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Strategic Responses to Innovation Shocks: Evidence from the Video Game Industry

Abstract

A major concern of the strategy and innovation literatures on platforms has been how complementors are affected by, and respond to, innovations in platform characteristics. We contribute to this research by examining how complementors choose their homing strategies in response to a platform innovation shock. We theorize that comparative adjustment and opportunity costs can predict these choices, and test our predictions using data on complementor responses to the introduction of Generation 6 videogame consoles. Consistent with our predictions, we find that complementors' choices of whether to develop games for a single console, multiple consoles sequentially, or multiple consoles simultaneously depend on proxies for their comparative adjustment and opportunity costs of adopting each of these strategies.

Keywords: Platforms, homing decisions, adjustment costs, opportunity costs, innovation shocks, adaptation.

INTRODUCTION

A central concern in the strategy literature on platform ecosystems is how strategic interactions between platform owners and their complementors affect the financial performance of ecosystem participants (e.g., Hagiu 2014; Chen et al. 2022a; Agarwal and Kapoor 2023). A major branch of this literature studies how complementors are affected by, and respond to, major innovations in platform characteristics introduced by platform owners (Venkatraman and Lee 2004; Kapoor and Agarwal 2017; Rietveld and Eggers 2018; Ozalp et al. 2023). The kinds of complementor responses studied to date include entry/exit (Pierce 2009; Saadatmand et al. 2019; Chung et al. 2024); complement launch timing (Rietveld and Eggers 2018); and efforts at innovation (Wen and Zhu 2019).

With a few exceptions, however, this literature has paid relatively little attention to the ways in which shocks to platform characteristics affect complementors' homing strategies: the decision to produce a complementary product for a single platform, or for multiple platforms ("multihoming").[2] This gap is important because: (1) innovation shocks represent inflection points in which the survival of many firms is put into question (e.g, Tushman and Anderson 1986; Henderson and Clark 1990); and (2) homing strategies often determine how platform owners and their complementors perform financially (Corts and Lederman 2009; Landsman and Stremersh 2011; Cennamo et al. 2018; Belleflamme & Peitz 2019; Li & Zhu 2021; Chen et al. 2022b). For example multihoming can be beneficial for some complementors and platform owners, but not for others (e.g., Lee 2013).

[2] Our review of 41 studies of homing strategies in the fields of strategy, economics, marketing, and information systems reveals only three in which homing strategy choices occured during technological transitions: Corts and Lederman (2009), Ozalp et al. (2018) and Srinivasan and Venkatraman (2018). We discuss these studies below. See the Appendix 2 describing the reviewed studies.

We help to fill this gap in the literature by studying how complementors' homing strategies are influenced by the comparative adjustment and opportunity costs they face following a shock to platform characteristics (Argyres et al. 2015; Argyres et al. 2019; Bigelow et al. 2019).[3] When such a shock occurs, complementors lack the time needed to make investments to lower their adjustment and/or opportunity costs to respond to it. Such costs may therefore become important in constraining or enabling complementors' response strategies. While some platform transitions occur with enough advance notice, technological understanding, and predictable demand so as not to come as a shock (Kapoor and Agarwal 2017), others are less foreseeable. We therefore define an innovation shock in this setting as a change whose precise timing, popularity, and technological characteristics complementors cannot fully anticipate.

The shock that we study was initiated by the introduction of Sony's Playstation 2 console in the video game industry in 2000, and continued with major innovations in competing platforms soon thereafter. The comparative adjustment costs were the costs to a complementor – in this case a game developer – from acquiring and developing the knowledge, assets, and capabilities required to adopt a given homing strategy, relative to rival firms' costs of doing so. For instance, a game developer specializing in PC games may face lower adjustment costs to adopt multihoming because doing so leverages similar programming languages. Comparative opportunity costs involve the foregone revenue associated with adopting a given homing strategy. For example, certain types of video games benefit much less from multihoming.

[3] Comparative adjustment and opportunity costs have been shown to be important in affecting strategic responses by automobile and bicycle firms in response to innovation shocks in those industries (Argyres et al. 2015; Bigelow et al. 2019). In such traditional manufacturing industries, however, the main concern is how incumbents who are rivals respond to shocks. In platform ecosystems, on the other hand, such costs become relevant for strategic responses made by complementors, as well as by rivals (Argyres et al. 2023).

We find that game developers were more likely to adopt a homing strategy for which they likely incurred low comparative adjustment and opportunity costs. Our measures of comparative adjustment costs are based on three different indicators of the fungibility of development capability across platforms post-shock: (1) the developer's breadth of experience in programming for various specific platforms; (2) its depth of experience from developing games for personal computers (PCs), and (3) the depth of its experience from console-specific game development. Opportunity costs are proxied by the game types that developers produced. While these measures are specific to the videogame context, they are suggestive of how such costs can be measured in other industry contexts by observing platform and product market choices. Our study therefore contributes to the literature by demonstrating an important role for comparative adjustment and opportunity costs in determining complementors' heterogeneous homing strategy choices in response to an innovation shock at the platform level.

Our study also contributes by exploring potentially distinctive determinants of simultaneous and sequential multihoming. The former involves producing a new product that is immediately available for multiple platforms, while the latter involves adapting an existing product so as to be compatible with an additional platform. The literature has studied sequential homing almost exclusively, even though simultaneous homing is important in many platform ecosystems (Chen et al. 2022b). Understanding the mechanisms driving each is therefore important for a more complete picture of homing strategy choice. For example, we contend that opportunity costs that arise from certain kinds of economies of scale and scope favor simultaneous over sequential multihoming, and find evidence consistent with this contention.

The remainder of the paper is organized as follows. We first provide theoretical background and grounding of our comparative adjustment and opportunity cost concepts as drivers of strategic responses to innovation shocks, as well as a literature review on the determinants of homing strategies in particular. The next section describes the videogame industry context, and is followed by an hypothesis development section. We then describe our data, estimation methods and empirical analyses, and offer a concluding discussion.

CONCEPTUAL BACKGROUND

Comparative adjustment and opportunity costs

Research in economics, organization theory, and strategy has long recognized that major changes to a firm's business in response to new competition are limited by various frictions. Macroeconomists highlighted the frictions involved in reallocating capital and labor to change output levels (e.g., Lucas 1967). Nelson and Winter (1982) emphasized organizational routines as creating organizational inertia, while Hannan and Freeman (1984) pointed to the firm's accountability to society as a source of such inertia. Porter (1985) highlighted the complexity of changing a firm's activity system to reposition successfully, while Henderson and Clark (1990) and Leonard-Barton (1992) emphasized other kinds of organizational rigidities. Dierickx and Cool (1989) introduced the notion of time compression diseconomies as a cause of delayed adjustment by firms, and contributions to transaction cost economics highlighted the role of contractual constraints and sunk costs in slowing firms' efforts to increase their efficiency (Argyres and Liebeskind 1999; Nickerson and Silverman 2003).

Strategy scholars have also emphasized, however, that some firms are able to overcome these frictions and rigidities, respond effectively to new opportunities and threats, and thrive. Such firms possess dynamic capabilities, enabling them to sense and seize opportunities and threats by reconfiguring their resources and capabilities (Teece et al. 1997; Helfat et al. 2007).

While the dynamic capabilities concept has captured the imaginations of many strategy scholars, operationalization has proven difficult (Arend and Bromiley 2009).

In part to address this challenge, several scholars maintain that measuring the frictions and rigidities to changing strategies is often easier than measuring firms' abilities to overcome them (Argyres et al. 2015; Argyres et al. 2019; Mahoney and Qian 2013). These authors argued that such frictions can be conceptualized as comparative adjustment and opportunity costs that limit firms' abilities to change strategy. Comparative adjustment costs are the costs incurred by a firm from changing its strategy relative to a rival's costs of adopting that same strategy.[4] Such costs include developing or acquiring the organizational capabilities and assets, including technological and marketing resources and capabilities, that are required to serve customers in the new position or otherwise adopt a strategy. These costs also include the cost of jettisoning capabilities no longer needed. Adjustment costs are lower if the firm possesses capabilities and resources that are relatively general and fungible, as opposed to market segment- or strategy-specific ones (Chatterjee and Wernerfelt 1991; Helfat and Lieberman 2002).

Opportunity costs arise when incumbents must decide whether to adopt a strategy following an environmental change. Adopting a new strategy quickly can cause an incumbent to forgo profits that would have been earned if this choice were delayed or avoided entirely. Alternatively, moving much later could result in ceding first-mover advantage to a faster-moving rival. An incumbent's opportunity costs of moving quickly or much later are determined by the

[4] The treatment in Argyres et al. (2019) conceptualizes "strategy" in terms of Porterian competitive positioning (Porter 1985). However, the logic applies to other dimensions of strategy, including homing strategy. Menon and Yao (2017) develop a game-theoretic treatment of competitive interactions that incorporates "repositioning costs", which are equivalent to "adjustment costs." They model two types of such costs, one based on distance-based repositioning and the other based on time and path dependency.

expected revenues less costs from the original strategy as compared to those from the new strategy.

Comparative adjustment and opportunity costs are largely determined by the kinds of capabilities the firm developed up to the time of the shock. Such costs loom particularly large during innovation shocks - fundamental changes in technology, market structure, or competitive dynamics that firms cannot fully anticipate or prepare for despite their industry experience. The unanticipated and substantial nature of these shocks means that firms' existing capabilities may suddenly become less valuable or require significant modification (Tushman and Anderson 1986). Therefore, the kinds of capabilities a firm developed in the past may constrain or enable a firm to respond to the shock in some ways and not others. Thus, when a new platform with significantly different technological characteristics is introduced and becomes popular, the ability and willingness of a complementor to respond in various ways will depend on the comparative adjustment and opportunity costs associated with each of its strategic options.

This theory based on comparative adjustment and opportunity costs, however, does not deny that other factors may also affect the nature and speed of a firm's response to a platform-based shock. Such factors might include firm aspirations, managers' risk appetites and cognitive biases, and the like. The theory merely postulates that comparative adjustment and opportunity costs are particularly important factors in conditioning such responses – important enough to be observable in the data.

Determinants of homing strategies

Platform homing strategies have attracted considerable attention in recent years due to their potential to shape competitive dynamics and the performances of platform owners and complementors (Cennamo et al. 2018; Belleflamme and Peitz 2019; Chen et al. 2022b;

Kapacinskaite and Mostajabi 2024; Polidoro and Yang 2024), including in the video game industry (e.g., Corts and Lederman 2009; Landsman and Stremersch 2011; Srinivasan and Venkatraman 2018). For example, the decision to multihome is often driven by complementors' desire to access a broader user base, achieve cross-platform economies of scope, and reduce dependency on a single platform (Wang and Miller 2020; Li and Zhu 2021; Chen et al. 2022b). On the other hand, multihoming usually requires complementors to adapt their offerings to the specific technological infrastructure and user expectations of each platform, which can involve significant costs and potential quality trade-offs (Cennamo et al. 2018).

Research has shown that the decision to multihome vs. single home is influenced by various factors, including platform characteristics, complementor capabilities, and competition. Thus, higher levels of ecosystem complexity and constraints on human capital availability can discourage multihoming due to increased adaptation costs (Venkataraman et al. 2018; Chen et al. 2022b). Conversely, complementors with more fungible resources and capabilities (often gained from experience) may find it easier to expand across platforms (Cennamo et al. 2018; Chen et al. 2022b; Kapacinskaite and Mostajabi 2024). Greater competition among complementors on the same platform may drive them to multihome to reduce that competition (Panico and Cennamo 2022).

Much of the literature on multihoming is focused on cases in which a complementor is currently producing a complement for one platform, and is considering producing that complement for an additional platform; i.e., "sequential multihoming". Less discussed in the literature is the case of simultaneous multhoming, in which a complementator makes a decision to multihome at a single point in time. Also less discussed in the literature is how firms make multihoming decisions following an innovation shock (see Appendix 2). In our hypothesis development section below, we combine the above findings about the determinants of multihoming with the theory of comparative adjustment and opportunity costs to predict how videogame developers make sequential and simultaneous homing decisions following an innovation shock. Before doing so, however, we describe the industry context for our study.

THE U.S. CONSOLE VIDEO GAME INDUSTRY: 2000-2005

The console video game industry is comprised of console owners, publishers, game developers, and middleware producers. Console owners (e.g., Sony, Microsoft, Nintendo) produce hardware and collect licensing fees from publishers, developers, and middleware producers. Developers design and program video games. Publishers provide services to developers, including managing their relationships with console owners, providing funding, and marketing and distributing games (Tschang 2007). Many publishers eventually acquire developers or otherwise launch their own inhouse development studio. Middleware producers sell tools and middleware that assist videogame developers with game development. Some developers produce their own middeware.

The history of the console video game industry is marked by the periodic introduction of a new generation of consoles (Argyres et al. 2023). Table 1 presents the consoles and their key hardware characteristics. The table lists those consoles that had active game releases during our sample period.

INSERT TABLE 1 ABOUT HERE

Our study focuses on the period 2000 to 2005, in which Generation 6 consoles and games competed, but includes some games released for the fifth and seventh generation consoles. We chose this period because it captures activity just prior to, and several years after, Sony's introduction of its breakthrough PS2 console in October of 2000, and finishes just after the first seventh generation console, Xbox 360, was released in November 2005. We contend that the PS2 initiated an innovation shock in 2000 because: (1) when it would be released in the U.S. was uncertain; (2) it involved one of the most significant leaps in technology, and therefore game development cost, in the history of the industry; (3) it resulted in an unanticipated surge in demand for the console, leading it to become the highest-selling console ever; and (4) it was followed by the entry of a new console, Xbox, as well as PC developers, into the console market in 2001. We explain these reasons as follows.

Sony introduced the PS2 in Japan in March of 2000, but when it would be released in the U.S. was not announced until May of that year. The delay was in part due to the fact that consoles such as Sega Saturn that had sold well in Japan performed poorly in the U.S., in part because of export restrictions due to security concerns.[5] Even less anticipated was the demand surge for the PS2 when it did arrive – a surge so large that it caused Sega to announce its discontinuation of the Dreamcast and its exit from the global hardware market. In addition, as explained below, Sony initially failed to anticipate that many developers would need middleware to ease their programming challenges. Finally, Microsoft announced that it would introduce its Xbox console in January 2001, but did not release it until November 2001. This delay caused more uncertainty for developers deciding for which console(s) to develop games. These factors together made it difficult for developers to quickly assemble the capabilities needed to program for the PS2 and other Generation 6 consoles.

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[5] Regarding the uncertainty of the US release see https://www.videogameschronicle.com/news/playstation-2-japan-launch/. The Japanese government initially imposed export restictons on the PS2 because of concern that its technology was so advanced that it could be used in North Korea's military programs (see: http://news.bbc.co.uk/2/hi/asia-pacific/716237.stm). The significance of the PS2's technological advance is also illustrated by the fact that it was used as a supercomputer by forming clusters through multitudes of PS2 (see: https://www.zdnet.com/article/your-next-supercomputer-playstation-2/).

Led by the PS2's technological advance, game development for Generation 6 consoles required much more effort, and hence substantially higher costs, than development for prior consoles. The complexity and novelty of the PS2's architecture was so significant that it triggered export controls due to its potential military applications. The architecture, for example, required programmers to invest in learning advanced graphics capabilities with faster processing speeds (Ozalp et al. 2018; Srinivasan and Venkatraman 2018). Even for experienced developers, this complexity and novelty required fundamentally modifying their development processes and capabilities. The technological changes led to multiplicative increases in the number of core team members (designers, producers, programmers, and artists) needed to develop a game for the console (Figure 1). The changes were particularly challenging because platform owners maintained secrecy around exact specifications and development requirements until release, making advance preparation especially difficult. As one developer explained regarding the PS2:

> *"The amount of time it took to develop a game was doubling. The amount of people it took was doubling. Hence the cost was going up about five times. And yet the cost of the software [for the consumers] was unchanged, if not descending. So the risk on each product was going up and the potential profit per person per year was going down.*[6]

INSERT FIGURE 1 ABOUT HERE

Following complaints by developers, and concerned that the greatly increased costs and risks would dissuade developers from developing games for the PS2, Sony introduced a "Tools and Middleware" program in 2001 aimed at reducing these costs. In the video game industry, middleware refers to an "abstraction" layer that functions between a console's operating system and the game program. Middleware facilitates game development by providing reusable modules and libraries that reduce coding requirements for game functions. Middleware also limits time-

[6]https://web.archive.org/web/20210824113321/https://www.gamasutra.com/view/feature/130449/the_end_game_how_top_developers_.php, accessed Dec 1, 2024.

consuming console-specific coding (e.g., in assembly language). Sony's program involved licensing independent software firms to develop middleware and development tools for the PS2 and sell them to game developers.

Later in the same year, Microsoft introduced its Xbox console, and followed up by launching its own middleware program. Nintendo, too, followed suit. Figure 2 displays the use of all middleware tools (game engines, minor middleware, and physics engines) for the period 1997-2005. The figure shows a dramatic rise in the use of middleware tools after 2001, which is evidence of the serious challenges faced by developers in producing games for Generation 6 consoles.

INSERT FIGURE 2 ABOUT HERE

For all of these reasons, we consider the introduction of the PS2 as precipitating a platform innovation shock. Following the shock, three alternative strategic choices for game developers became viable: single homing, sequential multihoming, and simultaneous multihoming (Corts and Lederman 2009). Single homing involves releasing games for one console only. Sequential multihoming involves releasing games for one (or more) videogame consoles and/or personal computers (PCs), and later releasing it for the other consoles or PCs. With simultaneous multihoming, games are released concurrently (or within a short time frame) for at least two platforms.

Beginning in 2001, simultaneous multihoming became advantageous for many game developers because of the potential to gain economies of scale and scope. The economies of scale stemmed mostly from reductions in per unit marketing, distribution, and advertising costs due to higher sales from multi-console releases. Such costs represented a large fraction of a typical game development budget.[7] For example, multiple releases of a game across consoles could be promoted with a single advertising campaign.[8] Economies of scope, on the other hand, accrued in the distribution of non-console-specific fixed game development costs (e.g., for artwork, cinematics, core game mechanics, story, and licensing fees) across multiple platforms, as well as modular development approaches that minimized code re-writing (Corts and Lederman 2009). Simultaneous multihoming therefore required a different approach to developing games (Wagner 2001).

Sequential multihoming, on the other hand, offers only some of the same economies of scope as simultaneous multihoming based on common arts, cinematics, mechanics, etc., because it usually involves rewriting or refactoring parts of the software code that are specific to a given console. Economies of scope for sequential multihoming are therefore usually fewer than what can accrue to simultaneous multihoming.

Economies of scale in advertising are also less important with a sequential multihoming strategy because most of the advertising for the version of a game for a new console must be duplicated (unless the initial release was so successful that word-of-mouth is significant). In addition, more retailer shelf space was required for sequential multihoming, which was costly during the 2000-2005 period (digital distribution was almost non-existent at the time). On the other hand, sequential multihoming and writing in console-specific code offers the important advantage of greater co-specialization to individual consoles, which can improve game performance.

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[7] In a 2009 interview, an Electronic Arts (EA) executive stated that: "EA now typically spends two or three times as much on marketing and advertising as it does on developing a game." http://venturebeat.com/2009/08/26/eas-chief-creative-officer-describes-game-industrys-re-engineering/.

[8] Such considerations of marketing, distribution, and advertising costs affected developers regardless of whether they were owned by a publisher or not, because even independent developers needed to coordinate their multihoming strategy with their publishers' marketing plans for a game title.

The emergence of the Generation 6 consoles had a profound effect on developer strategies. Figure 3 indicates that single homing decreased dramatically after its peak in 2000, whereas simultaneous multihoming increased dramatically in 2002 and onwards.[9] Sequential multihoming shows only a small decrease overall, with an increase between 2000-2002, and then a decrease in 2003 and onwards, reverting to slightly below its 2000 level.

INSERT FIGURE 3 ABOUT HERE

HYPOTHESIS DEVELOPMENT

Comparative adjustment costs

Developers' resources and capabilities are the main drivers of their comparative adjustment costs. Accessing these resources and capabilities through the strategic factor market, or developing them internally, usually requires significant time because software development talent is often in short supply, and because software development often involves a flatter learning curve and tacit knowledge, making it difficult to imitate or substitute for (Winter 1984; Dierckx and Cool 1989; Barney 1991; Argyres et al. 2019). Indeed, human capital availability has been found to constrain complementor homing strategies (Venkatraman, Ceccagnoli & Forman 2018).

Experience in developing different games for different consoles enables developers to learn about the distinctive features and requirements of each console (e.g., King and Tucci 2002; Eggers 2012). Knowledge of various consoles' technological idiosyncrasies leads to fungible capabilities -- capabilities that can be applied toward developing the same games for multiple platforms. Some developers with experience producing different games for different consoles

[9] With the release of Xbox and GameCube in November 2001, developers could simultaneously multihome across Generation 6 consoles. Prior to 2001, multihoming mostly involved homing across different console generations, or between PCs and a console. Relatively little simultaneous multihoming occurred in 2001 because it was infeasible for some developers to delay their game releases until the Generation 6 consoles had been introduced.

likely learned more quickly about the subtleties involved in porting games to new platforms, and were therefore in a better position to develop proprietary programming modules for multi-platform development (Srinivasan and Venkatraman, 2018; Chen et al. 2022b). Developers without experience in producing different games for different consoles might eventually move to multihoming, but because of higher adjustment costs, would have done so more slowly, potentially after our observation window closed. Therefore, we contend that developers who had successfully released products for multiple consoles prior to the innovation shock enjoyed lower adjustment costs for adopting simultaneous multihoming following the shock.

Previous experience in developing games for personal computers (PCs) also lowered adjustment costs to simultaneous multihoming. Producing games for a PC involves developing capabilities in computer languages such as C or C++ ("high-level languages"). Because these languages are console/platform-agnostic, they facilitate porting to multiple consoles. Developers with experience in PC games therefore enjoyed broader, more fungible capabilities. In contrast, developers without PC programming experience typically specialized in particular console architectures using assembly language that was specific to the CPU/architecture of a given console ("coding to the metal"). This experience therefore led to narrower but deeper programming capabilities. For these developers, shifting from programming in assembly code to programming in a console-agnostic language incurred comparatively substantial adjustment costs; namely, the costs associated with accessing the necessary but scarce human capital:

Hypothesis 1a: *Following the innovation shock, game titles produced by developers with experience in developing games for a broader variety of consoles were more likely to be simultaneously multihomed (rather than single homed) compared to titles produced by developers with narrower such experience.*

Hypothesis 1b: *Following the innovation shock, game titles produced by developers with more specialization in developing videogames for PCs were more likely to be simultaneously* *multihomed (rather than single homed) compared to titles produced by developers with less such experience.*

By the same logic, we can predict that developers with capabilities based on console-specific, assembly language programming were less likely to pursue multihoming following the innovation shock, and even if they did so, were more likely to pursue sequential rather than simultaneous multihoming. Such developers would have traded off the greater economies of scale and scope from multihoming for the ability to produce games – especially first-person shooter and action games – that featured the higher graphics fidelity and realism achievable with console specific and/or assembly-language programming. Adopting simultaneous multihoming would have entailed higher adjustment costs than rivals' costs because it would have required them to develop capabilities in higher-level programming languages. On the other hand, moving to sequential multihoming was more feasible for these developers; their comparative adjustment costs were lower because they did not need to develop higher-level language capabilities. Therefore, an alternative way of examing the importance of comparative adjustment costs is to empirically examine the following:

Hypothesis 2: *Following the innovation shock, developers that were more specialized in console-specific programming were less likely to release simultaneous multihoming game titles (and more likely to release single homing or sequential homing titles) than developers with less such specialization.* [10]

Opportunity Costs

The opportunity costs of single-homing versus multihoming also varied across developers. Licensed games, for example, face particularly high opportunity costs of single-homing. Such games exploit film tie-ins (e.g., Lord of the Rings), cartoon or comic characters (e.g., Batman), or sports leagues (e.g., FIFA). Licensed games incur high fixed costs from

[10] Srinivasan and Venkatraman (2018) find support for a similar hypothesis in video game industry data, although they did not distinguish between simultaneous and sequential homing.

license fees ranging from tens of thousands to millions of dollars.[11] The opportunity cost of not reaching a wider audience is particularly high for these games. Therefore, developers have particularly strong incentives to seek economies of scale in marketing and distribution by multihoming. In addition, the window of time in which licensed games can benefit from the popularity of a character is often short, which encourages faster multihoming. We thus predict that licensed games were less likely to be released as single homing titles because the high opportunity costs of doing so outweighed the adjustment costs of multihoming.

Hypothesis 3: *Following the innovation shock, licensed game titles were less likely to be released as single homing titles than were non-licensed titles.*

Specific types of games, on the other hand, faced lower opportunity costs of single-homing. These types include those based on stories, puzzles, music, or party games (e.g., Rock Band). Such games often enjoyed a highly devoted “cult-like” following, and did not necessarily feature or require the highest level of graphic fidelity or processing speed to make for a captivating game. Therefore, multihoming in response to a new, more technologically capable console was less beneficial, and therefore less urgent. These games stand in contrast to so-called “bleeding edge” games that relied heavily on high-level graphics capability and processing speed to make them as realistic as possible. Bleeding edge games take advantage of the most advanced console technology available. They include first-person shooter games, action games, and the like.

We therefore maintain that following the innovation shock, developers who were more specialized in developing game titles in “cult” genres would have faced the lowest opportunity costs of moving late because their games were not dependent on graphics properties, and their

[11] Wedbush Securities reported that the developer THQ paid an estimated $15 – 20 million guarantee when it produced Pixar titles, and an estimated $50 million annual guarantee for the NFL and Major League Baseball licenses.

customers were highly loyal. In addition, these developers faced opportunity costs from moving early because their customers might not immediately purchase a new console to access a game sequel (although they were able to do this later on) (Rietveld and Eggers 2018). Therefore, we predict that:

Hypothesis 4: *Following the innovation shock, developers who were more specialized in developing game titles in "cult" genres were more likely to release single homed titles.*

Note that while Hypotheses 1a and 1b compare single homing to simultaneous multihoming, Hypotheses 2, 3 and 4 compare single homing to both simultaneous and sequential multihoming. The reason for this asymmetry is that there are nuanced differences between the determinants of simultaneous and sequential homing. Thus, Hypotheses 1a and b imply that broader console and PC experience facilitated simultaneous multihoming, a particular homing choice that was relatively new to the industry beginning with Generation 6. On the other hand, Hypothesis 2 recognizes that console-specific programming specialization was likely to affect sequential and simultaneous multihoming strategies differently. In Hypotheses 3 and 4, the main theoretical distinction is between developing games for a single console versus multiple consoles, regardless of the timing of multi-console releases. In additional empirical analyses described below, we further explore nuances in the relationship between sequential and simultaneous multihoming strategies.

DATA AND METHODS

Our primary source of data is Mobygames.com, the most comprehensive encyclopedia of videogames that covers the full spectrum of games released since the advent of the industry (Mollick 2012; Miric et al. 2023). For each game title, the data provides information about its developer, publisher, consoles of release, release date (by consolde and country) and the use of middleware.

Our time period ends when Generation 7 consoles begin to be released in 2006, following the Xbox 360. We combined this data with proprietary data from NPD Research to create a final sample of commercially released games in the U.S. Our independent variables, however, which are based on experience and activity, are calculated by using developers' worldwide console and PC game releases to fully capture the history of these firms. In addition, we dropped games that were re-releases or compilations of previous releases since they did not involve (or minimally involved) game development activity. We also dropped titles produced by console owners themselves because homing strategies for these games were likely influenced by console ownership.

The data is structured at the unique title-developer level, with each row representing the first unique console release of a title (i.e., represented by one row whether it is released for a single or more consoles) by a developer.[12] If a game was not released for at least one console (i.e., a PC game only), then the observation was used to calculate our variables, but was not included in our final sample of 1,865 unique title observations by 629 developers.

Dependent variable

Our dependent variable, *Homing Strategy*, is measured at the unique title level, and takes the value of 1, 2, or 3, representing single homing, sequential multihoming, and simultaneous multihoming, respectively. A title is considered as simultaneously multihomed if it was released across two or more platforms (consoles and PCs) within 30 days. We chose this cutoff because a large share of multihomed games were not made immediately available for other platforms but

[12] During our observation window, 3% of games were developed by more than one developer. We coded only the primary developer for these games.

still benefited from economies of scope in cross-platform development and marketing (see Appendix 1 Figure A1). As a robustness check, we also ran our analysis with 0, 90, and 180 day cutoffs, with mostly similar results (see Appendix 1 Tables A2, A3, and A4).

A title is considered sequentially multihomed if it was released across two or more platforms with a separation of more than 30 days. If a title was neither simultaneously nor sequentially multihomed, then it was coded as a single-homed title. In our additional analyses below, we provide results from a sample of Generation 6 console homing strategies only. That is, we only consider Generation 6 titles, and determine simultaneous, sequential, and single homing based on within-Generation 6 releases of a given title, dropping all other versions of the title.

Independent variables

Our independent variables are as follows. *Breadth of Unique Consoles* is measured as the number of unique consoles (i.e., other than PCs), for which the developer released a title in the previous 5 years. *PC Specialization* is the number of titles released for a PC by the developer in the previous 5 years divided by the total number of unique titles released by the developer. *Console-Specific Programming Specialization* is the number of titles released as single or sequential homing console titles in the previous 5 years divided by the total number of unique titles released for consoles by the developer.[13] *Licensed Title* is a dummy variable that takes the value of one for games based on a movie or franchise license (e.g., *Harry Potter* or the NFL), and zero otherwise. *Cult Game Specialization* is measured as the number of titles released in the

[13] Note that *Breadth of Unique Consoles* can be high even with a developer that single-homes different games for different consoles. In addition, since a unique title can be developed both for a PC and then sequentially to a console (or vice versa), increases or decreases in *PC Specialization* and *Console-Specific Programming Specialization* are not mechanically related. This unrelatedness is also evident from the low correlation between these two variables (-0.06).

cult game genres (strategy, role-playing, adventure, family entertainment, children's entertainment, and arcade) by the developer in the previous 5 years, divided by the total number of unique titles released by the developer.

As noted above, game engine adoption is likely an important determinant of homing strategy. We therefore include the variable *Game Engine Use*: a dummy variable that takes value of 1 if the title used a licensed game engine, and zero otherwise. In Appendix 1, we instrument for *Game Engine Use* because it is likely endogenous. In additional analyses below, we further highlight the role of game engines for homing strategies.

Control variables

We controlled for numerous developer and game title characteristics that might affect homing strategy. *Bleeding Edge Game Specialization* is measured as the number of titles released in the bleeding-edge game genres (Action, Shooter, Extreme Sports, and Survival Horror) by the developer in the previous five years, divided by the total number of unique titles released by the developer. *Bleeding Edge* and *Cult* are dummy variables that control for the type of game, based on the genres provided above. *Physics Engine Use* and *Minor Middleware Use* are dummy variables that control for whether the title uses middleware such as video and sound compression modules. Recall that the use of middleware and game engines facilitated simultaneous mulihoming. *Sequel* is a dummy variable that controls for games that follow from previous (successful) games, therefore partially controlling for expected game popularity. *Inhouse* is a dummy that controls for whether the developer was owned by a publisher. Publishers provide additional resources to developers, which may affect their homing strategies. *Project Size* measures the number of people who worked on the title, divided by the average number of people who worked on console titles released in the same year. This indicator of a game's budget is the best that is publicly available. Where this information was unavailable, we coded the variable as one, and also coded a dummy variable, *Assumed Project Size* as one (Mitchell 1989). Dummy variables for each calendar year are included to control for the trend towards multihoming.

ESTIMATION AND RESULTS

We estimated a multinomial logit model of the likelihood that a developer adopted one of the three homing strategies for the focal game title: simultaneous multihoming (value=3), sequential multihoming (value=2), or single homing (value=1). For robustness, we also considered these choices as ordinally ranked both in terms of their difficulty and economic returns, and ran an ordered Probit regression.

Table 2 presents variable summary statistics and correlations. Table 3 provides results for the multinomial logit regressions. First, *Breadth of Unique Consoles* is associated with a higher probability of releasing a new title with simultaneous multihoming as compared to single homing (0.230, p = 0.000, average marginal effect (AME) = 0.028), although no such increase in probability is found for sequential homing (0.039, p = 0.379, AME = -0.007). This result is consistent with Hypothesis 1a. Coefficient estimates for *PC Specialization* indicate an increased probability of both sequential (1.980, p = 0.000, AME = 0.248) and simultaneous multihoming (1.535, p = 0.000, AME = 0.090) as compared to single homing. These results are also consistent with Hypothesis 1b. In the next section, we further explore this difference in results regarding sequential homing.

The coefficient estimate for *Console-Specific Programming Specialization* indicates a lower likelihood for the focal title to be simultaneously multihomed, as compared to single homing (-1.223, p = 0.000, AME = -0.145), with no significant difference between the likelihood of sequential multihoming over single homing (-0.275, p = 0.164, AME = 0.023). This result is consistent with Hypothesis 2. The coefficient for *Licensed Title* shows a higher likelihood for both simultaneous (1.256, p = 0.000) and sequential multihoming (0.447, p = 0.003), as compared to single homing (AME = -0.144). Thus, these coefficient estimates are consistent with Hypothesis 3.

The coefficient for *Cult Game Specialization* indicates a lower likelihood of both simultaneous (-0.712, p = 0.033) and sequential multihoming for those developers (-0.568, p = 0.020), as compared to single homing (AME = 0.027). These coefficient estimates are consistent with Hypothesis 4.

ADDITIONAL ANALYSES

Repositioning

As noted above, the theory of comparative adjustment and opportunity costs originally conceptualized changes in strategy in response to a shock in terms of Porterian positioning (Argyres et al. 2015; Argyres et al. 2019). In this section, we examine whether such costs indeed condition respositioning choices regarding homing strategies in our data. Conducting a meaningful econometric analysis of repositioning in our context is difficult for two reasons. First, homing strategies are most precisely measured at the game title level, whereas repositioning is a firm-level concept. Second, many developers exited or were acquired following the shock, leaving too few for an econometric analyis of repositioning. Therefore, we instead examine descriptive evidence of homing strategy switches at the developer level.

The top panel in Figure 4 shows developer switching from single homing to either sequential or simultaneous multihoming. The bottom panel shows developer switching from multihoming to single homing. The calculations underlying this graph are based on *Breadth of Unique Consoles*, *PC Specialization*, *Console-Specific Programming Specialization*, *Cult Game Specialization*, *Licensed Title* (calculated at the developer-year level), and *Game Engine Use* (calculated at the developer-year level). Homing strategies are defined at the developer-year level, with the highest percentage of releases in terms of either single homing or multihoming (sequential and simultaneous) recorded as the homing strategy for that year (a tie is coded as multihoming).

Each bar in the plots corresponds to one of these variables, split into two categories: "Below Median" and "Above Median". The patterns in these panels are generally consistent with the notion that comparative adjustment and opportunity costs affect repositioning choices. For example, recall that developers with high *PC Specialization* values featured low comparative adjustment costs to multihoming. Consistent with this, the *PC Specialization* bar in the top panel shows that about 20% of developers who were single homing at a below-the-median value for this variable moved to a sequential or simultaneous multihoming position for the focal developer-year observation, whereas more than 50% of the developers that were single homing with an above median value moved to either sequential or simultaneous multihoming for the focal developer-year observation. On the other hand, the bottom panel shows that a lower percentage of developers shifted from multihoming to a single homing strategy among those that had above-the-median *PC Specialization* value compared to those with below-the-median values. This result is consistent with our prediction.

Generation 6 Titles Only

Recall that our main sample includes games released for PCs (as long as a console version for that game existed between 2000-2005) as well as games from other generations. In order to shed additional light on our main results, we coded homing strategies based on Generation 6 console releases only. For example, if a game was only released for PC and Xbox, for purposes of this analysis, it is considered as a single homing title instead of a multihoming title.

Table 4 shows that the coefficient estimate for *Console-Specific Programming Specialization* is positive and significant (0.627, p = 0.016) for sequential homing, but negative and significant for simultaneous multihoming (-0.864, p=.001). These estimates indicate that developers with this specialization were able to leverage their console-specific coding knowledge by releasing their games sequentially across consoles, whereas simultaneous multihoming involved higher adjustment costs. In contrast, in our main sample many titles were released by PC developers that were sequentially multihomed to another platform, usually to Xbox. This multihoming likely weakened the effect of the *Console-Specific Programming Specialization* on sequential homing in the main sample.

Notice also that the coefficient for *Engine Use* is positive and significant for sequential homing (0.814, p = 0.004), but not for simultaneous homing (0.302, p = 0.294) in Table 4. This difference implies that PC games with console versions may have used game engines differently than those released on consoles only. In particular, developers with console-specific programming specialization may have combined that expertise with the use of game engines to facilitate multihoming sequentially.[14] This approach would have lowered their adjustment costs to consoles with more or less complex architectures.

Alternate Multihoming Pathways

The above findings suggest that developers pursued different pathways for sequential and simultaneous multihoming. To examine these pathways further, we divided our 480 sequentially homed titles in the main analysis into three groups: the 110 that were initially released for PS2; the158 that were initially released for Xbox and/or PC; and the remaining 212 ("Other Sequential Homing"). We ran a multinomial logit analysis to examine the drivers of these three strategies. The results, reported in Table 5, indicate that titles first released for PS2 were from developers with higher *Console-Specific Programming Specialization,* as compared to the baseline group ("Other Sequential Homing"). On the other hand, titles first released for Xbox and/or PC were from developers who had higher *PC Specialization* compared to the baseline group. This finding further supports the notion that firms with different prior specializations pursued different sequential homing pathways.[15]

Next, we examined how sequential homing delay, measured as the logged number of days between the first and the last platform of release, was affected by developer and game characteristics, as well as the three sequential homing categories. The results, presented in Table

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[14] As an example, "State of Emergency" was a game title that was initially developed for PS2 and then ported to Xbox, i.e., it was sequentially homed. According to Brace (2003), the game "... was developed as a PS2 game; the underlying rendering and animation technology consists of over 5000 lines of hand written vector unit assembly code. The biggest hurdle to overcome was the fact the entire game was built around code that was handtuned to derive the maximum performance from the PS2 architecture...the approach taken was to develop a very specialized Xbox rendering engine that was optimized to perform extremely well in areas of the engine that had relied on the high performance of specific PS2 hardware." This game is this an example of how sequential homing strategy was used to move from a more to a less complex architecture (Cennamo et al. 2018).

[15] Note as well that both groups were lower on *Breadth of Unique Consoles* compared to the baseline group, implying that the baseline group consists largely of developers that released their titles across many platforms, and possessed less console-specific and less PC specialization.

6, show two notable patterns. First, *Licensed Title* games show much less delay in their sequential releases, which is consistent with the argument above that these games featured high opportunity costs of late multihoming. Second, games that used an engine, and were also first released for Xbox and/or PC, show less delay between their sequential releases. Consistent with the finding above, this pattern implies that PS2-first sequential releasers, who were most likely to be those with console-specific programming, needed more time to multihome, even with the use of a game engine.

Finally, Table 7 shows detailed simultaneous homing patterns. The results are consistent with those above: developers with PC specialization were more likely to simultaneously multihome across PC and Xbox, whereas those with console-specific programming specialization were less likely to do so. Also consistent in Table 7 is the finding that *Game Engine* is positively associated with the PC/Xbox multihoming.

ROBUSTNESS TESTS

We conducted a series of robustness checks to scrutinize the reliability of our findings that are summarized in Table 8, and are available in Appendix 1, Tables A1-A17. First, we excluded the Cult Game and Bleeding-Edge Game control variables due to their high correlation with other variables of interest. These exclusions did not alter our main results (Table A1). Second, we used alternative delay day cutoffs for sequential homing, with results for 0-day, 90-day, and 180-day cutoffs. Our core findings remained consistent across these variations (Tables A2, A3, A4).

Table A5 shows results from treating homing strategy as an ordinal variable, and estimating ordered probit regressions. The results are consistent with our main findings. In addition, to better control for the possible effects of game genre on homing strategy, we employed a BERT vectorization model to cluster games based on synopses of their content. This method allowed us to introduce cluster fixed effects. The results are shown in Table A6, and demonstrate the robustness of our findings with this clustering.

Table A7 shows results from logit regressions in which the dependent variable is one of two homing strategies only. The results here mirror our primary findings. Table A8 introduces an alternate proxy for game popularity: timed exclusive release, wherein a game is released exclusively on one platform for a set time period before becoming available on others. Developers view such games as likely to enjoy particular appeal. Table A9 controls for prior hits by the developer, another alternate proxy for game popularity. Again, the results with either of these controls are consistent with our main findings.

While our main analysis concerns the U.S. videogame industry, we were also able to gather data on the Japanese industry. Table A10 reports results from regressions similar to those in our main analysis, but on Japanese data. The results are consistent.

A potential concern is that some sequential homing was unplanned, rather than being a forward-looking strategic choice. We therefore ran logit models on early- and late-period subsamples, with the idea that sequential homing may have been more strategic in the later period. Table A11 demonstrates that our results here are consistent with our main findings.

Given the potential endogeneity of the game engine use decision, we employed an instrumental variable for *Game Engine Use* based on the engine providers' geographic proximity to the developer. The second-stage results, presented in Table A12, reveal consistent results with our main findings, and Table A13 presents the first-stage results.

Given instrumental variables' potential to introduce noise into estimates, we assessed whether our analyses necessitated the IV approach. Following the methodology proposed by Cinelli and Hazlett (2020), we measured how large unobserved effects would need to be to discredit these results. Using *Breadth of Unique Consoles* as a benchmark variable, we found that unobservables would need to be four times its magnitude to undermine our findings (Table A14). This finding indicates that the magnitude of unobservables would have to be very large to undermine our results. Table A15 shows diagnostic tests of the sensitivity of our results to potential violations of the exclusion restriction, as proposed by van Kippersluis and Rietveld (2018). The tests indicate low sensitivity. In addition, Table A16 shows that our results are robust to a different function form for our game engine instrument.

Finally, we implemented coarsened exact matching as an alternative to instrumental variable estimation. Results from this analysis, found in Table A17, exhibit qualitative consistency with our initial findings.

DISCUSSION AND CONCLUSION

Our study makes several contributions to the literature on platform ecosystems and complementor strategies. First, we demonstrate that comparative adjustment and opportunity costs were important determinants of multihoming decisions by complementors in response to an innovation shock at the platform level. Specifically, we find that following the shock, complementors were likely to adopt a homing strategy for which they had low comparative adjustment costs. In addition, those complementors with high opportunity costs of moving early, but low opportunity costs of moving late, were likely to forgo multihoming. We thereby provide a dynamic perspective on such strategies. Second, we show that simultaneous and sequential multihoming strategies can have different determinants. The literature has largely not distinguished between these two strategies, even though the difference between them can be important (Chen et al. 2022b).

While prior research has shown how complementors adapt to predictable platform evolution through ongoing capability development (Kapoor and Agarwal 2017), our study reveals how complementors respond when platform transitions come as a shock. We show that during such shocks, complementors' strategic responses are particularly constrained by their pre-existing capabilities and the costs of rapid adaptation, rather than by their ability to make sustained investments over time.

An implication of our findings is that when planning to introduce a new platform, platform owners should consider the comparative adjustment and opportunity costs faced by heterogeneous complementors in order to help predict how they would respond to various types of platform innovations. A similar analysis can be performed by complementors. This kind of predictive exercise could be a valuable input to the strategizing process.

Third, our study contributes to the broader literature on platform governance and ecosystem orchestration by illuminating how complementors' strategic choices in response to shocks can shape the overall evolution and resilience of platform ecosystems (Jacobides et al. 2018, 2024). For instance, the adoption patterns of multihoming strategies we observe can affect the relative strength and competitive positions of different platforms within the ecosystem. This pattern, in turn, may prompt platform owners to adjust their governance strategies, such as altering policies on complementor support (Rietveld et al. 2019; Bakos and Halaburda 2020). Furthermore, our findings shed light on how ecosystem resilience is built and maintained in the face of technological disruptions. By revealing the mechanisms through which complementors adapt to shocks, we provide insights into the factors that contribute to ecosystem stability and flexibility (Adner and Kapoor 2010; Wareham et al. 2014; Jacobides et al. 2024).

Fourth, we extend recent work by Polidoro and Yang (2024) and Kapoor and Agarwal (2017) on learning and capability development in platform ecosystems by showing how complementors' prior experiences and specializations influence their ability to adapt to new platforms. Our study reveals that the nature and breadth of complementors' previous platform experiences significantly affects their homing strategy responses to technological shocks at the platform level. This insight builds on the growing recognition that complementors' capabilities are not static, but rather evolve through their interactions within and across platform ecosystems (Kapoor and Agarwal 2017; Tavalaei and Cennamo 2021).

Finally, we contribute to the larger literature on strategy and innovation by placing our analysis of homing strategy responses to innovation shocks into a broader theoretical framework that applies outside of platform ecosystems as well (Argyres et al. 2019; Bigelow et al. 2019). This placement contributes to developing more general theories of strategy that apply across platform and non-platform settings, thereby helping to avoid the development of unnecessarily narrow theoretical silos.

Our study features several limitations. First, our focus on comparative adjustment and opportunity costs, while providing a novel perspective, does not capture all the factors that likely influence complementors' homing strategy choices. Organizational culture and leadership, managerial cognition, or firm-specific capabilities beyond those proxied by our variables, could also play roles in shaping complementor strategies. Future studies could explore how these additional factors interact with adjustment and opportunity costs in shaping complementor responses. Second, our study is situated in a context of significant technological change. Our findings may be of less relevance in contexts in which innovation is more gradual or incremental. Future research could therefore explore how the importance and impact of these costs vary across different types and magnitudes of platform innovations, from incremental updates to disruptive technological shifts. Third, the use of proxy measures for adjustment and opportunity costs, while theoretically grounded and empirically justified, introduces potential limitations. More direct measures, perhaps obtained through surveys or detailed financial data, could provide more precise estimates of these costs and their effects on complementor strategies. Future research could explore alternative or more direct measures to further validate and refine our findings.

Our study is only a first step in understanding how such comparative adjustment and opportunity costs impact firm responses to innovation shocks in platform markets. Major questions remain, including the extent to which outsourcing arrangements could impact firm responses, and the performance implications of those responses. Scholars should also study how regulations of platform markets, which are tightening in several countries, shape firms' comparative adjustment and opportunity costs to innovation shocks, and to further regulations. We look forward to future studies that address these important questions.

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Table 1. Active Consoles (by Ongoing Game Releases) in US Video Game Industry (2000-2005)

Console	Generation	U.S. Launch Date	Platform Parent	CPU	System RAM (Mb.)
Playstation	5	Sept. 1995	Sony	R3000 @ 33.87 MHz (RISC)	2
Nintendo 64	5	Sept. 1996	Nintendo	NEC VR4300 @ 93.75 MHz (RISC)	4
Dreamcast	6	Sept. 1999	Sega	Hitachi SH-4 @ 200 MHz (RISC)	24
Playstation 2	6	Oct. 2000	Sony	Custom Made "Emotion Engine" @ 294 MHz (RISC)	36
Xbox	6	Nov. 2001	Microsoft	Intel Pentium III @733 MHz (CISC)	64
Gamecube	6	Nov. 2001	Nintendo	IBM PowerPC "Gekko" @ 485 MHz (RISC)	43
Xbox 360	7	Nov. 2005	Microsoft	IBM PowerPC "Xenon" @ 3200 MHz with 3 PPE Main Cores (RISC)	512

Table 2. Descriptive Statistics and Correlation Matrix

	n= 1,865					Pairwise Correlations														
		Mean	S.D.	Min	Max	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
[1]	Homing Strategy	1.69	0.81	1	3															
[2]	Breadth of Unique Consoles	2.53	2.1	0	9	0.11														
[3]	PC Specialization	0.33	0.37	0	1	0.25	0													
[4]	Licensed Title	0.4	0.49	0	1	0.24	0.05	0.11												
[5]	Cult Game Specialization	0.23	0.32	0	1	-0.11	0.07	0.11	-0.12											
[6]	Console-Specific Programming Specialization	0.69	0.41	0	1	-0.12	0.48	-0.06	-0.05	0.21										
[7]	Game Engine Use	0.08	0.28	0	1	0.15	-0.05	0.14	0.01	-0.03	-0.06									
[8]	Bleeding-edge Game Specialization	0.22	0.3	0	1	0.08	0.12	0.21	-0.07	-0.22	0.24	0.15								
[9]	Bleeding-edge game	0.33	0.47	0	1	0.06	-0.01	0.08	-0.11	-0.11	-0.03	0.13	0.4							
[10]	Cult game	0.25	0.43	0	1	-0.12	-0.09	-0.01	-0.09	0.44	0.01	-0.03	-0.16	-0.4						
[11]	Physics Engine Use	0.02	0.15	0	1	0.16	0.01	0.09	0.03	-0.01	-0.04	0.11	0.08	0.11	-0.07					
[12]	Minor Middleware Use	0.07	0.25	0	1	0.03	-0.03	-0.07	-0.09	-0.03	0.04	0.12	0.06	0.06	-0.05	0.09				
[13]	Sequel	0.57	0.5	0	1	0.02	0.19	0	-0.08	-0.03	0.14	0.03	0.11	0.02	-0.1	0.04	0.08			
[14]	Inhouse	0.36	0.48	0	1	0.11	0.47	0.01	0.03	0	0.17	0.06	0.1	0.05	-0.08	0.03	0.12	0.22		
[15]	Project Size	1.02	0.63	0.01	9.55	0.1	0.13	0.02	0.04	-0.03	0.05	0.04	0.08	0.16	-0.06	0.07	0.06	0.17	0.21	
[16]	Assumed Project Size	0.2	0.4	0	1	-0.14	0.04	-0.09	0.04	0.09	0.07	-0.07	-0.08	-0.14	0.07	-0.04	-0.06	-0.07	0	-0.02

Table 3. Multinomial Logit Regression Results

	Base Outcome: Single Homing	Outcome: Sequential Multihoming	Outcome: Simultaneous Multihoming
Independent Variables			
Breadth of Unique Consoles		0.039	0.230***
		(0.044)	(0.061)
PC Specialization		1.980***	1.535***
		(0.198)	(0.249)
Licensed Title		0.447***	1.256***
		(0.150)	(0.154)
Cult Game Specialization		-0.568**	-0.712**
		(0.244)	(0.334)
Console-Specific Programming Specialization		-0.275	-1.223***
		(0.198)	(0.244)
Game Engine Use		1.103***	0.789***
		(0.252)	(0.280)
Control Variables			
Bleeding-edge game		0.095	-0.307
		(0.177)	(0.189)
Cult game		-0.026	-0.318
		(0.195)	(0.239)
Physics Engine Use		1.385*	1.904***
		(0.713)	(0.652)
Minor Middleware Use		0.708***	0.107
		(0.266)	(0.301)
Bleeding-edge Game Specialization		-0.311	0.053
		(0.286)	(0.354)
Sequel		-0.027	-0.210
		(0.156)	(0.192)
Inhouse		0.388**	0.153
		(0.167)	(0.212)
Project Size		0.021	0.332***
		(0.107)	(0.118)
Assumed Project Size		-0.942***	-0.796***
		(0.202)	(0.178)
Observations		1,865	1,865
Year Dummies		YES	YES

Notes. Robust standard errors clustered by developer and reported in ( ); results show effects compared to the base outcome (single homing). *p < 0.1; **p < 0.05; ***p < 0.01.

Table 4. Multinomial Logit Regression Results for Generation 6 Releases Only, with within-Generation 6 Homing Strategies

	Base Outcome: Single Homing	Outcome: Sequential Multihoming	Outcome: Simultaneous Multihoming
Independent Variables			
Breadth of Unique Consoles		-0.034	0.266***
		(0.053)	(0.070)
PC Specialization		1.057***	0.904***
		(0.246)	(0.282)
Licensed Title		0.421**	1.183***
		(0.192)	(0.178)
Cult Game Specialization		-1.024***	-1.076**
		(0.314)	(0.416)
Console-Specific Programming Specialization		0.627**	-0.864***
		(0.260)	(0.271)
Game Engine Use		0.814***	0.302
		(0.286)	(0.287)
Control Variables			
Bleeding-edge game		-0.055	-0.347*
		(0.212)	(0.203)
Cult game		-0.312	-0.804***
		(0.259)	(0.253)
Physics Engine Use		0.428	1.345***
		(0.878)	(0.492)
Minor Middleware Use		0.403	-0.338
		(0.319)	(0.299)
Bleeding-edge Game Specialization		-1.254***	-0.541
		(0.377)	(0.364)
Sequel		-0.010	-0.183
		(0.183)	(0.198)
Inhouse		0.456**	0.137
		(0.224)	(0.236)
Project Size		0.041	0.519***
		(0.141)	(0.134)
Assumed Project Size		-0.894***	-0.892***
		(0.255)	(0.192)
Observations		1,468	1,468
Year Dummies		YES	YES

Notes. Robust standard errors clustered by developer and reported in ( ); results show effects compared to the base outcome (single homing). *p < 0.1; **p < 0.05; ***p < 0.01.

Table 5. Multinomial Logit Regression Results for Sequential Homing Patterns

	Base Outcome: Other Sequential Homing	Outcome: PS 2 Release First Sequential Homing	Outcome: Xbox and/or PC Release First Sequential Homing
Independent Variables			
Breadth of Unique Consoles		-0.290***	-0.155**
		(0.103)	(0.077)
PC Specialization		0.748*	1.576***
		(0.423)	(0.366)
Licensed Title		0.115	0.111
		(0.299)	(0.271)
Cult Game Specialization		-0.688	0.621
		(0.688)	(0.532)
Console-Specific Programming Specialization		1.008**	-0.396
		(0.414)	(0.362)
Game Engine Use		0.024	0.098
		(0.403)	(0.384)
Control Variables			
Bleeding-edge game		-0.704*	-0.086
		(0.381)	(0.329)
Cult game		-0.426	0.417
		(0.466)	(0.357)
Physics Engine Use		-13.790***	-0.897
		(0.543)	(0.757)
Minor Middleware Use		-0.092	-0.140
		(0.591)	(0.482)
Bleeding-edge Game Specialization		-0.316	0.412
		(0.571)	(0.479)
Sequel		-0.212	-0.127
		(0.306)	(0.265)
Inhouse		0.595	-0.335
		(0.406)	(0.309)
Project Size		0.560**	0.159
		(0.220)	(0.215)
Assumed Project Size		0.366	-0.093
		(0.426)	(0.489)
Observations		480	480
Year Dummies		YES	YES

Notes. Robust standard errors clustered by developer and reported in ( ); results show effects compared to the base outcome (single homing). *p < 0.1; **p < 0.05; ***p < 0.01.

Table 6. OLS Regression Results for the Sequential Title Delay (Logged # of Days between the Last and First Release Platform)

	DV = ln (# of days between the last and first release)
PS2 Release First Sequential Homing	-0.233
	(0.146)
Xbox and/or PC Release First Sequential Homing	0.082
	(0.125)
Game Engine Use	0.251
	(0.204)
PS2 Release First X Game Engine Use	-0.251
	(0.291)
Xbox and/or PC Release First X Game Engine Use	-0.891***
	(0.292)
Breadth of Unique Consoles	-0.056
	(0.039)
PC Specialization	0.264**
	(0.129)
Licensed Title	-0.415***
	(0.090)
Cult Game Specialization	0.105
	(0.207)
Console-specific Programming Specialization	0.075
	(0.141)
Control Variables	
Bleeding-edge game	0.106
	(0.109)
Cult game	0.323**
	(0.152)
Physics Engine Use	-0.343
	(0.238)
Minor Middleware Use	0.140
	(0.174)
Bleeding-edge Game Specialization	0.164
	(0.178)
Sequel	0.226**
	(0.104)
Inhouse	-0.056
	(0.122)
Project Size	0.013
	(0.084)
Assumed Project Size	0.025
	(0.169)
Constant	5.418***
	(0.192)
Observations	480
Year Dummies	YES
R-squared	0.174

Notes. Robust standard errors clustered by developer and reported in ( ). *p < 0.1; **p < 0.05; ***p < 0.01.

Table 7. Logit Regression Results for Simultaneous Homing Patterns

	Outcome: Simultaneous Multihoming with PC and Xbox
Independent Variables	
Breadth of Unique Consoles	-0.005
	(0.074)
PC Specialization	1.925***
	(0.368)
Licensed Title	0.397
	(0.355)
Cult Game Specialization	-0.108
	(0.551)
Console-Specific Programming Specialization	-0.914**
	(0.410)
Game Engine Use	0.918**
	(0.422)
Control Variables	
Bleeding-edge game	-0.078
	(0.364)
Cult game	-0.275
	(0.514)
Physics Engine Use	-0.689
	(0.574)
Minor Middleware Use	-0.037
	(0.533)
Bleeding-edge Game Specialization	0.938*
	(0.513)
Sequel	0.372
	(0.282)
Inhouse	0.068
	(0.329)
Project Size	0.139
	(0.244)
Assumed Project Size	-1.409***
	(0.507)
Observations	480
Year Dummies	YES

Notes. Robust standard errors clustered by developer and reported in ( ); results show effects compared to the base outcome (other simultaneous multihoming). *p < 0.1; **p < 0.05; ***p < 0.01.

Table 8. Robustness Checks

Robustness Check/Issue	Description	Associated Appendix 1 Table	Key Findings
Regression Without Certain Controls	Regressions performed without including 'Cult Game' and 'Bleeding-Edge Game' control variables.	Table A1	Main findings remained consistent.
Delay Day Cutoffs for Sequential Homing	Regression with alternative delay day cutoffs (0, 90, 180 days) for defining 'Sequential Homing.'	Tables A2, A3, A4	Results robust across different cutoffs.
Ordinal Homing Strategy	Treated 'Homing Strategy' as an ordinal variable and performed ordered Probit regression.	Table A5	Findings consistent with multinomial logit results.
Estimation within Comparable Sample of Games	BERT vectorization model to cluster games based on synopses of their content and using cluster FE	Table A6	Findings are consistent with the baseline analyses
Logit Models with Subsamples	Logit models run on subsamples of single vs. simultaneous and sequential vs. simultaneous homing strategies.	Table A7	Results congruent with initial findings.
Controlling for Timed Exclusivity	Inferring potential timed exclusivity arrangements (180-day or 365-day delayed sequential releases. +/- 5 days)	Table A8	Results remain consistent.
Controlling for ex-ante Game Popularity	In addition to the sequel variable, the cumulative number of hit titles by the developer (based on Corts and Lederman, 2009) is added as a control.	Table A9	Main findings remained consistent.
Capturing PS2 Innovation Shock Better	Focusing only on those titles with a release in Japan	Table A10	Findings are consistent with the baseline results.
Differences between early- and late-periods in findings	Running analyses for 2000-2002 and 2003-2005 subsamples	Table A11	Results are consistent with main findings.
Endogenous Game Engine Use Decision	Instrumental Variable based on the geographic proximity between the engine provider and game developer	Tables A12, A13	First stage results supporting the instrument, and second stage result showing consistent effect for the Game Engine Use
Validity of Exclusion Restriction	Examines relationship between proximity to engine providers and other variables.	Table A14	No significant correlation detected.
Sensitivity to violation of Exclusion Restriction	Sensitivity analysis to evaluate the potential violation of the exclusion restriction.	Table A15	Results robust to potential violations.
Different Instrument Functional Form	Addressing non-linear model limitations with a different instrument functional form.	Table A16	Strong instrument F-statistic; results consistent with initial findings.
Coarsened Exact Matching	Alternative methodology to IV for matching firms based on certain characteristics.	Table A17	Results qualitatively similar to IV-based findings.

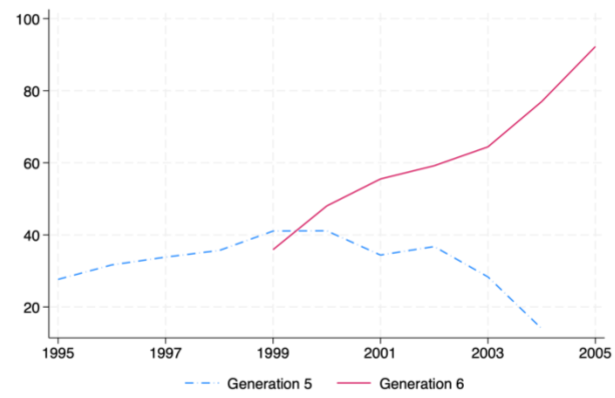

Figure 1. Yearly Average Unique Title Core Team Size by Console Generation

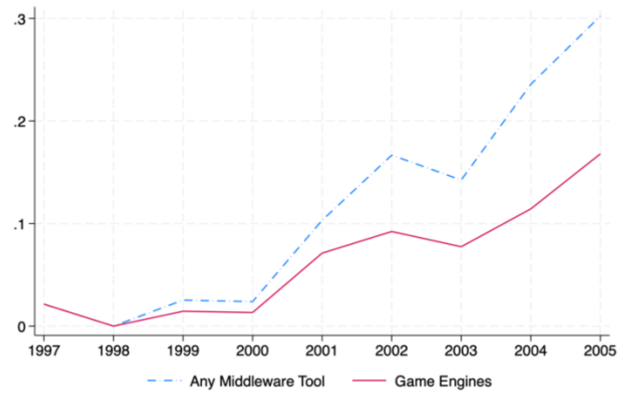

Figure 2. Yearly Share of Unique Game Titles that Use Middleware and Engines

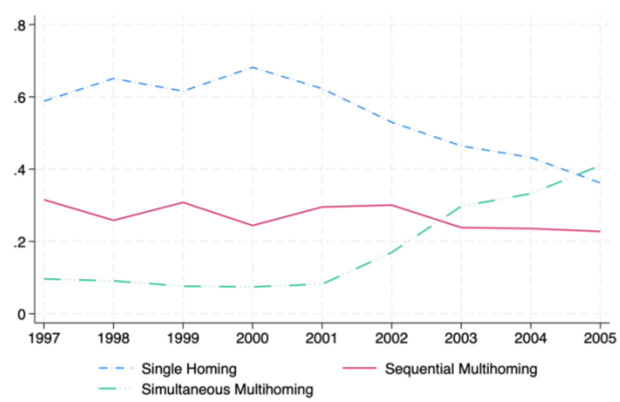

Figure 3. Yearly Share of Unique Game Titles by Homing Strategy

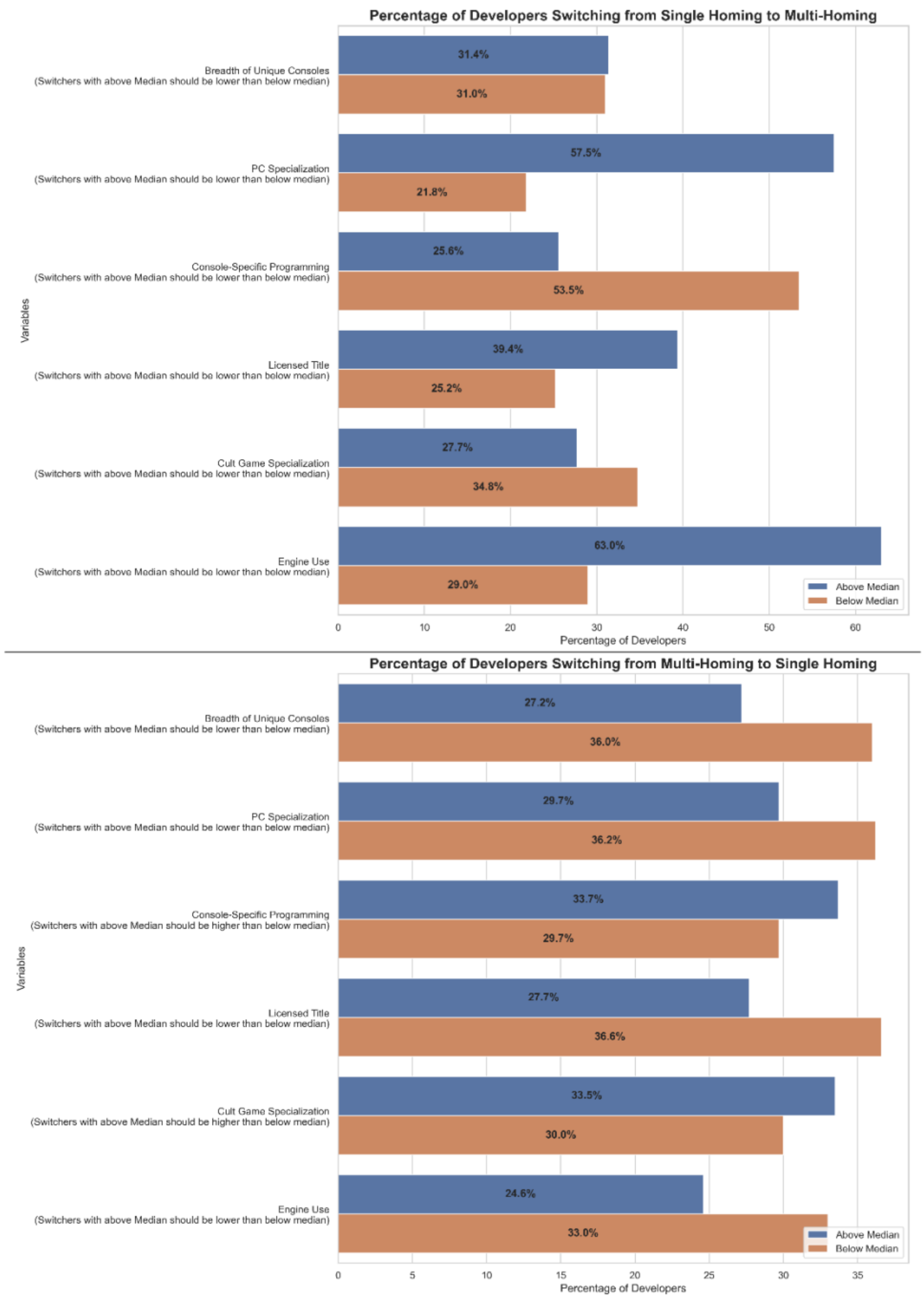

Figure 4. Descriptive Evidence of Repositioning Based on Key Variables