pressure, which may ultimately drive them to innovate (Barnett & Hansen, 1996; Barnett &

Pontikes, 2008; Foerderer et al., 2018). The control and informational advantages of owners with respect to alliances is amplified by recent advances in artificial intelligence, which can, for example, help identify innovative and resourceful complementors for partnership (Gregory et al., 2021; Jacobides et al., 2021).

Overall, we therefore expect alliances between a platform owner and complementor to outperform alliances among complementors because the owner can (perhaps implicitly) endorse the output of the alliance, provide deep insights and technical guidance, and use its power on the ecosystem to maximize its own profits. Accordingly, we hypothesize:

> *Hypothesis 2:* Alliances between a platform owner and a complementor firm is more likely to be positively associated with product performance than alliance between complementor firms.

Platform maturity moderation

How a platform grows from early stages to maturity has been a focal point of platform scholars, due largely to the recognition of the centrality of network effects (Cennamo, 2018; Daymond et al., 2023; Rietveld & Eggers, 2018) and related issues such as the "chicken-and-egg" problem where sellers (i.e., complementors) will not join the platform unless there are many buyers and buyers will not join unless there are many sellers. Thus, to engage more fully with extant platform research, it is important to examine not only a comparative assessment of different platform governance modes (as undertaken above), but also how this comparison changes over time. Our central claim in this regard is that the alliance and owner-involved alliance performance benefits in platforms is particularly strong in the nascent stages of a platform, which is the time when the viability of a platform is most likely to hang in the balance.

We argue that the performance differential of alliances over vertical integrations in platforms is likely to be high in the early stages of a platform's emergence and decline as the

platform matures. One basic reason for this relates to why a platform is needed in the first place in the given context, namely, that the technological scope of the underlying value proposition (Adner, 2017) is too large for any one firm to address (Gawer & Henderson, 2007; Teece, 2007). Consistent with this logic, firms are likely to focus on fewer components in the early stages of a platform rather than being spread too thin (e.g., from vertical integration), particularly amid the uncertainty surrounding that period of a platform's existence. Thus, in addition to the points previously discussed, alliances are a particularly effective means to augment a platform's alignment structure (i.e., its configuration of components and rules that tie them together) in enabling firms to coordinate in the platform. By doing so, firms are better able to achieve nongeneric complementarities in the platform. As a platform matures, firms become better equipped to diversify (e.g., through integration) as they accrue knowledge of the platform and uncertainty surrounding the platform is resolved.

A second reason surrounds learning in the context of platforms. A long tradition of learning in the alliance literature (Gulati, 1995, 1998) speaks to learning considerations within platform alliances. This literature has highlighted learning races in alliances and the sensible implication that an alliance might serve little strategic purpose for a firm that achieves its learning objectives from that alliance (Khanna et al., 1998). By way of analogy, during the early stage of a platform, firms can use alliances to learn about both the platform and the component(s) that its partner specializes in, so that the firms can achieve synergies. As the platform matures (and becomes more effective at facilitating complementarities), and as firms correspondingly gain knowledge of the platform and partners' knowledge, they become more capable at internalizing prior synergies with alliance partners through integration.

In view of these arguments, we hypothesize that:

Hypothesis 3: As a platform matures, the product performance advantages of alliances over vertical integration are diminished.

Earlier (H2), we hypothesized that alliances with a platform owner will give rise to higher product performance than alliances between complementors. We now develop arguments for why this difference grows smaller as a platform matures. First, platform owners are likely to favor alliances (versus integration) more in new versus mature platforms. A growing literature has recognized the delicate balance of owners opening a platform in order to incentivize complementors to innovate and create value, versus maintaining greater control to capture value (Boudreau, 2010; Eisenmann et al., 2009; Gawer & Henderson, 2007). The underlying logics from this prior research suggests that an owner's moves to gain control are more problematic when a platform is young. Indeed, potential complementors are likely to be especially wary of integrations involving an owner in a newer platform because the owner's intentions are yet to be established, and, in a similar vein, aggressiveness by a platform owner is more likely to be seen as an effort to establish its dominance over the platform (Gawer & Henderson, 2007). Thus, owners are likely to favor alliances (over integration) more in new platforms than in mature platforms.

Second, and relatedly, owners are highly vested in alliances and their success early on due to a desire to grow the platform and realize network effects, particularly when there is competition from other platforms (Rietveld & Schilling, 2021). For example, early-stage platform survival may require a platform owner to address the aforementioned chicken-and-egg problem by forming alliances with complementors in order to give them additional support in growing their portion of the ecosystem market. Therefore, the level of mutual dependence between platform owners and complementors is likely to be higher during the early stages of a platform, leading a platform owner to primarily focusing on enlarging its installed user base and tying in as many

complementors as possible. Platform owners may even offer considerable incentives to complementors and abstain from scaring off complementors. However, as platforms get older, the mutual dependence between an owner and complementors is likely to decrease over time, with increasing potential for a platform owner to enter the most lucrative complements markets (Gawer & Henderson, 2007). Given these shifts in the strategic incentives and intentions of platform participants as a platform matures, we hypothesize:

Hypothesis 4: As a platform matures, the product performance advantages of owner-complementor alliances over complementor-only alliances are diminished.

METHODS

Research Setting and Sample

Our research context is the global video game industry, a platform mediated industry (Shankar & Bayus, 2003) that has an extensive amount of competitive and collaborative behaviors among platform participants. Our study encompasses three distinct types of firms: (1) platform owners, who are responsible for providing the gaming consoles, (2) game developers, which are companies responsible for conceiving and creating video games, and (3) game publishers, which handle the distribution and marketing of the products. In this context, first-party publishers refer to the platform owners themselves, while first-party developers indicate the internal studios associated with these owners. Notably, major platform owners in our study include Microsoft (Xbox), Sony (PlayStation), and Nintendo (Switch). Third-party companies refer to developer and publisher companies such as Activision Blizzard, Electronic Arts, Ubisoft, etc[1]. Platform owners

[1]Please see details: https://gamingstreet.com/game-developer-publisher-relationship/#:~:text=Game%20Developer%3A%20A%20game%20developer,the%20creation%20of%20video%20games.&text=Game%20Publisher%3A%20Companies%20that%20publish,%2C%20distribution%2C%20and%20public%20relations.

are the most powerful players in a platform ecosystem, and publisher companies mostly consist of established firms who are often more powerful than developer companies. Thus, the alliances formed in this context involve parties with varying degrees of power asymmetries.

Our data comes from several websites, including VGChartz, mobygames, giantbomb, ign, and gamefaqs. Individual game sales data are collected from VGChartz database[2]. We also obtained additional variables related to companies, platforms, and games from various websites like mobygames, giantbomb, CrunchBase, LinkedIn, Twitter, Facebook, and Bloomberg.[3]. The original data collected from VGChartz consist of 52,475 unique video game titles. We cross-validated video game titles, genres, platforms, release dates, and some other control variables from other game websites based on platform, year, and title variables. While initial cross-validation was automated (in R code) by creating a unique id for each game title based on platform, year, and game title, we also manually cross-validated game titles that include typographical errors or alternate spellings. After cross-validation, we chose to include only game titles that globally sold more than 10,000 units because of missing data for those that sold fewer than 10,000 units. Deletion of data for those that sold fewer than 10,000 units results in a sample of 18,169 unique video games that were created by 546 video game publisher companies and 1,924 video game developers across 38 platforms between 1977 and 2017. Among the 38 platforms, 14 of them had fewer than 30 observations, totaling 96 game titles. Due to the sparse nature of games across the platform life cycle, we excluded these games from our sample. Additionally, we removed two consoles, the Nintendo Entertainment System (NES) with 100 game

[2] According to Google Scholar, there are over 900 studies based on the VGChartz database.

[3] A company name search on the Compustat and CRSP datasets only shows 10% of the names in the dataset. This can be interpreted as a rough percentage of public companies in the dataset.

titles and the Atari 2600 with 133 game titles, due to missing data on software life to week sales, which were crucial for calculating the platform diffusion variable. Finally, we dropped PC games (1184 game titles) from our sample because there were no platform owners for PC games. After these exclusions, our final sample consisted of 16,656 games created by 476 publisher companies and 1,775 developer companies across 21 video game platforms between 1989 and 2017. Among the games in the final sample, 1,364 were developed/published by alliances of platform owners and complementor firms, 9,481 games were developed/published by alliances among complementor firms, 502 games were developed/published through vertical integration of platform owners, and 5,309 games were developed/published through vertical integration of a complementor firm. When comparing this subsample to the initial data with non-missing publisher and developer information, we found that the missing observations were relatively evenly distributed across alternative governance modes. For instance, platform owners' vertical integration, their alliance with a complementor firm, vertical integration of complementors, and alliances of complementor firms respectively accounted for approximately 3%, 8%, 32%, and 57% in the current sample, while in the initial data, they respectively accounted for approximately 3%, 11%, 24%, and 62%.

Dependent Variable

Product performance. Our dependent variable for product performance is the game title's platform-specific lifetime unit sales. This measure is widely accepted in the literature for evaluating the performance of complementary products (Cennamo & Santaló, 2019; Rietveld & Eggers, 2018). We collected global unit sales data from VGChartz (as of January, 2019). Because we use the platform-specific lifetime unit sales at a single time point, we have cross-sectional

data. The data analysis revealed that most individual video games achieve approximately 62% of their lifetime sales within seven months (28 weeks). This trend aligns with findings from Rietveld and Eggers (2018) and Nair (2007). As a result, we intentionally excluded video game data from 2018 to maintain consistency. Due to the right-skewed nature of the dependent variable, we applied a natural logarithm transformation to the data

Independent Variables

Alliances vs. vertical integrations. In our study, we focus on non-equity-based collaborations that are different from the typical equity-based alliances in other settings. These alliances involve specialized companies in different positions within an ecosystem coming together to produce a product. To operationalize alliances in this specific context, we leverage the publisher and developer information available in our dataset. We used a coding scheme to identify the governance mode for each game title: "1" represents an alliance if the game was developed and published by two different companies, and "0" indicates integration if the game's development and publishing were handled by the same company. In further operationalization, we created the four variables to test our hypotheses: (1) *Alliance with an owner* **–** coded "1" if the platform owner is either publisher or developer and "0" otherwise; (2) *Alliance among complementor firms* - coded "1" if both publisher and developer companies are complementors and "0" otherwise; (3) *Vertical integration of platform owner* - coded "1" if platform owner, publisher, and developer are the same company and "0" otherwise; and (4) *Vertical integration of a complementor firm* **–** coded "1" if the game is developed and published by the same complementor and "0" otherwise.

Moderating Variable

Platform diffusion. Platform diffusion refers to the process through which the composition of a platform changes over time, with significant differences observed between the early and late stages of the platform's existence (Cennamo, 2018; Daymond et al., 2023). To capture the changing effects of governance forms on product performances, it is crucial to identify a continuous variable that represents the platform's evolution over time. In this study, we adopted an approach used in previous research (Rietveld & Eggers, 2018) to measure the platform's diffusion based on its user base. Specifically, we created a variable by calculating the ratio of total software sales of a platform at the release time of a focal game to the total software sales at the end of the platform's life cycle. As individual platforms have different lifespans, this measure standardizes platform maturity and shows how the composition of a platform changes over time.

Control Variables

Major factors that affect the performance of a video game include a game's platform, genre, year and month of release, and critic score (Cox, 2014; Rietveld & Eggers, 2018). In addition to accounting for these factors, our dataset helps us eliminate the effects of some other unobservable factors to pinpoint a more precise effects of governance mode on product performance in platform ecosystems. In particular, we created two additional sets of control variables based on company and game-specific factors. The company-related control variables include publisher age, developer size, publisher and developer average performance. On the other hand, the game-specific control variables encompass critic score, multiplayer capability, stereoscopic features, sequel status, multihome compatibility, and graphic quality. A detailed description and the source of these control variables are provided in Table 1.

[Insert TABLES 1 about here]

Analysis

To identify the optimal method to analyze our data, we have respectively taken the following steps. First, we estimated ordinary least square regressions to test our hypotheses. We removed multicollinear variables from our models by checking variance inflation factors (VIF). Next, we performed a Breusch-Pagan (1979) test to detect heteroscedasticity, which indicated its presence (χ^2 = 73.22, p = 0.000). To address this issue, we employed robust standard errors in our estimations. Additionally, to mitigate potential omitted variable bias in our results, we introduced fixed effects for genre, year, and month to account for any omitted variable related to the popularity of specific genres or seasonal heterogeneity. Furthermore, we conducted the Durbin-Wu-Hausman test (Durbin, 1954; Greene, 2003; Hausman, 1978; Wu, 1973) to formally examine endogeneity in our estimations. The test results rejected the presence of endogeneity in the data (Durbin-Wu-Hausman χ^2 = 2,31, p = 0.1282; Wu-Hausman F value = 2.30, p = 0.1290). Based on these test results, we report ordinary least square regression estimations of results. Considering the observational nature of our data, we refrain from claiming causality. However, through supplementary analyses like the impact threshold of a confounding variable (ITCV) (Frank, 2000; Busenbark, Yoon, Gemache, & Withers, 2022) and propensity score matching (PSM), we have confidence in our results and can minimize the effects of any unobserved heterogeneity that may bias our findings.

RESULTS

Table 2 presents descriptive statistics and correlation matrix. The dependent variable, representing game unit-sales, has a mean of 0.527 million units, ranging from 0.01 to 82.86

million units. Of games in our sample, 8% are developed by an alliance between platform owners and complementor firms, 57% are developed by an alliance among complementor firms, 3% are developed by vertical integration of the platform owners, and 32% are developed by vertical integration of a complementor firm. While an average game is published on 48% diffused platform, the average critic score for games in our sample is 68.43. Furthermore, 55% of the games in our sample are multiplayer, and an average game is available on 2.1 different platforms (multi-home). Miscellaneous (16.74%) and sports (13.84%) are the two most frequent genres; and Nintendo DS (13.55%) and Sony PS2 (13.25%) are the most frequent platforms.

[Insert TABLES 2 & 3 about here]

Table 3 presents the main estimations from our study. In the base model, we find a negative association between platform diffusion (β= -0.5594, $p< 0.001$) and product performance, which aligns with existing literature (Rietveld & Eggers, 2018). Furthermore, the base model reveals positive relationships between product performance and the average past performances of both publishers (β= 0.6262, $p< 0.001$) and developers (β= 0.3104, $p< 0.001$). These results are not only intuitive but also account for any unobservable characteristics of publisher and developer companies that could potentially bias our findings. Moreover, the base model also indicates that multiplayer, stereoscopic, and multihoming games are positively associated with product performance. Given these intuitive and consistent findings in our base model, we formally test our hypotheses in the subsequent models.

The effects of alliance governance mode on product performance – Hypothesis 1

Hypothesis 1 explores the effects of alliance governance mode on product performance. We proposed that alliances would show a more positive association with product performance

compared to integrations between firms. This is because platforms tend to diminish the transaction-cost advantages of vertical integrations while preserving, or even enhancing, the benefits of alliances. We test this hypothesis in Model 1 of Table 3. The results in the table demonstrate that, in contrast to vertical integrations, alliances ($\beta = 0.2857$, $p < 0.001$) within platforms exhibit a significant and positive relationship with product performance. The exponential value of the coefficient reveals that a game developed and published under the alliance governance mode achieves approximately 33.06% higher unit sales than a game produced under the vertical integration governance mode. In economic terms, for every 100K unit sales of a game developed and published through vertical integration, a game developed and published by an alliance mode sells nearly 133,060 units. Assuming most new games are priced at $59.99, this difference results in a revenue gap of nearly 2 million USD for games produced under different governance modes.[4] Consequently, these findings provide substantial support for hypothesis 1, confirming that alliances have a more positive impact on product performance within the platform ecosystem compared to vertical integrations.

The effects of alliance with an owner on product performance – Hypothesis 2

Hypothesis 2 investigates the association between alliances with an owner and product performance, compared to alliances among complementors. We posited that alliances with an owner would be more likely to have a positive impact on product performance due to the owner's ability to implicitly endorse the alliance's output, offer valuable insights and technical guidance, and leverage its power within the ecosystem to maximize its own profits. Model 2 in Table 3 reveal that, in comparison to alliances among complementors, alliances with an owner ($\beta = 0.3806$, $p <$

[4] Please see: https://www.ranker.com/list/why-are-video-games-60-dollars/jordan-breeding

0.001) show a significant and positive correlation with product performance. By analyzing the exponential value of the coefficient, we find that a game developed and published under an alliance with an owner achieves approximately 46.32% higher unit sales than a game produced under an alliance among complementors. In economic terms, for every 100K unit sales of a game developed and published through an alliance with an owner, there is an estimated revenue difference of 2.78 million USD. This substantial gap reinforces hypothesis 2, providing strong support for the notion that alliances with an owner have a more positive impact on product performance than alliances among complementors.

The diminishing positive effects of alliances on product performance as platform matures – Hypothesis 3

Hypothesis 3 proposes that as a platform matures, the product performance advantages of alliances over vertical integrations diminish. This is attributed to firms becoming more proficient at internalizing prior synergies with alliance partners through integrations in mature platforms. Model 3 in Table 3 is designed to test this hypothesis. The results from the model indicate that the interaction effect of alliances and platform diffusion (β= -0.0457, p. 0.463) no longer demonstrates a positive impact of alliances on product performance. While this hypothesis is not supported, the negative and insignificant coefficient suggests a diminishing positive influence of alliances on product performance in more mature platforms. Despite not achieving statistical significance, the coefficient's negative trend implies that as the platform matures, the advantage of alliances over vertical integrations tends to lessen.

The diminishing positive effects of alliances with an owner on product performance as platform matures – Hypothesis 4

Hypothesis 4 posited that as a platform matures, the product performance advantages of owner-complementor alliances over complementor-only alliances diminish. This is due to the shifts in strategic incentives and intentions among platform participants as the platform matures. To test this hypothesis, we used Model 4 in Table 3. The results from the model reveal a positive and significant effect of alliances with an owner (β= 0.5131, $p<0.001$) and a negative and significant interaction effect of alliances with an owner and platform diffusion (β= -0.3526, $p<0.01$). These findings strongly support Hypothesis 4. They indicate that as the platform matures, the positive impact of alliances with an owner on product performance remains significant, but the advantage diminishes, possibly due to changes in the strategic dynamics of platform participants over time.

Supplemental Analyses

To ensure the robustness of our findings and to pinpoint the precise effects of governance modes on product performance, we conducted several supplemental analyses.

Inclusion of dummy variables for each governance mode.

Although alliances may offer advantages within platform ecosystems, their individual effects relative to other governance modes are likely to differ. To identify a more precise effect of alliances on product performance, we created four dummy variables for each governance mode, taking alliance among complementors and alliance with an owner as the reference groups. This allowed us to examine the individual effects of other governance modes relative to these reference categories. Model 5 in Table 3 demonstrates that, compared to alliances among complementors (the reference category), vertical integrations of complementors (β= -0.2584, $p<0.001$) and vertical integrations of owners (β= -0.206, $p<0.001$) are negatively associated with product performance. In contrast, alliances with an owner (β= 0.3192, $p<0.001$) are positively

associated with product performance relative to alliances among complementors. These results indicate that alliances, in general, are positively associated with product performance in platforms, and among alliances, alliances with an owner are particularly advantageous. Therefore, this model provides support for both hypotheses 1 and 2. Moreover, Model 6 in the table presents similar results. Relative to alliances with an owner, the other governance modes - alliances among complementors (β= -0.3192, $p<0.001$), vertical integrations of complementors (β= -0.5776, $p<0.001$) and vertical integrations of owners (β= -0.5252, $p<0.001$) – are negatively and significantly related to product performance. These findings further reinforce hypotheses 1 and 2.

Models 7 and 8 in Table 3 introduce the interaction effects of platform diffusion with each respective governance mode. Analyzing Model 7, we observe that the interaction effect of platform diffusion and alliances with an owner (β= -0.3322, $p<0.001$) is statistically significant when compared to the interaction effect of platform diffusion and alliances among complementors. However, the interaction effects of platform diffusion with both vertical integrations among complementors (β= -0.0489, p. 0.451) and vertical integrations of owners (β= 0.2057, p. 0.271) are not statistically significant. These findings provide support only for hypothesis 4, suggesting that as the platform matures, the product performance advantages of owner-complementor alliances over complementor-only alliances diminish. Conversely, examining Model 8 in Table 3, we find that relative to the interaction effect of platform diffusion and alliances with an owner, the interaction effects of platform diffusion with other governance modes - alliances among complementors (β= 0.3322, $p<0.01$), vertical integrations of complementors (β= 0.2834, $p<0.05$), and vertical integrations of an owner (β= 0.5379, $p<0.05$) –

are positively and significantly related to product performance. These results offer support for hypothesis 4 and partial support for hypothesis 3. They suggest that as platforms mature, the product performance advantages of owner-complementor alliances over other governance modes decrease. Visualization of these results in Figure 1 illustrates that as platforms mature, all four governance modes exhibit negative slopes, but alliances with an owner have the steepest negative slope relative to other governance modes.

[Insert FIGURE 1 about here]

Impact threshold of a compounding variable (ITCV).

In observational studies, special attention must be given to endogeneity resulting from omitted variables. Although the Durbin-Wu-Hausman test indicates no endogeneity in our data, we conducted the impact threshold of a compounding variable (ITCV) test to ensure the robustness of our results. The ITCV test provides insights into the relative strength of a potential omitted variable that could invalidate the findings (Frank, 2000; Busenbark, Yoon, Gemache, & Withers, 2022). Estimating ITCV scores for our models, we find that nearly 74.04% (12,332 game titles out of 16,656 games) of the estimate would have to be due to bias to invalidate the finding that alliances have a product performance advantage over vertical integrations in platform ecosystems. Additionally, nearly 73.17% (7,935 game titles out of 10,845 games) of the estimate would have to be due to bias to invalidate the finding that alliances with an owner have a product performance advantage over alliances among complementors. These two results strongly support Hypotheses 1 and 2. Moreover, our study consistently reveals the diminishing benefits of alliances with owners in mature platforms. The ITCV test indicates that at least 31.71% (3,439 game titles out of 10,845 games) of the estimate would have to be due to bias to invalidate the finding that

the product performance advantages of owner-complementor alliances over complementor-only alliances are diminished in mature platforms. This finding also provides strong support for Hypothesis 4.

[Insert TABLE 4 about here]

Propensity score matching (PSM).

Propensity score matching (PSM) is commonly employed in observational studies to create an artificial control group by matching treatment with control groups based on other available variables. Estimating PSM is valuable for scholars as it enables them to rule out potential endogeneity resulting from unobservable factors by comparing similar cases to each other. Table 4 presents the propensity scores for alliances (treatment) and vertical integrations (control group), as well as the propensity scores for alliances with an owner (treatment) and alliances among complementors (control group)[5]. The table demonstrates that even within a matched control group based on key variables, alliances in platforms have a positive and significant effect on product performance (ATT=0.173; $p<0.001$). Furthermore, the table indicates that among alliances, alliances with an owner show a positive product performance advantage over alliances among complementors (ATT=1.113; $p<0.001$). These results validate our main findings in the study.

DISCUSSION

Platform owners enter into complementors' markets for many reasons – for instance, to appropriate more value from their innovations, engender a "catfish effect" by stimulate

[5] We computed these scores with the radius (0.1 decile) matching method and bootstrapped standard errors based on the following variables: Plat. diffusion, Publisher age, Developer size, Pub. avg. perf, Dev. avg. perf, Pub genre exp., Critic score, Multiplayer, Stereoscopic, Sequel, Multihome.

improvement in a given product category, exercise better quality control, solve the "chicken-and-egg" problem, and expand the installed user base (Foerderer et al., 2018; Wen & Zhu, 2019; Zhu, 2019; Zhu & Liu, 2018). Given the importance of complementors for general health of platform ecosystems (Boudreau, 2010; Eisenmann et al., 2010; McIntyre & Srinivasan, 2017; Rochet & Tirole, 2006), platform specific mechanisms – the existence of "standards or base requirements," "loosely-coupled" modular organizational systems and "non-generic" complementarities – create mutual dependence between platform owners and complementors by binding them together and enabling them to act like a coherent whole (Jacobides et al., 2018; Kretschmer et al., 2022). As platforms mature over time, we suggest that mutual dependence between platform owners and complementors decrease.

Drawing upon recent contributions toward understanding ecosystems (Adner, 2017; Jacobides et al., 2018; Kretschmer et al., 2022) , we contribute to the literature by investigating the performance implications of alternative governance modes in platform ecosystems. While the existing studies mostly focus on the effects and implications of the platform owners' entrance on the general health of an ecosystem, installed user base, and complementor innovation (Foerderer et al., 2018; Wen & Zhu, 2019; Zhu, 2019; Zhu & Liu, 2018), we offer empirical evidence on the entry behaviors of platform owners into the complementors' zone and incorporate collaborative behaviors of platform participants into the existing framework. Building upon studies that investigate the abusive behaviors of platform owners in the complementors' zone (Beattie et al., 2021; Kim & Luca, 2019), we show how and when alliances and vertical integrations in platform ecosystems may be beneficial for platform participants. In particular, we find that alliances between platform owners and complementor firms, as well as alliances among complementor

firms, yield a higher product performance than vertical integration of platform owners and complementor firms do. Alliances between platform owners and complementors, on average, lead to the highest product level performance. The second highest performing behavior is alliances among complementors. Although we don't find any significant difference between vertical integration of complementors and that of platform owners, Figure 1 shows that vertical integration of complementor firms is usually more profitable than vertical integration of platform owners in older platforms. While performance of alliances between platform owners and complementors decreases with platform maturity, the interaction effects and visualization of predictive margins show that platform maturity increases the profitability of vertical integration behaviors. Regardless of platform maturity, games produced by alliances among complementors usually outperform games produced by vertical integration of complementors.

Recent research suggests that "ecosystems allow for some degree of coordination without requiring hierarchical governance" (Jacobides et al., 2018, p. 2263). We find that alliances between platform owners and complementors as well as alliances among complementors outperform vertical integration of these parties. However, our results also indicate that there may be some limits to the coordination benefits of "standards or base requirements" because platform maturity weakens the positive effects of alliances between platform owners and complementor firms on product performance. Thus, as mutual dependence decreases between platform owners and complementors on mature platforms, vertical integration behaviors of platform participants may become more beneficial.

Our study has several limitations. First, our results may not be generalizable to some other contexts. We believe the results can be generalizable to innovation and hybrid platforms

(Cusumano et al., 2019) and potentially to the pharmaceutical, movie, hardware, and software industries. However, we are still cautious about this proposition because some of these industries lack a platform providing firm who coordinate interactions and transactions with "standards or base requirements." Second, the cross-sectional data do not allow us to see how evolution of alliances affects the performance outcomes of products and may limit our ability to infer causality. Future research based on time series data can help us overcome these limitations. Third, the analysis still may suffer from availability bias as the study only focuses on products available on the Internet and is only able to perform the analyses for games that sold more than 10,000 units. Similarly, while we create a simulation to calculate the development costs of individual games, we don't have information about the actual cost. A future study may collect the actual project profit to measure product performance. Finally, our research context is based on non-equity contractual alliances. Similarly, we don't have acquisition data to compare vertical integration behaviors through acquisition to vertical integration through internal development. Future studies may replicate our study based on equity- or joint venture-based alliances and collect acquisition data to see the differences between vertical integration through acquisition versus that through internal development.

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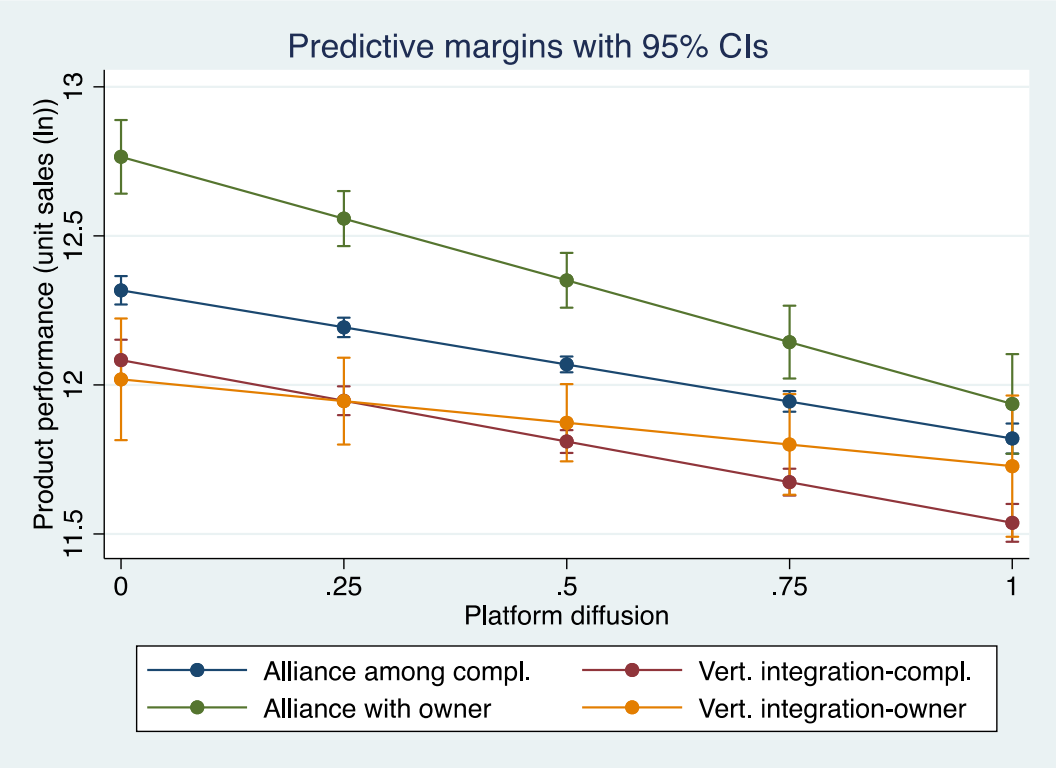
FIGURE

FIGURE 1: Predictive margins of product performance and platform diffusion based on alliance and integration governance modes.



TABLES

TABLE 1: Control variables (Source)

1. Relative alliance experience	The number of previous games the focal companies had with an alliance governance mode divided by the total number of games they had with both alliance and vertical integration modes. (VGChartz)
2. Common partners	The number of common partners developer and publisher companies have. (VGChartz)
3. Critic score	Professional game critics' evaluation based on a scale from 0 to 100. 8,961 missing observations were filled with platform-year averages. (VGChartz – Metacritic)
4. Developer age	Game release year minus developer's foundation year. (Mobygames – Google Search)
5. Developer average perf.	Average performance of previous games developed by the same developer. (VGChartz)
6. Developer genre exp.	The number of games developed by the developer in the same genre. (VGChartz)
7. Developer size	The total number of games developed and published by the developer company. (VGChartz)
8. Developer unique partner (#)	This variable refers to the number of unique partners a developer has. (VGChartz)
9. Hardware LTW sale	Total number of hardware units sold in a platform's lifespan until the game release week. It is divided by 100,000 for ease of representation. (VGChartz)
10. Multihome	The number of platforms that have a game with the same title. (VGChartz)
11. Multiplayer	Coded "1" if the game is a multiplayer game "0" otherwise. (Metacritic - Google Search)
12. Multirelease (y/n)	Coded "1" if the game is released with other games on the same date and "0" otherwise. (VGChartz)
13. No alliance	This variable is coded "1" if the focal companies had only produced games with a vertical integration mode before game release date and "0" otherwise. (VGChartz)
14. No integration	This variable is coded "1" if the focal companies had only produced games with an alliance mode before game release date and "0" otherwise. (VGChartz)
15. Only Partner	This variable is coded as "1" if either the developer or the publisher is the only partner of the other firm. (VGChartz)
16. Plat. unique dev. #	The number of unique developers a platform has. (VGChartz)
17. Publisher age	Game release year minus publisher's foundation year. (Mobygames – Google Search)
18. Publisher average perf.	Average performance of previous games published by the same publisher. (VGChartz)
19. Publisher genre exp.	The number of games published by the publisher in the same genre. (VGChartz)
20. Publisher size	The total number of games developed and published by the publisher company. (VGChartz)
21. Publisher unique partner (#)	The number of unique partners a publisher company has. (VGChartz)
22. Recurrent partnership (y/n)	This variable is coded "1" if the focal game is developed and published by a recurrent partnership of the companies and "0" otherwise. (VGChartz)
23. Same country plat. owner	Coded "1" if the platform company, publisher, and developer are from the same country, and "0" otherwise. (Google Search)
24. Sequel	Coded "1" if a game is a part of a sequel and "0" otherwise (VGChartz – Giantbomb – Mobygames – Google Search)
25. Software LTW sale	Total number of software units sold in a platform's lifespan until the game release week. It is divided by 100,000 for ease of representation. (VGChartz)
26. Stereoscopic	Coded "1" if the game is a stereoscopic game "0" otherwise. (Metacritic - Google Search)
27. Graphic quality	Coded "1" for low quality, "2" for decent, and "3" for high. (Explained with the dependent variable) (Amazon AWS review dataset)
28. Game release month	Dummy variables for game release months. (VGChartz)
29. Game release year	Dummy variables for game release years. (VGChartz)
30. Platform dummies	Dummy variables for 38 major gaming platforms such as Game Cube (GC), PC, Xbox, or PlayStation. (VGChartz)
31. Genre dummies	Dummy variables for 16 major gaming genres such as action, sports, simulation, fighting, or racing. (VGChartz)

TABLE 2. Means, standard deviations, and correlations.

Variables	**Mean**	S.D.	Min.	Max.	1	2	3	4	5	6	7	8	9	10
1. Game unit sales (ln)	12.02	1.5	9.21	18.23	1									
2. Alliance	0.65	0.48	0	1	0.055	1								
3. Alliance with owner	0.08	0.27	0	1	0.206	0.219	1							
4. Plat. diffusion	0.48	0.3	0	1	-0.146	-0.062	-0.07	1						
5. Publisher age	32.22	24.79	0	128	0.221	-0.032	0.541	-0.028	1					
6. Developer size	179.97	320.55	0	1523.5	0.09	-0.616	-0.104	0.022	0.239	1				
7. Pub. avg. perf	0.53	0.6	0	4.94	0.425	0.012	0.476	-0.065	0.62	0.08	1			
8. Dev. avg. perf	0.5	0.8	0	13.37	0.392	-0.08	0.218	-0.031	0.36	0.124	0.537	1		
9. Pub genre exp.	68.88	81.69	1	770	0.198	-0.208	0.06	0.027	0.348	0.516	0.155	0.14	1	
10. Critic score	68.43	10.44	13	98	0.258	-0.103	0.125	0.066	0.129	0.087	0.179	0.179	0.116	1
11. Multiplayer	0.55	0.5	0	1	0.277	0.051	0.018	-0.12	0.035	0.054	0.112	0.131	0.122	0.062
12. Stereoscopic	0.1	0.3	0	1	0.155	0.062	0.051	-0.052	0.05	-0.02	0.078	0.089	0.019	0.093
13. Sequel	0.89	0.31	0	1	0.237	0.051	-0.031	-0.004	-0.008	0.007	0.06	0.065	0.079	0.082
14. Multihome	2.1	1.56	0	9	0.256	0.056	-0.169	0.012	-0.142	0.05	-0.003	0.04	0.148	0.054
15. Graphic quality	2.25	0.52	1	3	0.101	0.027	0.097	-0.05	0.083	0.014	0.074	0.051	-0.005	0.033
16. Month	7.36	3.45	1	12	0.101	0.012	-0.002	-0.018	-0.032	0.012	0.009	0.038	0.013	-0.036
17. Year	2007.21	5.49	1989	2017	-0.156	-0.057	-0.108	0.225	0.054	0.18	-0.197	-0.069	0.237	-0.051

Note: Mean and S.D. values are based on unstandardized variables. N = 16656.

TABLE 2. Means, standard deviations, and correlations (*Cont'd*).

Variables	**Mean**	S.D.	Min.	Max.	11	12	13	14	15	16	17
11. Multiplayer	0.55	0.5	0	1	1						
12. Stereoscopic	0.1	0.3	0	1	0.072	1					
13. Sequel	0.89	0.31	0	1	0.187	0.058	1				
14. Multihome	2.1	1.56	0	9	0.326	0.1	0.241	1			
15. Graphic quality	2.25	0.52	1	3	0.012	-0.005	0.073	-0.123	1		
16. Month	7.36	3.45	1	12	0.037	0.008	0.052	0.101	0	1	
17. Year	2007.21	5.49	1989	2017	-0.035	-0.055	-0.025	0.214	-0.086	-0.018	1

Note: Mean and S.D. values are based on unstandardized variables. *N* = 16656.

TABLE 3. Results of ordinary least square regression – effect of governance mode on product performance

DV: game unitsale (ln)	BASE	MODEL 1	MODEL 2	MODEL 3	MODEL 4
Alliance		0.2857 [0.025] (0)		0.3083 [0.041] (0)	
Alliance with owner			0.3806 [0.053] (0)		0.5131 [0.07] (0)
Alliance # Plat. diffusion				-0.0457 [0.062] (0.463)	
Alliance with owner # Plat. diffusion					-0.3526 [0.123] (0.004)
Plat. diffusion	-0.5594 [0.034] (0)	-0.5438 [0.034] (0)	-0.511 [0.042] (0)	-0.5146 [0.053] (0)	-0.4681 [0.044] (0)
Publisher age	-0.0016 [0.001] (0.004)	-0.0022 [0.001] (0)	-0.0042 [0.001] (0)	-0.0022 [0.001] (0)	-0.0041 [0.001] (0)
Developer size	0.00001 [0] (0.803)	0.0003 [0] (0)	0.0001 [0] (0.375)	0.0003 [0] (0)	0.0001 [0] (0.386)
Pub. avg. perf	0.6262 [0.025] (0)	0.6218 [0.025] (0)	0.5806 [0.028] (0)	0.622 [0.025] (0)	0.5863 [0.028] (0)
Dev. avg. perf	0.3104 [0.019] (0)	0.3223 [0.019] (0)	0.3343 [0.023] (0)	0.3227 [0.019] (0)	0.3375 [0.023] (0)
Pub genre exp.	0.002 [0] (0)	0.0018 [0] (0)	0.0024 [0] (0)	0.0018 [0] (0)	0.0024 [0] (0)
Critic score	0.0221 [0.001] (0)	0.0229 [0.001] (0)	0.0193 [0.001] (0)	0.0229 [0.001] (0)	0.0193 [0.001] (0)
Multiplayer	0.2739 [0.022] (0)	0.2676 [0.022] (0)	0.2513 [0.026] (0)	0.2673 [0.022] (0)	0.2525 [0.026] (0)
Stereoscopic	0.2359 [0.031] (0)	0.2226 [0.031] (0)	0.1865 [0.036] (0)	0.2229 [0.031] (0)	0.1865 [0.035] (0)
Sequel	0.52 [0.03] (0)	0.5108 [0.029] (0)	0.531 [0.037] (0)	0.5109 [0.029] (0)	0.5343 [0.037] (0)
Multihome	0.1827 [0.007] (0)	0.1768 [0.007] (0)	0.1667 [0.008] (0)	0.177 [0.007] (0)	0.166 [0.008] (0)
Graphic quality (decent)	0.0362 [0.047] (0.438)	0.0464 [0.046] (0.319)	0.0189 [0.05] (0.707)	0.0462 [0.046] (0.32)	0.0189 [0.05] (0.707)
Graphic quality (high)	0.2634 [0.049] (0)	0.2617 [0.048] (0)	0.1725 [0.053] (0.001)	0.2615 [0.048] (0)	0.1722 [0.053] (0.001)
Genre	Y	Y	Y	Y	Y
Month	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Constant	10.4842 [0.56] (0)	10.4033 [0.548] (0)	11.3625 [0.944] (0)	10.3915 [0.548] (0)	11.1805 [0.95] (0)
Number of obs.	16656	16656	10845	16656	10845
Prob > F	0	0	0	0	0
R-squared	0.41661	0.42117	0.38652	0.42119	0.38708
F-test	186.92473	188.36702	548.82	185.8081	550.23

Note: Table respectively reports coefficients, [robust standard errors], and (p-values).

TABLE 3. Results of ordinary least square regression – effect of governance mode on product performance – robustness check (cont'd)

DV: game unitsale (ln)	Model 5	Model 6	Model 7	Model 8
Alliance among compl.	REFERENCE	-0.3192 [0.048] (0)	REFERENCE	-0.4481 [0.067] (0)
VI compl.	-0.2584 [0.026] (0)	-0.5776 [0.053] (0)	-0.234 [0.043] (0)	-0.682 [0.074] (0)
Alliance with owner	0.3192 [0.048] (0)	REFERENCE	0.4481 [0.067] (0)	
VI Owner	-0.206 [0.07] (0.003)	-0.5252 [0.073] (0)	-0.2986 [0.108] (0.006)	-0.7467 [0.117] (0)
Alliance among compl. # Plat. diffusion			REFERENCE	0.3322 [0.122] (0.007)
VI compl. # Plat. diffusion			-0.0489 [0.065] (0.451)	0.2834 [0.128] (0.026)
Alliance with owner # Plat. diffusion			-0.3322 [0.122] (0.007)	
VI Owner # Plat. diffusion			0.2057 [0.187] (0.271)	0.5379 [0.215] (0.012)
Plat. diffusion	-0.5325 [0.034] (0)	-0.5325 [0.034] (0)	-0.4969 [0.042] (0)	-0.8291 [0.117] (0)
Publisher age	-0.0038 [0.001] (0)	-0.0038 [0.001] (0)	-0.0037 [0.001] (0)	-0.0037 [0.001] (0)
Developer size	0.0003 [0] (0)	0.0003 [0] (0)	0.0003 [0] (0)	0.0003 [0] (0)
Pub. avg. perf	0.5867 [0.026] (0)	0.5867 [0.026] (0)	0.59 [0.026] (0)	0.59 [0.026] (0)
Dev. avg. perf	0.325 [0.02] (0)	0.325 [0.02] (0)	0.3271 [0.019] (0)	0.3271 [0.019] (0)
Pub genre exp.	0.0019 [0] (0)	0.0019 [0] (0)	0.0019 [0] (0)	0.0019 [0] (0)
Critic score	0.0223 [0.001] (0)	0.0223 [0.001] (0)	0.0223 [0.001] (0)	0.0223 [0.001] (0)
Multiplayer	0.2645 [0.022] (0)	0.2645 [0.022] (0)	0.2651 [0.022] (0)	0.2651 [0.022] (0)
Stereoscopic	0.223 [0.031] (0)	0.223 [0.031] (0)	0.2235 [0.031] (0)	0.2235 [0.031] (0)
Sequel	0.5198 [0.029] (0)	0.5198 [0.029] (0)	0.5204 [0.029] (0)	0.5204 [0.029] (0)
Multihome	0.1827 [0.007] (0)	0.1827 [0.007] (0)	0.1823 [0.007] (0)	0.1823 [0.007] (0)
Graphic quality (decent)	0.045 [0.046] (0.332)	0.045 [0.046] (0.332)	0.0468 [0.046] (0.313)	0.0468 [0.046] (0.313)
Graphic quality (high)	0.2543 [0.048] (0)	0.2543 [0.048] (0)	0.2556 [0.048] (0)	0.2556 [0.048] (0)
Genre	Y	Y	Y	Y
Month	Y	Y	Y	Y
Year	Y	Y	Y	Y
Constant	10.792 [0.529] (0)	11.1112 [0.534] (0)	10.7508 [0.524] (0)	11.1989 [0.528] (0)
Number of obs.	16656	16656	16656	16656
Prob > F	0	0	0	0
R-squared	0.42303	0.42303	0.42341	0.42341
F-test	184.75568	184.75568	178.09175	178.09175

Note: Table respectively reports coefficients, [robust standard errors], and (p-values).

Table 4. Propensity Score Matching for alliances and vertical integrations with the radius (0.1 decile) matching method with bootstrapped standard errors.

Alliance	**Vertical Integration**				
N. treat	N. control	ATT	Std. Err.	t	p value
10845	5811	0.173	0.023	7.670	0

Note: Treatment and control groups are matched for the following variables: Plat. diffusion, Publisher age, Developer size, Pub. avg. perf, Dev. avg. perf, Pub genre exp., Critic score, Multiplayer, Stereoscopic, Sequel, Multihome

Table 4. Propensity Score Matching for alliance with owner and alliance among complementors with the radius (0.1 decile) matching method with bootstrapped standard errors (Cont'd).

Alliance with owner	**Alliance among complementors**				
N. treat	N. control	ATT	Std. Err.	t	p value
1364	9481	1.113	0.031	36.272	0

Note: Treatment and control groups are matched for the following variables: Plat. diffusion, Publisher age, Developer size, Pub. avg. perf, Dev. avg. perf, Pub genre exp., Critic score, Multiplayer, Stereoscopic, Sequel, Multihome