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Strategies for Digital Platforms at Early Stage of Development: Insights Gained from Three Empirical Studies

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Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. The thesis has been composed by myself under the supervision of Professor Ola Henfridsson and Doctor Aleksi Aaltonen and has not been submitted in any previous application for any degree. The work presented - including data collection and data analysis – was all carried by myself. Therefore, I am holding the exclusive ownership for any mistakes.

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Abstract

This thesis consists of three empirical studies of growing digital platforms at their early stage of development. The thesis tackles three vital challenges nascent digital platforms face: growing the platform's complementary markets, scaling the platform user base, and building and expanding the platform ecosystem. The mingled use of the econometric and qualitative research approaches has been operationalized in three empirical settings: Amazon Alexa, Pinduoduo, and PingAn OneConnect's Blockchain. The first study investigates how platform owners may leverage the timing of entry to the nascent platform complementary market as a strategic means to grow the viability of that market. The second research draws on the psychology domain and discusses an alternative design of platform referral scaling in acquiring platform users. The third paper explores the platform's engagement with emerging technology and investigates how the adapted layered modular architecture could be used in building a platform ecosystem. Overall, by deciphering platform strategy studies through the proposed component view and carefully conducting three empirical analyses, this thesis aims to contribute novel insights into growing nascent platform's generativity, user base, and ecosystem.

Abbreviations

FAAMG – Facebook (Meta), Apple, Amazon, Microsoft, Google

GMV – Gross Merchandise Value

API – Application Programming Interface

SDK – Software Development Kit

DID – Difference-in-difference

TWFE – Two-way Fixed Effects

PSM – Propensity Score Matching

CEM – Coarsened Exact Matching

PDD – Pinduoduo Inc.

ICO – Initial Coin Offering

MADA – Mobile Application Distribution Agreement

BPaaP – Blockchain Product as a Platform

BNaaP – Blockchain Network as a Platform

CHAPTER 1. INTRODUCTION

1.1 Digital Platforms and Platform Strategy

The past two decades of the twenty-first century have witnessed digital technologies' rapid development. As one of the key inventions born in this digital era, digital platforms have brought unprecedently significant impact to many aspects of society. Often referred to as a multi-sided digital infrastructure (McIntyre et al., 2021; Cusumano et al., 2019; Hagiu, 2014), platforms connect and facilitate interactions between multiple groups of users, such as consumers, producers, and advertisers. Some of the key ways that digital platforms have impacted society include: 1) connecting previously disconnected entities to find and connect and build new forms of collaboration and interaction; 2) mobilizing social resources, such as capital, labour, and knowledge, to accelerate economic growth; 3) creating new ways of running civil activities in many areas such as innovation, employment, public transport, education, and healthcare; 4) enabling the spread of knowledge through the proliferation of online learning and knowledge sharing platforms and boosting the democratization of information. Examples include the countless digital innovation developed on mobile platforms such as iOS and Android, the no-broker instant matching of employers and employees on Upwork and Mechanical Turk, the on-demand reuse of idle social assets on Airbnb and Uber, and the unrestricted spread of the digitized knowledge on those sharing platforms such as GitHub and Coursera.

Looking back for twenty years, leading businesses such as General Motors, Walmart, and Ford Motor were mostly outcompeting their global enemies by efficiently integrating the production and logistics chain worldwide [1]. Today, four of the top five valuable companies worldwide are no longer engaging in mass production but relying on digital intelligence. Eight of the leading 20 companies measured in the market capitalization are following platform-based business logic. Besides, regarding the capabilities in generating business revenue, these eight leading platforms constitute

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[1] The information is obtained from the FORTUNE 500 database.

more than 55% of the total market cap owned by the top twenty firms (see Figure 1). Summing up the market value of the so-called Big Five FAAMG platform companies (Facebook (meta), Apple, Amazon, Microsoft, and Google), the figure will weigh out Japan's GDP, which makes FAAMG the third largest economy unit worldwide.

Figure 1. Proportion of Market Cap Contributed by Platforms and Non-Platforms Businesses Among the Top 20 Valuable Companies (in April 2022)[2]
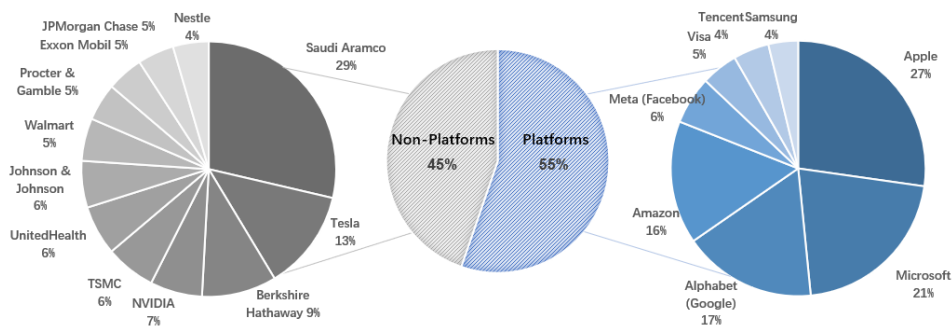
Given the prevalence of digital platforms and the complexity of the platform ecosystem, which often engages the organisation of organisations (Kretschmer et al., 2022), having the right set of platform strategies has always been a key concern for platform owners. Contrary to conventional organisations that eagerly look to improve efficiency or integrate upstream and downstream players, the success of digital platforms relies on the sustaining value co-creation fostered at the ecosystem level (Adner, 2017; Kretschmer et al., 2022). Strategically speaking, it is not the best product but the best platform that could win in platform competition (Cusumano et al., 2019). And the most successful platforms are often those that can utilise heterogeneous resources to constantly build and adjust their platform boundaries (Kapoor, 2018).

Broadly, platform strategy consists of a series of activities and networked resources through which platforms can mobilize to survive and expand in a given market (Cusumano and Gawer 2002; Parker and Van Alstyne 2014). From the implementation's point of view, platform strategy is often considered as a containing schema which encompasses various forms of techniques, tactics, and methods that are

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[2] The market cap data of each company is collected from https://companiesmarketcap.com/. The data accuracy is cross validated with Google Finance.

combinatorically used to encourage the desirable platform activities and promote ecosystem-wide value co-creation (Rietveld et al., 2019; Foerderer et al., 2021).

By revisiting and refining the definition of platform strategy from Cusumano and Gawer (2002), Parker and Van Alstyne (2014), and Rietveld et al. (2019), this thesis comprehends platform strategy as "***the mobilisation of a set of resources, techniques, regulations, concepts, and theories that aim to enhance and sustain platform's competence in a given market***". The definition of platform strategy adopted by this thesis poses two startling implications that are departed from previous studies. First, it recognises the mingled engagement of tangible and intangible apparatuses that platforms could use. Some strategic tools, such as regulatory policies, financial investment, or promotive rewards, may come in concrete forms. At the same time, it is equally important to stay aware of those intangible gears, especially of high spiritual or emotional impact on the platform. For instance, the building of the platform identity, the sense of collective community, or the use of social capital and reciprocity belong to this soft platform strategy segment. Second, the definition suggested by this thesis particularly perceives the contingent nature of platform strategy. More than merely operating in a given market, the selection of platform strategy on many occasions should hold prolonged intentions to enhance and sustain platform competence. This slightly startling implication pinpoints that a specific strategic tool's impact should always be discussed in the platform's context. Platforms without strategies may become blind. Similarly, claiming a strategy's effects without clarifying its platform specifications will weaken the power of strategy studies in making relevant implications.

1.2 Research Question and the Motivation of Three Studies

Informed by the dynamic feature of platform strategy, platforms at different stages of development could face a distinct set of strategic challenges. Not to mention the countless lessons told by history on platforms that are doomed to fail due to various misconducts at an early time, platform managers and entrepreneurs have never escaped from must responding to this crucial question: how to kick off the platform's initial

value growth so that to possibly realize the winner-take-all or most? Cusumano, Gawer, and Yoffie, in their book The Business of Platforms (2019), once said that "launching a platform and solving the chick-and-egg problem is probably the most difficult challenge for platform strategies" (p71). Building on Van Alstyne, Parker, and Choudary (2016), this thesis further comprehends three reasons that make such a challenge so tough and crucial for new platforms.

First, given the unfamiliar products and services that a newly launched platform may present to its intended users, complementors who wish to develop complementary products and gain profits from the platform may face high ambiguity and uncertainty on that platform. The ambiguity is mainly rooted in the lack of prior examples to learn from and the lack of knowledge about the new platform. Also, complementors may remain uncertain about the platform's viability when very few profits may be realized at the early stage of platform launch. The second source of challenge emerges from obtaining platform consumers. In addition to the needed efforts to configure platform usefulness, consumers interested in the new-born platform often hold limited information and knowledge in their decision-making. The mutual reliance on the variety and quality of platform complements, and the platform's attractiveness in the eyes of platform consumers further increases the platform owner's pressure to find the right platform strategies in the early days. Third, upon stimulating the growth of platform complements and platform consumers, platform owners, subjected to orchestrating platform operation, are urged to mobilize various elements and entities to promote platform ecosystem growth.

In recognition of both the significance and sources of challenges faced by platforms that are at their early stage of development, the research question this thesis aims to answer is:

What strategic movements can help nascent platforms to grow in terms of flourishing complementary markets, scaling user base, and fostering ecosystem prosperity.

As illustrated in Table 1, the studies included in this thesis aim to provide some new insights into tackling each aspect of the challenges platforms face at their early

stage of development. Specifically, the first study investigates platform owners' entry to grow the platform's complementary markets and decipher the critical impact of entry timing. The second study examines the platform referral scheme in scaling its user base and probes the involvement of behavioural motives in improving the scaling efficacy. The third study draws on the layered modular architecture design of digital technology and explores how this design could be operationalized to embark on ecosystem growth on a new platform.

Table 1. Motivation of Three Studies

Platform Challenges at Early Stage of Growth	Strategy Mechanisms Investigated	Empirical Context
Flourish complementary markets	Platform owners enter to the complementary market	Study 1: Amazon Alexa
Scale user base	Behavioural motives in user referral scheme	Study 2: Pinduoduo
Foster ecosystem prosperity	Adapted layered modular architecture in building platform ecosystem	Study 3: PingAn Blockchain

This thesis is entitled to contribute novel insights that could help nascent platforms design and determine their strategic actions. Meanwhile, these three studies also focus on making specific theoretical and managerial implications for platform managers. The first paper on platform owners' entry into the complementary market aims to resolve the conflictual views found by previous research and provide more precise and relevant implications to nascent platforms. The second and the third papers are more explorative as they both investigate two new forms of platform strategy that have not been studied before. Furthermore, though not designed with the subjective motive to diversify the research context in each paper, the three papers practically cover major variations of digital platforms, including a digital innovation platform, a transaction platform, and an industrial platform.

1.3 Key Terms and the Structure of the Thesis

Before diving into the in-depth look at the digital platform strategy, it is worth articulating some of the terminologies frequently mentioned and discussed in this thesis. First, the *platform owner* used in this thesis stands for the enterprises and organizations

that sponsor or are in charge of providing platform infrastructure. Notably, platform owners may hold the proprietary ownership of the platforms (e.g., Apple iOS) or distribute the ownership to the crowds (e.g., GNU Linux) (Tiwana et al., 2010). Second, the *platform complementors* represent the worldwide distributed third-party developers. Complementors often draw on their unique wits to create add-on products and services (i.e., complements) to the platform and gain revenue (Jacobides et al., 2018). The diversity and quality of these add-on complements largely determine the usefulness and value of the platforms to the indented platform users. Third, *platform consumers* are a group of subjects who consume platform services and feedback valuable user data to platform owners and platform complementors. Last, the platform ecosystem represents the overarching environs consisting of various actors and organizations, multilateral and dynamic interactivities, congruent or conflicting interests, and social-technical complexities (Kretschmer et al., 2022).

Depending on the varying business activities and objectives, prior research in the field of digital platforms often follows one or more of the following streams in viewing a platform. First, the *economics stream* considers platforms as a marketplace and emphasises the multi-sided nature of digital platforms in enabling transactions and exchanges. Typical examples may include Amazon Marketplace and many e-commerce sites. Second, the *technological stream* tends to highlight the infrastructure aspect of digital platforms. This stream focuses more on the innovative activities facilitated and governed by a platform such as Amazon Alexa. The third is the *ecosystem stream* which depicts platforms as meta-organisations. In addition to configuring the provision of goods and services, this stream treats the platform as a continuously developing object and concerns more broad questions, such as cultivating an ecosystem around a platform or expanding into a new market sector.

The body of this thesis is unfolded into six chapters. Chapter 2 is designated for a systematic literature review of the extant studies on digital platforms and platforms strategy. Section 2.1 will first discuss three strands of platform organizing logic that have been widely followed and utilized by prior research. Section 2.2 will then introduce two views on the platform strategy to construct comprehension of extant

studies in this domain. Building on chapter 2, chapter 3 proposes an alternative angle of platform strategy—the component view. Content in this chapter revolves around discussing the rationale and validity of the proposed component view and connecting it to the three papers.

Chapters 4, 5, and 6 are designated for the three empirical studies. Chapter 4 examines the impact of Amazon's entry into Amazon Alexa's complementary market. Previous research in this strand has highlighted the post-entry profit squeeze and complementors' drop-out. This research sheds light on the potential market expansion effects if platform owners create their presence at an early timing. Chapter 5 examines a game-based platform referral scheme employed by an e-commerce platform Pinduoduo to attract its early platform consumers. Drawing on behavioural science knowledge, this research explores the potential incorporation of behavioural motives to rapidly promote individuals' platform adoption after platform launch. Chapter 6 studies the establishment of a platform infrastructure that transforms a commercial bank into a platform-based organization. This research revisits the modular layered architecture of digital technologies and discusses its affordance in building a Blockchain-enabled banking ecosystem that revolutionizes multiple business actors' interactions.

Last, chapter 7, as a conclusion, aims to highlight both the theoretical and practical implications that this thesis could bring to the platform strategy research. Meanwhile, with great respect to scientific rigour, this chapter will also be transparent about the limitations of the thesis and propose some potential directions for future research.

CHAPTER 2. THEORETICAL BACKGROUND

2.1 Platform as An Organizing Logic

The notion of logic has a long history stretching from ancient times to modern days. The development of logic burgeons when we, as human beings, question the origin of lives and the essence of the universe. The ongoing debate on these philosophical wonders gradually emerged a set of scientific and systematic patterns of thinking, arguing, reasoning, and concluding, which later constituted the notion of logic known today. The term logic in the modern context is universally referred to when someone wants to assert that an object or a concept is founded on a well-reasoned basis and has been extensively tested in practice (Copi et al., 2019). Consistent with the implications of the term logic, this thesis uses the "organising logic" to represent the type of organisation form widely seen in the practices and is thought to hold scientific bedrock. The phrase "platform as an organising logic" is used to indicate the revolutionary impacts of platforms on modern organisations in terms of organising business and economic activities.

The first and the second industrial revolution are the exceptional incarnations of efficiency gains in modern society. Informed by such efficiency improvement, organisations constantly seek to increase productivity through automation and business integration. Since the 1990s, the growing use of the Internet has largely reshaped the landscape of modern organisations. The types of products circulated on the market have expanded from manufacturing goods to the inclusion of digital items. The information and data used to privilege organisations' centralised decision-making can now be generated and used by individuals outside organisations. Consumers who were previously tied to a few leading brands due to information asymmetry are now liberated to unlimited options. The broad penetration of digital technologies significantly releases business prosperity in the established sectors and those long-tail niche sectors.

The unprecedented connectivity brought by the Internet, the ongoing advancement of digital technologies, and the proficient use of digital technologies catalysed the emergence of digital platforms. Many of the super successful leading

businesses in the first two decades of the twenty-first century is based on the platform organisation logic.

In the following, this thesis will present three main streams of platform organisation logic that have been identified and widely followed by information systems research. Notably, the three streams listed in this thesis commonly recognise the complexity of digital platforms regarding the involvement of multiple types of actors. However, each stream has its unique angle to decipher the platform complexity and provide a different set of useful implications for practices.

Table 2. Three Streams of Platform as an Organizing Logic

Organizing logic	Definitions	Key issues	Exemplar studies
Platform as marketplace	Platform facilitates the economic transactions of multiple sides of platform participants.	multi-sided network externalities; pricing structure; trust; disintermediation; business legitimacy	McIntyre et al. (2021) Gu and Zhu. (2021) Kuratko et al. (2017) Evans and Schmalensee. (2016) Hagiu and Wright. (2015)
Platform as innovation infrastructure	Platform enables the innovation activities of heterogenous developers in producing novel products and services.	platform architecture design; platform integration resources; generativity and unity; coordination management and control.	Tan et al. (2020) Karhu et al. (2018) Henfridsson et al. (2018) Constantinides et al. (2018) Eaton et al. (2015) Baldwin and Woodard (2009)
Platform as meta-organization	Platform connects multiple organizations that underpinned by interrelated social and economic value propositions.	Organization structure; launch platforms in a new market; inter-platform competition;	Jones et al. (2022) O'Mahony and Karp. (2022) Bakos and Halaburda (2020) Jacobides et al. (2018) Tiwana (2018) Adner (2017)

2.1.1 Platform as marketplace

Digital platforms, according to the economic tradition of information systems, have been widely recognised as a multi-sided market, which aims to facilitate the interactions and exchanges of multiple sides of users who would be otherwise disconnected from each other (McIntyre et al., 2021; Cusumano et al., 2019; Hagiu, 2014; Boudreau, 2010). The interactions of the main players, which are platform owners, platform

complementors, and platform consumers, are often described as triangular affiliations. As the provider of the foundational infrastructure, the platform owners hold a multilateral relationship with both platform complementors and consumers. Accordingly, the complementors and consumers are incentivised to ally with the platform owner in return for the mutual connections that would otherwise be hard to gain without the platform. In this regard, platforms are often viewed as a multi-sided marketplace. The platform owner serves as an intermediate party that facilitates the transactions and exchanges of multiple sides of platform users (McIntyre et al., 2021; Hagiu & Wright, 2015).

The engagement of multiple sides of participants who hold the interrelated interest in exchange is a prominent feature that distinguishes digital platforms from traditional organizations (Armstrong, 2006; Hagiu, 2014; Kretschmer et al., 2022). In contrast to the traditional pattern of pipeline business logic, where the organizations often need to materialize and monetize the goods from suppliers at one end to the consumers at the other end, a digital platform as a marketplace enables the autonomous interactions as long as the different parties involved agree to the exchange value provided by each other (Eisenmann et al., 2011; Boudreau, 2012). By eliminating the excessive intervention along the production chain and letting different sides of users to be connected directly, the digital platform creates an economic surplus for its participants by improving the exchange efficiency with the rising mutual accessibility and the reduced operational costs.

Viewing platforms as a marketplace yields several key concerns for scholars and practitioners. Among many challenges, the first critical task faced by platforms is to attract a vast number of platform participants to kick off the platform's exchange value (Gawer, 2014). Especially for a new platform entrant that needs to create genuine user value in a fresh market or grab shares from the established incumbent platforms, the first vital barrier the platform faces is often referred to as the chicken-and-egg problem (Caillaud & Jullien, 2003). As indicated by its name, the chicken-and-egg dilemma describes a seemingly unsolvable loop where either side of platform users has less incentive to join without the presence of the other side (Evans, 2009).

The underlying motivation that platforms often put enormous investment in tackling the chicken-and-egg problem lies in the platform's fundamental "positive feedback" growth pattern (Boudreau, 2010; Boudreau, 2012; Katz & Shapiro, 1985). The platform's value to each of its users is a fraction of the total number of users residing on the same platform (Parker et al., 2016). Subject to the network effects, platforms will largely benefit from the self-reinforced value growth loop, where scaling the user base drives increased returns on the platform to each of its existing and potential users (Eisenmann et al., 2006; Arthur, 1989; Katz and Shapiro 1985). Depending on the direction of such ripple influences, network effects can be further divided into the same-side network effects and the cross-side network effects. The same-side network effects imply the value growth among the same type of platform users (Rohlfs, 1974). Having an additional Uber rider instantly benefits other riders because the collective demands can incentivise the improvement of services. Similarly, the cross-side network effects indicate the mutual attraction of platform users of different kinds (Song et al., 2018). More drivers joined on Uber will certainly attract more riders to that platform because of the widened coverage of the services and shortened waiting time for each rider.

The platform's pricing structure is the second group of critical issues that emerged in a platform marketplace. Guided by the platform goals where multiple sides of users should be ideally "on board" before platforms can demonstrate and create a surplus to potential users, how platforms design the pricing scheme that charges each side of users pertains significant importance in attracting and retaining the platform users. One of the widely discussed pricing techniques applied on platforms is the divide-and-conquer (Rochet & Tirole; 2003), where the platforms often charge one side of platform users the below the marginal costs and, in return, recoup the revenue from the other side, which is charged with above the marginal costs. The decision on the partition of such "subsidy side" and "pricing side" (Eisenmann et al., 2006) depends on several determinants, such as the side's sensitivity to price and quality, the degree of subsidization required to swell the critical mass, and the degree of premium that the money side is willing to pay for the privileged access to its counterparty (Eisenmann et al., 2006; Parker and van Alstyne, 2014). The online game console platform is an

exceptional example where game players who need to pay to purchase a game console are treated with low purchasing costs, and the game publishers who are highly in need of access to the players are charged high premium fees.

In addition to such a static pricing structure departed between different platform users, the pricing structure can also remain dynamic for a specific side of platform users. For instance, McIntyre et al. (2021) mentioned Uber's dynamic pricing structure applied to its divers. Instead of setting a fixed level of unit prices that divers can make, Uber allows its divers to gain premium surplus during the "rush hours". Similarly, Möhlmann, Zalmanson, Henfridsson, and Gregory (2021) also revealed that Uber drivers might deliberately adapt to the platform's pricing system to gain more from participating in the platform activities.

Trust is the third issue that addresses significant influences on the platform marketplace (Möhlmann, 2016). Bringing "on board" different sides of users not only strengthens the platform's attractiveness with the improved return from the scale. It also serves as a foundation to build the platform's trustworthiness and reputation, which is valuable and necessary for platform growth. For instance, Afuah (2013) revealed the positive impact of endorsing a platform rating scheme to enhance trust among different platform sides. The study of ter Huurne et al . (2017) also listed several trust-related mechanisms, such as the verification of platform participants, the provision of a reputation system, platform security measurements, and the escrow services provided by platforms. However, enhancing trust among different sides of the platform does not give indefinite benefits to the platform as a marketplace. Because the parties that have once entered a trust relationship might create disintermediation risks to platform owners, where platform participants circumvent platform fees and form point-to-point off-platform interactions (Gu & Zhu, 2021).

2.1.2 Platform as innovation infrastructure

In addition to the economic view that emphasizes the platform's transactional features in facilitating exchanges, the other key strand of research views platforms as an organizing infrastructure which contains a set of resources, interfaces, modules, and

rules that are collectively used to enable innovation activities (Henfridsson and Bygstad 2013; Tiwana et al., 2010; Baldwin and Woodard 2009). Informed by this research stream, the platform serves as a codebase where third-party developers could contribute add-on services and products. Rather than configuring what value platforms could and should offer, such infrastructure orientation allows the platform to leverage heterogenous externalities' wits to fulfil different consumers' demands. These third-party externalities often can come up with novel products and services on a platform through the recombination of physical and digital resources (Yoo et al., 2010; Schumpeter 1934; Lusch and Nambisan 2015).

The first constitutive element of the platform's capacity to serve as an innovation infrastructure relies on the digital technology's layered modular architecture design (Yoo et al., 2010). First, compared to static products, where different components often have designated functions with closely coupled interfaces at the time of product design, digital technology entails greater flexibility in terms of its dynamic usefulness at the time of use. According to Yoo et al. (2010), the structure of the complexity of digital technology can often be devised into separate layers, including the device layer, the network layer, the service layer, and the content layer. Therefore, for the same device (e.g., a smartphone), its user value can remain highly open to the specific needs of consumers at the time of use. The usefulness of a smartphone could be achieved through the recombination of a camera app to turn a phone into a smart camera, to become a connected device that maintains users' virtual relationship with their social circles or to be used as an efficiency-related tool which serves the purposes such as reading documents and accessing to cloud. The essential benefit realized by the layered design of digital technology is the separation of the physical carriers to the growth of add-on digital value (Eaton et al., 2015).

To extend the variety of products and services that could be developed at each layer, the platform often organizes innovation activities by decomposing a complex system into subsystems and a large array of individual modules (Schilling, 2000). Therefore, developers could enjoy much freedom and autonomy in developing separate modular services without intervening with the platform's main system. Meanwhile,

platforms can ensure the best integration of all these modules from the decentralized development using the platform interfaces. In this regard, platform infrastructure reduces the complexity of digital innovation and provides the most flexibility to its complementors (Simon, 2002; Ennan and Richter 2010). Such layered modular design of platform infrastructure instils the platform services diversity to the greatest extent and achieves the growing platform usefulness among consumers (Baldwin and Woodard 2000).

Building on the layered modular design of digital innovation, one of the imperative issues in coordinating the autonomous innovation on a platform is the provision and managing of the platform's integration resources (Karhu et al., 2018; Anderson et al., 2018; Ghazawneh and Henfridsson 2013; Ghazawneh, 2012). Given the arm's length relationship between platform owners and third-party developers, Karhu et al. (2020) once defined two gateways that can encourage complementors' heterogeneity. The first is to grant greater access for complementors to interact with the platform by releasing platform resources such as APIs and SDKs. The second route is to assist complementors' innovation efficiency and quality by forfeiting the platform's proprietary resources, such as intellectual property rights, which signals the platform's commitment to coordinating with external innovation (Gawer and Henderson 2007). Furthermore, Eaton et a. (2015) examined the emergence and tuning of boundary resources in a broader platform context that involves multiple participating actors and further categorized the integration resources into the technology resources, such as hardware and software codes, the integration resources APIs, and the auxiliary boundary resources such as those used by jailbreaking applications developers.

2.1.3 Platform as meta-organization

The notion of meta-organization builds on the essential characteristic of the platform ecosystem, which is often described as the "organization of organizations" (Kretschmer et al., 2022; Ciborra, 1996). On the fundamental level, meta-organization highlights the institutional multiplicity of the platform that may contain varying types of organizations,

activities, and actors (Ander, 2017; Cusumano et al., 2019). Viewing a platform as a meta-organization hinges on some substantial features and concerns of an organization, such as incentivizing and retaining platform participants, managing intra-platform coordination and competition, designing and adjusting platform business models, and managing the competition with other rivalries in a given market (Adner, 2017; Kapoor, 2018; Kretschmer et al., 2022). In short, as a meta-organization, the platform owners or the platform sponsors need to coordinate well and orchestrate "a diverse and often very large array of organizational units and agents, some of whom face conflicting incentives or are direct rivals" (Kretschmer et al., 2022).

In Kretschmer et al. (2022), the challenges of the key features that distinguish a platform meta-organization from a traditional hierarchical business organization are unfolded into three aspects. The first feature is authority. This feature relates to the ownership of key assets on a platform. Compared to the contractual employment relationship, where the employers can have a central authority in delegating the production tasks and resource allocation, the platform ecosystem tends to grant more autonomy to its participants regarding what services could be exchanged with a minimal level of restrictions (Gawer, 2014). The second feature is motivation and incentives. This feature relates to various financial and non-financial benefits that encourage users' adoption and contribution to a platform. In addition to the direct revenues made by conducting transactions on a platform, entities within a platform organization also weigh other core or peripheral platform premiums, such as access exclusivity and prestigious platform reputation (Rietveld et al., 2019). The third difference that highlights the unique feature of platform meta-organization is governance and coordination. This feature particularly emphasizes some of the key challenges platform owners face in coordinating platform activities. Example questions asked in this aspect include how the decision rights should be partitioned among multiple entities, how the quantity and quality of platform services should be governed and balanced, how a platform could embrace heterogeneous innovation from diverse external parties while maintaining united as a whole.

Interpreting platforms as meta-organisations posts several key managerial

issues. The first strand of thinking is about organisation structure design in managing ecosystem actors' behaviour. A key implication of this group of reach is that the platform's success is highly associated with adopting and applying the right organisation structure. For example, Gawer and Henderson (2007) discussed how platform owners could leverage establishing an independent non-profit organisation to relieve platform actors' concerns about potential intra-platform competition. Anderson et al. (2017) also investigated the redesign of organisation structure in promoting and managing the decentralised development activities.

The second strand of research on platform competition concerns the management of the opportunistic adoption behaviours of platform participants. Given the ease of technology and the diverse benefits of different platforms, both complementors and consumers might simultaneously home on multiple platforms to maximise their utilities. Such a multi-homing phenomenon calls for the platform's attention to carefully evaluate its competition strategy compared to a single-home platform. In this regard, Barua and Mukherjee (2021) modelled the challenges of platform pricing when facing multi-homing consumers. They suggested the potentially opposite platform surplus depending on the extent of platform services differentiation. Cennamo et al. (2018) instead focused on the complementors' multi-homing tendency and revealed the complementors' departed investment in their complements' innovation and specialisation to a single platform. Besides, Bakos and Halaburda (2020) considered the platform's strategy when both sides of a two-sided platform are potentially multi-homing. Their study questioned the validity of the platform's subsidy because the mutual attraction between both sides could diminish when either side's participants are flexible to gain benefits from other platforms.

2.2 Platform Strategy

This thesis follows Levy and Ellis (2006) and Webster and Watson (2002) to construct a comprehensive view of prior studies in the platform strategy domain. First, I applied the broad search using the keywords "platform strategy", "platform growth", "platform

development", "platform scaling", and "platform development". The target journals include those from the AIS basket of eight, the ABS information management section, and some prestigious IS conference proceedings. In the second stage, I used techniques such as backward references and author search to extend the research pool. During this process, each of the related studies has been processed with the particular purpose of generating meaningful and synthetic understanding (Webster and Watson 2002).

Building upon the literature search, the third step mainly aimed at developing insightful output from the literature review, which can motivate the construction of this thesis. This thesis first digests the research orientation of platform strategy studies into two main streams: the business stream and the governance stream, and further discusses the tendency to integrate both streams. Besides, the other attempt made during this step was to decompose the relevant elements that strategy studies have covered. Doing so enabled the development of a platform strategy research blueprint, which can be potentially used to position the research question, identify the research gap, and articulate the unique research contribution.

The platform strategy is a widely discussed topic in the platforms related literature. The platform strategy is often understood as a broader term containing varying mechanisms in mobilizing and promoting the healthy platform ecosystem. For example, Parker and Van Alstyne (2014) described platform strategy as "the mobilization of a networked business platform to expand into and operate in a given market". Their study highlighted the importance of properly designing a platform's launch tactic, governance, and competition forces. Besides, according to Kretschmer et al. (2022) and McIntyre et al. (2021), given the multiplicity of actors and the heterogeneous innovation engaged within a platform ecosystem, platform owners also need to devise and wisely tune its institutional logics, standards, infrastructure, and governance (Cennamo et al., 2018; Eaton et al. 2015; Gawer and Cusumano 2014; Parker and Van Alstyne 2013).

2.2.1 Business view of platform strategy

According to Porter (1996), a business's strategy broadly concerns positioning itself in

a market and nimbly adjusting its adaptability to the changing competitive environment. To this end, positioning concerns what activities should be performed by an organization and how different activities can be related to each other. Porter (1996) quoted, "while operational effectiveness is about achieving excellence in individual activities, or functions, strategy is about combining activities." (p45). Porter's idea poses insightful implications for thinking of the platform strategy.

Broadly speaking, the platform strategy describes the platform's positioning in a given market. Such positioning may be based on providing various products or services, fulfilling unique consumers' demands, or branding the premium access to otherwise unobtainable resources (Porter, 1996). For instance, the Android and iOS platforms are positioning themselves as the market-leading provider of various digital services that can operationalize users' digital devices. LinkedIn, as a community platform, particularly facilitates professional conversations and digital connections. UpWork, as a matching platform, strategically leverages the demands of accessibility between job seekers and employers.

In addition to the positioning decision, the strategy also pertains to capturing the collective benefits generated from a series of business activities. This attribute highlights the necessity of gaining operational efficiency and maintaining sustainability for a business. Android and iOS have similar positioning objectives, but their approaches to developing varying digital services and the ancillary activities to promote business sustainability are fundamentally distinct. With both of them open access to third-party developers in 2008, Android allows multiple device markers to share ownership of created digital products. Apple has always privately controlled these digital assets with homemade Apple products. Accordingly, over the years, Android and iOS have adopted different sets of managing techniques to retain their ecosystem value to the intended users (see Karhu et al. 2020).

2.2.2 Governance view of platform strategy

When speaking of facilitating the sustainable growth of a platform, platform governance has always been a core issue that cannot be bypassed. According to Tiwana

et al. (2010), platform governance could be summarised as "who makes what decisions about a platform". Embedded within this definition are three major attributes of platform governance: the decisions right partitioned among multiple platform participants, the control mechanisms implemented to foster platform synergy, and the selection between the proprietary and the shared ownership. Decisions on these three components should eventually target resolving the "Goldilocks Governance Problem", where the platform owners should balance the trade-off between implementing sufficient control on platform participants to ensure platform integrity and nimbly waiving these controls at the right timing to foster innovation made by developers on that platform.

Digging into Tiwana's (2010) 's three attributes of platform governance may create a solid ground for understanding the platform governance's purposes. First, decision rights partitioning refers to granting and distributing authority and responsibility in making platform decisions. To this end, the core decisions consist of concerns regarding what products and services the platform should offer, what and how different resources can be used and aligned with platform purposes, and who controls the platform interfaces that draw platform boundaries (Baldwin and Woodard 2009). Second, the control decision deals with the formal and informal techniques that the platform owner and participants implement to encourage the desired behaviour from each other. For example, platform owners may enforce output control to regulate how the developers' contributions are assessed, measured, and penalized. Similarly, platform participants may revert the process control by creating additional resources or eliminating current restrictions through jailbreaking activity. Third, the proprietary and shared ownership of the platform concerns the degree to which the platform stakes are dispersed or concentrated. Platforms such as Linux can hold shared ownership by multiple developers, while GitHub, as an open based sharing platform, has proprietary ownership from Microsoft.

Building on Tiwana's (2010) fundamental work, Gulati et al. (2012) view platform governance as an overall design of platform mechanisms. Eaton et al. (2015) instantiate the platform governance challenge as a tension between the platform's

infrastructural control and the platform's generative and democratic innovations. By tracing the discourse of disputes among Apple developers and the Apple platform from the dynamics of boundary resources used, this study found that the distributed tuning action, which consists of the accommodation and resistance behaviour from the distributed heterogeneous parties, is constantly shaping and reshaping the platform landscape. Similarly, Huber et al. (2017) define platform governance as an artistic job that balances the ecosystem-wide control and the platform participants' cocreation incentive. One critical variation of Huber et al. (2017) is its dialectic recognition of the changing nature of platform governance. Despite the mechanisms and the rules applied by the governance, its success relies upon its sensitiveness and responsiveness to the dynamic platform ecosystem value over time.

By viewing the salient platform governance research, there emerges a key observation that the major focus which almost all papers have taken is around implementing ecosystem-wide control and maintaining platform developers' motivation at an appropriate level (Boudreau, 2010; Wareham et al., 2014). In doing so, what types of platform integration resources should be provided and how these boundary resources may relate to the tight and loose platform control should be well understood and designed by platform owners (Ghazawneh & Henfridsson, 2013; Eaton et al., 2015). Besides, some other elements, such as the control mechanisms and decisions rights partitioning, also form a key area of concern in platform governance.

2.2.3 Relationship of the business and governance view of platform strategy

The business and governance aspects of the platform strategy discussed above show substantive complementary value to each other. The business aspect is founded on the basis that platforms, regardless of what types of exchange activities are served, are essentially types of business exchanges. Therefore, to survive and succeed in a given market, platforms must constantly seek the right propositions and adjust their business position to compete against other rivals. Noting such commercial essence of platforms ushers the thinking of platform strategy into a familiar area that has been extensively

tested in traditional, non-platform businesses. For example, some promotion strategies, such as mass marketing and cross-channel advertising, still apply in the platform contexts. Also, some broader techniques regarding business positioning and growth, such as services differentiation, niche market strategy, and expansion into new and foreign markets, remain highly relevant to platform success.

Apart from the business aspect, which roughly emphasises the conventional strategy tactics, the governance aspect tends to spotlight the peculiar attributes that only apply to the platform's context departing from traditional organisational forms. The governance aspect focuses on identifying the unique issues involved in managing the multiple types of actors, interactivities, and relationships within a platform ecosystem. Discussion in this stream is unfolded into several types of tensions that are particularly relevant to platform organisations. For instance, the degree of control and autonomy between platform owners and platform complementors, the proprietary and shared assets allocated among platform owners and platform participants. In short, the governance aspect of platform strategy pinpoints the designated challenges faced by the platform in orchestrating the multilateral interactions within the platform ecosystem.

Though having different foci in driving the platform's success in a given market, the business and governance aspects of platform strategy are profoundly intertwined. First, the platform's decision on platform value creation types is inseparable from the platform's ally with externalities. As an intermediate facilitator, the platform is not engaging in the direct production of platform services but relying on third-party complementors. Therefore, the overall presentation of a platform in terms of the provision of services, the identity that departs it from other homogenous platforms, and the reputation that is granted by the market against the platform's competitors are substantially factoring to the complementors that reside on a platform (Karhu et al. 2020). For example, for an online game platform (e.g., Xbox, Nintendo), one of the key business objectives is to maintain consumers' continuous buy-in of platform value. This business goal is achieved by regularly upgrading users' experiences through the complementors' game updates or new title release activities. In this sense, the means that platforms rely on to maintain their business propositions

remarkably depend on the effective implementation of governing the platform complementors. Furthermore, at some points during the platform's growth, the online game platforms might think to spotlight some superior allure to players. For example, Microsoft made Halo an exclusive game on Xbox and appealed to many early adopters after it was launched.

Second, the synergy of business and governance aspects is also reflected by the dual roles played by key platform resources in growing the scope of platform services and the affiliation with platform participants (Tan et al., 2020; Ghazawneh and Henfridsson 2013). For example, platform owners often need to release integration tools that serve as interfaces between the platform and externalities (Tan et al. 2020). Integration resources are used to build a gateway for platform complementors' decentralized development of add-on innovation on platforms (Tiwana et al., 2010). In the meantime, these resources also enforce the arm's length relationship between platforms and externalities (Ghazawneh, 2012; Ghazawneh and Henfridsson 2013). In this regard, the business objectives and governance tools hold compatible effects to lead platform growth and enhance platform control. Platform owners may open up boundary resources to increase platform services' diversity when the variety is privileged by platform participants. Also, platforms may decide to tighten such arm-length relationships by granting lesser flexibility to platform developers so that to reinforce the platform's central control (Ghazawneh and Henfridsson 2013).

Third, the synthesis of the business and governance traits of the platform strategy has become highly pertinent in some recent studies in which the platform ecosystem is the core unit of analysis. Notably, Rietveld et al. (2019) merge the idiosyncrasy of platform business and governance by interpreting platform strategy as what embodies the platform sponsor's varying techniques in managing the overall value of a platform ecosystem. Foerderer et al. (2021) granted more radical equality to platform strategy and governance and articulated all those different means taken by platform owners as a form of governance. Because these means reflect the platform owner's objectives in growing and promoting a platform and also soliciting the platform's design in encouraging desirable behaviours and outcomes, these business needs and governance

demands together outline the complexity of the platform ecosystem as a meta-organization (Chen et al., 2022). In this regard, the platform strategy as the platform evolvement gear accommodates essential concerns from the business's viewpoint regarding the platform's positioning and competition in a given market (Trischler et al., 2021), as well as the governance's viewpoint regarding the institutional incentives and controls (Kretschmer et al., 2022).

CHAPTER 3. THE COMPONENT VIEW OF PLATFORM

SRATEGY AND RESEACH DEISGN

3.1 Component View of Platform Strategy

Upon demonstrating the imperative and integrative nature of platform strategy that consists of both business criticalness and governance criticalness, this section aims to propose a new reception of platform strategy, which is believed to offer superiority in terms of developing platform strategy research and bridging platform strategy studies to practices with more unequivocal implications.

The provenance of this component view on platform strategy emerged from my observation of a seemingly obvious yet overlooked phenomenon in platform strategy research. Many of the studies, regardless of their origins in adopting the business or governance view, acquire some commonalities in their construction of the platform strategy research. To specify, these studies all have a focal instrument or strategy mechanism (e.g., subsidy, seeding) as their focus of study. The research aims are often built around emperically investigating or testing the effects of the understudied instrument on certain aspects of platform growth (e.g., attracting platform participants; promoting quality improvement). Given these, each of those platform strategy studies tends to seek a unique and novel contribution by differentiating through the under-studied platform context (e.g., software development platform; e-commerce platform), or the stage of the platform that is concerned by that specific mechanism (e.g., platform launch; platform expansion).

The component view of platform strategy research greatly reverberates to Gawer (2014), who once described platform strategy as what "appeared in reality, in a different organisational context, at different levels of analysis, and highlight their essential characteristics". Gawer's interpretation of platform strategy makes several important implications. First, platform strategy is an entity that resembles intimate associations to the practices. Studies on platform strategy greatly build on empirical observations and should contribute managerial insights to platform practitioners.

Second, the context under which the platform strategy is discussed should never be omitted when making conclusions. The platform background, such as the context and characteristics, could dynamically complicate investigating a specific platform strategy. Therefore, such information should be carefully counted when designing platform strategy research and drawing conclusions on platform strategy's implications.

In the following, I will define and explain the components identified from the past research. Table 3 below provides an overview of the five major components or elements that have been extracted by reviewing the previous studies. They are the strategy mechanism, the platform type, the strategy execution timing, the target entity, and the outcomes. The demonstration of the component view, which is employment with prior platform strategy studies, could be seen in Table 3 (see in Appendix).

Table 3.Components of Platform Strategy Research

Component	Explanation
Strategy mechanism	The specific techniques, methods, tools, and instruments adopted by platform owners. e.g., subsidy; platform endorsement; platform sponsorship.
Platform type	The foci of platforms distinguished by the activities, services, and products that circulated on platforms. e.g., e-commerce platform; social network platforms; game console platforms.
Time of strategy implementation	The time gap between the platform launch year to the execution time of a platform strategy mechanism.
Target entity	The platform participants and objects that are aimed by the application of strategy mechanism. e.g., complementors; consumers; interfaces.
Implications	The observed consequences of the implementation of a specific strategy mechanism. e.g., incentivise; restrain; neutral.

Strategy mechanism

The first element that comes into the discussion of platform strategy research is identifying the specific mechanism being operationalized on a platform. Given the complexity of the platform ecosystem where multiple actors and organizations are involved, platform owners need to adopt different tools and instruments to achieve their

strategic intentions on a platform (Cozzolino et al. 2021; Jacobides et at., 2018; Gawer and Cusumano 2014). The mechanisms can take a variety of forms, such as the platform's subsidy provided to its participants (Evans and Schmalensee 2010), platform's endorsements (Liang et al., 2021; Rietveld et al., 2019), financial assistance given to complementors (Foerderer et al., 2021), platform's redesign of its organization structure (Bakos and Halaburda 2020; Gawer and Henderson 2007), and many other types of instruments that are excelled in promoting platform value growth.

Platform type

The second element is the type of platforms that are being studied. This element is a necessary area of inquiry needed by the readers to understand the contextual background of the understudied strategy mechanism. Which further serves as a prerequisite to drawing any conclusions on the generalizability of the investigated strategy mechanism in relation to other platform scenarios.

Time of Strategy Implementation

The third element is strategy execution time. This factor is often mentioned as supplementary information in platform strategy research. Many studies descriptively reveal this information in the research data section but do not make explicit inferences about this dimension to the research implications. For example, the research might mention that they investigate the platform owner's entry to the platform's complementary market that occurred at a particular time. However, what is lacking here is to articulate whether that specific strategy mechanism applied at that particular time point has some implications for their conclusions. Imagine if the findings are that the platform owner's entry might discourage complementors' participation. The next relevant question is whether the platforms want such complementors' drop-off. Answers to the latter question indeed depend on the clarification of the platform's characterises at the time of strategy implementation.

The most salient motivation to highlight the time element of a platform strategy is informed by the platform's essence as an evolving ecosystem, which presents similar

attributes to other organizations meant to tackle different challenges as it develops. For example, Parker and Van Alstyne (2014) indicate that platform owners need to initiate platform development with permissive governance at the platform's launch stage and a tighter control orientation towards a more mature stage to recoup revenue (O'Reilly, 2010). Trischler et al. (2021) once distinguished these different stages as birth, expansion, leadership, and renewal. To avoid the over-subjective judgement on the time of strategy implementation concerning the platform's developmental status, this thesis decides to present the time gap of the strategy implementation of the platform launch year and slightly draw on Trischler et al. (2021)'s framework in the latter discussion.

Target entity

The fourth element is the target entity concerned with platform strategy research. This element emphasizes the differences between the intended objects targeted by a specific strategy. Based on the main entities and the gateway involved in a platform ecosystem, this attribute considers the platform interfaces, platform complementors, and platform consumers (Boudreau and Hagiu 2008; Gawer, 2014; Tiwana et al. 2010).

Implications

The last element is the implications of platform strategy research regarding implementing a certain strategy mechanism. Chen et al. (2022) summarize the platform strategy's consequences into incentive and control. Budling on Chen et al. (2022) and accommodating theoretical research that is not built on empirical analysis, I organize the objective of the understudied platform strategy into four variations. The incentive indicates that the understudied strategy mainly aims to promote desirable reactions and results to the platform. The restrain means the suppression effects brought by that strategy. Specifically, the restraining impact can be active, such as preventing undesirable behaviour. But it can also be passive, such as the side effects when implementing a strategy. The simultaneous occurrence of both positive and negative implies the duality of research findings, where the authors identified both the push and pull forces of that strategy. The last variation is the neutral result. It mostly concerns

those purely theoretical studies, in which the authors rely on theoretical modelling to dissect the inner logic of a strategy but do not empirically investigate its application impacts.

3.2 Application of the Component View in Developing Platform Strategy Research

As discussed in the preceding chapter, five key components are often involved in platform strategy studies. They are strategy mechanism, platform type, platform development stage, intended target(s), and implications. The first four elements often set the foundation and context of platform strategy research, and the last outcome element is the research findings on which the conclusions are drawn. Therefore, based on the possible different combinations of the four background components, a typical platform strategy research could be designed and situated itself in the extant body of literature through the following three routes (see Figure 2).

For the first group of combinations (A1, A2, A3), platform strategy research may differentiate itself from other studies by emphasizing the unique features of any two components out of four. Studies following the A1 pathway may investigate the same strategy mechanism but different from the platform context or vice versa. For instance, in Tan et al. (2020), the platform integration resources (e.g. APIs) are studied together with the pricing structure on the hardware/software platform like Nintendo and the B2B retail platform like Saleforces.com. This study found that on a digital development platform, the platform's investment in improving the integration resources should be well-coordinated with the pricing structure charged to both developers and consumers to gain the maximum benefit. While on a retail platform, the buyers and sellers see the complementary spillover where one side's improved investment in the integration tool will trigger the other side to increase investment.

For the second group of combinations (B1, B2, B3), the platform strategy study may aim to contribute new knowledge by highlighting their research uniqueness based on combinations of any three elements. Studies following this pathway might be more

unprecedented than having a fresh view of all three elements. Alternatively, this study may add incremental updates to platform strategy by holding one or two fixed elements but focusing on the outstanding component. To illustrate, the authors might be interested in investigating an e-commerce platform's pricing structure but with a different setting regarding the platform's development stage. Factors influencing a platform's pricing strategy at the early stage of development might yield some unexpected nuances to the pricing on a matured platform. Or the same mechanism and platform's mutuality are presented but in a different platform context. For example, both Zhu and Liu (2018) and Foerderer (2018) studied platform owners who offered first-party products and built a presence in the platform's complementary market. While Zhu and Liu (2018) found the post-entry profit squeeze that drives complementors' drop out on the e-commerce platform, Foerderer (2018) found the boosted platform value creation because the mobile app developers in the entered Android photo complementary market increase their investment in innovation and product quality.

The third group of research design entails the maximum level of flexibility. The platform strategy research following this route have a great chance to show its uniqueness by having an entirely new design on all four elements. Or hold still for at least three components and highlight the differences made by the fourth outstanding component. Gawer and Hender's (2007) paper on Intel's use of shared IP resources and organization structures in influencing the participants in connecting markets is a good example of ground-breaking research. Their study examined how a well-established organization can motivate and coordinate with external parties to grow the entire industry towards an open co-creation ecosystem. This research is not only unique in terms of its research design but also entails greater capabilities in making highly specific and targeted implications to practitioners due to the least number of potential assumptions embedded in the research.

For future platform strategy researchers, Figure 2 offers some usefulness in terms of summarizing and positioning the prior studies, looking for the research gaps and potential discrepant findings, and developing a new research that can have explicit and specific contribution.

Figure 2. Application of Platform Strategy Components in Developing Platform Strategy Research

A1: How strategy mechanism **P** can be applied on/influences **Q** platform
A2: How strategy mechanism **P** can be applied on/influences platforms at **R** stage of development
A2: How strategy mechanism **P** can be applied on/influences **S** entities on a platforms

B1: How strategy mechanism **P** can be applied on/influences **Q** platform at **R** stage of development
B2: How strategy mechanism **P** can be applied on/influences **Q** platform's **S** entities
B3: How strategy mechanism **P** can be applied on/influences **S** entities at **R** stage of development

C1: How strategy mechanism **P** can be applied on/influences **Q** platform's **S** entities at **R** stage of development

3.3 Application of the Component View in Developing Three Studies

This section will present the motivations of the three empirical papers included in this thesis. To avoid repeating the groups of literature discussed in each paper, this section will focus on accentuating how each paper emerged using the component view addressed above. As well as highlight the intended contribution of each paper concerning the current literature.

3.3.1 The timing of entering complementary market

The first paper (see Chapter 4) is "comparing platform owner's early and late entry into complementary markets". As indicated by the research title, this empirical study follows the B1 research design approach--how strategy mechanism P can be applied to / influence the Q platform at the R stage of development (see Graph 1). The primary motivation that underlines this research originated from observing the conflictual findings revealed by prior studies. Following the component view of platform strategy, this study fell into an increasingly popular stream of debates around the platform owners offering first-party products in the platform's complementary markets and positioning themselves as direct competitor to platform complementors. This issue has been attended by several scholars, including Wen and Zhu (2019), Zhu and Liu (2018), and Foerderer et al. (2018).

What distinguishes this paper from prior work lies in the new angles regarding

the platform type and development stage. First, the type of platform context dealt with by those studies mainly consists of the e-commerce platform like Amazon e-marketplace (Zhu and Liu 2018), the digital innovation platforms such as Google Android and Apple iOS (Wen and Zhu 2019; Foerderer et al., 2018), and the online game console (Cennamo et al., 2016). To diversify the contextual richness of platform strategy research in this domain, the first paper of this thesis adopts Amazon Alexa as the targeted platform and exams Alexa's entry into its smart home complementary markets. Taking such home-oriented Internet of Things platforms as the main context extends our views into a platform where both physical and digital innovation are engaged. Because the complementors of Amazon Alexa need to come up with the potential home control services demanded by consumers and thus are valuable to be added to the Alexa smart speakers. Also, the developers should swiftly realize their ideations of the demanded services with a tangible product that often sits at different places around the home.

The second feature that distinguishes this research from the prior study is the timing of strategy implementation. It is speculated to be a major reason that might explain why past studies in this field indicate some divergent opinions on entry's impacts. Specifically, a group of studies suggest the increased platform-complementor competition after entry and the squeezed profits space that reduce complementors' motivation in the entered market (Zhu and Liu 2018; Wen and Zhu 2019). There is also prominent support for platform entry's incentivising effects on complementors' participation and innovation improvement (Gawer and Henderson, 2007; Foerderer et al., 2018). Therefore, this paper proposes a possible resolution to reconcile such divergent implications by distinguishing the early or late entry timing. It is based on the speculation that the platform complementors could have a different interpretation of the platform's entry depending on whether it happens at the early stage of platform development (i.e., early entry) or the more matured stage of platform development (i.e., late entry). Because the level of gained knowledge on consumers, the stability and maturity of the platform's core technology, the degree of establishment of the market structure and the competition landscape, and the bargaining power of complementors

in relation to the platform's infrastructure control are all different at early times of platform development compared to that in the later stages.

3.3.2 Behavioural motives in scaling platform consumer base

The title of the second paper (see Chapter 5) is "apply human behavioural instincts in designing platform's scaling strategy". The primary motivation that underscores this research is based on observing a new form of platform scaling techniques from empirical evidence. Using a Chinese-based e-commerce platform as a single understudied unit, this research joins the controversy that concerns the effective stimulation of the same-side network effects on a platform. Overall, this research aims to contribute a new angle to prior studies that focused on the use of the platform subsidy in incentivizing platform participation (Parker et al., 2016; Parker and van Alstyne, 2014; Caillaud and Jullie, 2003; Rocket and Tirole, 2003).

The unique contribution of this paper departs from the previous studies on platform scaling and is about the origins of research assumptions. The previous studies on platform scaling techniques have been largely built on the ground that platform users' behaviours are rational. Building on such a rationality basis, the same-side and cross-side network externalities could often be initiated and boosted by deploying the conquer-and-divide strategy and other incentive financial mechanisms (Rocket and Tirole 2003). To complement this rationality-oriented platform scaling strategy, this research sheds light on the possible behavioural instincts that could be embedded in the design of the platform strategy. In particular, this research investigates an alternative design of the platform's subsidy scheme applied on the consumer side. Compared to the traditional subsidy such as charging below-the-margin prices, giving discounts, coupons, or free products, and offering referral rewards (Parker et al., 2016; Parker and van Alstyne, 2014; Lee and Mendelson, 2008; Caillaud and Jullie, 2003), this research presents a new game-based subsidy strategy which extensively utilizes the consumers' psychological motives to actively pursue the same-side network externalities.

Following Yin (2003)'s single case analysis approach with various data sources (Baxter and Jack 2008), this research analysed consumers' adoption behaviour of a

Chinese-based e-commerce platform called Pinduoduo. As the third-largest commercial platform, Pinduoduo made its success an exceptionally interesting case, given the dominant market power possessed by Alibaba and JD.com in this industry for more than ten years. While many prior platforms have failed to make breakthrough changes in this market, Pinduoduo surged forward with an unprecedented scaling technique that entertained consumers with a lottery-like game. Furthermore, based on our analysis, the key forces that made Pindudou's scaling scheme so successful lie in its acute utilisation of psychological instincts in many aspects of the strategy design, such as induced framing, process control, and atmosphere creation. Overall, this research constitutes the earliest troop of platform strategy study that draws on interdisciplinary knowledge from the psychology and behavioural field (Afuah 2013; Kock 2009).

3.3.3 Grounding on a technology to build platform ecosystem

The third paper (see Chapter 6) is "Blockchain Network as a Platform: conceptualising its adapted layered architecture design." This paper is closely tied to the studies that focus on developing a platform ecosystem (Basak and Petrakis, 2021; Park et al., 2020; Chintakananda and MacIntyre, 2014). As an emerging technology essentially built with the logic of the distributed ledgers, Blockchain has seen its increasing applications in some sectors such as cryptocurrency, digital contract, records storage and tracking, supply chain monitoring and management, and cross-broader transactions. Inspired by McIntyre et al. (2021), which calls for attention to the four research gaps that exist in the current research on platform ecosystem dynamics, this research aims to stress one empirical example where a core technology (i.e., Blockchain) and its interfaces fundamentally enable the formation of a platform ecosystem. Informed by the explorative nature of the research theme that examines the application of Blockchain in the platforms context, this research draws on a case study of OneConnect's Blockchain network.

Appendix of chapter 3

Table 4. Key Studies on Digital Platform Strategy and the Engaged Strategy Components

Research	Strategy Mechanism	Platform type	Development stage		Entities			Implications		
			Platform launch year	Strategy implement ation time	Compleme ntors	Consumers	Interfaces	Incentive	Restrain	Neutral
Foerderer et al. (2021)	Platform awards	Digital innovation (Google Android)	2008[3]	2016-2018	X			X		
Liang et al. (2021)	Platform-provided editor recommendations	Digital innovation (Apple iOS and Google Android)	Apple: 2008[4] Google: 2007	2016	X			X		

[3] Morrill, Dan (September 23, 2008). "Announcing the Android 1.0 SDK, release 1". Android Developers Blog. https://android-developers.googleblog.com/2008/09/announcing-android-10-sdk-release-1.html

[4] Dalrymple, Jim (March 6, 2008). "Apple unveils iPhone SDK" *International Data Group*. *https://www.macworld.com/article/189618/iphonesdk-2.html*

Karhu et al. (2020)	Leverage; Control; Exploit; and Defense	Digital innovation (Apple iOS and Google Android)	NA	NA	X			X	X	
Tan et al. (2020)	Pricing and platform resources	Hardware/software platforms; Retail	NA	NA	X	X		X		
Rietveld et al. (2019)	Platform selective promotion (endorsement)	Video game console (PS3; Xbox 360)	PS3[5]: 2006 Xbox 360[6]: 2005	2007-2011	X			X		
Wen and Zhu (2019)	Platform provides first-party complement	Digital innovation (Apple iOS; Google Android)	Apple: 2008 Google: 2007	Apple: 2009-2012 Google: 2011-2014	X			X	X	
Karhu et al. (2018)	Platform forking	Digital innovation (Google Android)	2007	2007-2017			X		X	

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[5] BBC (2006). "PlayStation 3 sells out at launch" http://news.bbc.co.uk/1/hi/technology/6135452.stm

[6] Microsoft (2005). "Microsoft Announces Xbox 360 Day One Launch Lineup—Strongest Launch in the History of Video Game Consoles" https://news.microsoft.com/2005/11/14/microsoft-announces-xbox-360-day-one-launch-lineup-strongest-launch-in-the-history-of-video-game-consoles/
Xbox (2001) https://web.archive.org/web/20130612000737/http://www.microsoft.com/en-us/news/press/2001/nov01/11-14midnightmadnesspr.aspx

Author	Concept	Context	Year	Period						
Zhu and Liu (2018)	Platform provides first-party complement	Retail (Amazon)	2000[7]	2013-2014	X				X	
Foerderer et al. (2018)	Platform provides first-party complement	Digital innovation (Google Android)	2007	2015	X			X		
Cennamo et al. (2016)	Platform provides first-party blockbuster complement	Video game console (PS; Xbox; Nintendo, etc)	Seven generations of game consoles	1995-2008	X				X	
Eaton et al.(2015)	Distributed tuning	Digital innovation (Apple iOS)	2008	2007-2011	X		X			X
Anderson et al. (2014)	Platform performance	Two-sided market	NA		X	X				X
Zhu and Iansiti (2012)	Platform quality, indirect network effects, and consumer	Video game console (Xbox)	2005	2000-2005		X		X		

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[7] Amazon (2001) "Amazon Marketplace a Winner For Customers, Sellers and Industry; New Service Grows over 200 Percent in First Four Months" https://press.aboutamazon.com/news-releases/news-release-details/amazon-marketplace-winner-customers-sellers-and-industry#:~:text=Launched%20in%20November%202000%2C%20Amazon.com%20sells%20the%20item%20new.

	expectation when enter a market									
Ghazawneh & Henfridsson (2013)	Platform's boundary resources	Digital innovation (Apple iOS)	2008	2008-2010	X		X	X	X	
Eisenmann et al. (2011)	Platform Envelopment	Two-sided market	NA	NA	X	X		X		
Evans and Schmalensee (2010)	Prices and non-prices products (launch)	Two-sided market	NA	NA	X	X				X
Gawer and Henderson (2007)	Platform shared IP resources and organization structure	Industry (Intel)	1968[8]	1990-2004	X			X		
Hagiu (2006)	Pricing	Two-sided market	NA	NA	X	X				X
Caillaud and	Pricing	Two-sided market	NA	NA	X	X				X

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[8]Silicon Valley Historical Association (2008). "Intel" https://www.siliconvalleyhistorical.org/intel-history

Julien (2003)										
Rochet and Tirole (2003)	Pricing	Two-sided market	NA	NA	X	X				X
Fath and Sarvary (2003)	Pricing and switching costs	Commerce	NA	NA	X	X				X

CHAPTER 4. COMPARING PLATFORM OWNER'S EARLY AND LATE ENTRY INTO COMPLEMENTARY MARKETS

Abstract

Research on platform owner's entry into complementary markets points in divergent directions. One strand of the literature reports a squeeze on post-entry complementor profits because of increased competition. Another strand of the literature observes positive effects as increased customer attention and innovation benefit the complementary market as a whole. In this research note, we seek to transcend these conflicting views by comparing the effects of early and late timing of platform entry. Using data from three entries of Amazon into its Alexa voice assistant's complementary market, we apply a difference-in-differences design to analyze the drivers and effects of the timing of platform owner's entry. Our findings reveal that early entry is driven by the motivation to boost the reputation and value creation of the complementary market, whereas late entry is driven by the motivation to secure the platform owner's access to the value capture of a key complementary market. Importantly, we show that early entry, contrary to late entry, creates substantial consumer attention, primarily benefitting complementors that offer specialized functionality. Overall, this research note contributes novel insights about the timing of platform entry into complementary markets.

4.1 Introduction

Platform complements are add-on services that enhance the usefulness of a platform's core offering (Cennamo and Santaló 2019; Hukal et al. 2020; Tiwana 2018). They add

specific functionalities that otherwise would be difficult for the platform owner [9]to offer (Adner 2017; Jacobides et al. 2018). For instance, in 2015, the Google Play Store hosted more than 1,200 photography applications extending the platform and competing for consumer attention (Foerderer et al. 2018). Such clusters of complements typically form highly competitive markets on popular platforms (Boudreau 2012). Since the platform business in premised on platform owners and platform complementors mutually benefiting from each other, platform owners need to govern the complementary markets to satisfy both their own interests and the interests of the third-party complementors (Hukal et al. 2020; Tiwana et al. 2010). However, platform owners sometimes dramatically change their relationship to the complementors of a specific complementary market by choosing to enter the market.

Research on platform owner's entry into complementary markets points in divergent directions. One stream of research emphasizes that platform owner's entry is contentious as it puts platform owners in direct competition with complementors (Gawer and Henderson 2007; Jiang et al. 2011; Cennamo et al. 2016; Foerderer et al. 2018; Zhu and Liu 2018; Lan et al. 2019; Zhu 2019). In particular, the platform owner's entry leaves less room for existing complementors to make profits (Zhu and Liu 2018). In addition, such entry may also reduce innovation by third-party complementors (Lan et al. 2019; Wen and Zhu 2019), forcing complementors to adapt to new competitive patterns (Edelman and Lai 2016), or even making complementors to exit the entered market (Cennamo et al. 2016). This stream of literature rests on the assumption that complementary markets are mature and exhibit stable customer demand so that there is distinct value to be extracted. Another stream of literature emphasizes the positive impact of platform owners' entry. It suggests that entry of the platform owner promotes the popularity of a complementary market among consumers (Li and Agarwal 2017), stimulate quality improvements among its complementors (Foerderer et al. 2018), and improve consumer retention on the platform (Li and Agarwal 2017).

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[9] We view platform owners as a mediating party in the value exchange between a platform's complements and a platform's users (Rietveld and Schilling 2020).

In this research note, we propose that the timing of entry is a significant factor in explaining the differences manifested in the literature. When the market is only starting to grow there is typically little immediate value to appropriate as the markets exhibit "extreme ambiguity about opportunities and customer demand" (McDonald and Eisenhardt 2020, p. 485). Early entry is therefore likely motivated by an ambition to grow the market and its value than to capture value in the short term. For instance, the platform owner may try to signal its commitment to the complementary market (Hukal et al. 2020), and thus to stimulate market growth by indicating first-mover advantages and by showing the platform owner's determination to secure the long-term viability of the market. By contrast, late entry to a relatively mature complementary markets is different and may involve a squeeze on post-entry complementor profits from the increased competition.

In view of the limited empirical evidence, we designed an empirical study that examines the timing of platform owner's entry and its impact on value creation in complementary markets. Our study addresses the following research question: how does the timing of platform owners' entry into a complementary market influence value creation? We collected panel data from the Amazon's Alexa platform and harness two early entries and one late entry by Amazon to Alexa smart home complementary markets as natural experiments using difference-in-differences design with fixed effects and a robust set of controls. The three selected entries are particularly suitable for answering our research question because the Alexa's smart home market was inherently new (as opposed to, for instance, games) as it largely emerged along with the introduction of Echo smart speakers to consumers. The findings show that Amazon's early entry into the Home Surveillance market increased complement popularity and by proxy value creation in that market. The increasing popularity particularly benefited complements with specialized functionality, which is typically associated with easy configuration and adoption of the complement. By contrast, our findings show that a corresponding increase in complement popularity did not occur in the case of late entry.

This research note contributes to platform research by showing that the timing of the platform owner's entry into complementary markets matters, reconciling

conflicting findings regarding the consequences of the platform owner's entry to the complementary markets (cf. Rietveld and Schilling 2020).

4.2 Literature Review

4.2.1 Platform owners' entry into complementary markets

Market entry is a central topic in the broader management and strategy literature. The decision to enter a new market is often a deliberate way to diversify the firm (see e.g., Mayer et al. 2015; Teece 1982) by using excess resources that are "surplus to current operations" (Chatterjee and Wernerfelt 1991, p. 33). Such use of excess resources for establishing a firm's presence in a market is typically realized through internal development or acquisition (Lee and Lieberman 2010). At the same time, a platform's success rests on the viability and quality of its complements (see e.g., Ghazawneh and Henfridsson 2013; Karhu et al. 2018; Parker et al. 2017; Teece 1986; Tiwana et al. 2010). It is therefore important for a platform owner to ensure that complementors continue to operate and thrive on its platform. A platform owner's entry into a complementary market can therefore disrupt the mutual relationship between the platform and its complements. The entry changes the bilateral relationship between the platform owner and the complementors in the specific complementary market, also potentially sending a signal to complementors in other markets (Hukal et al. 2020; Zhu and Liu 2018). The move can redistribute the value captured in the complementary market at the expense of complementors, but it may also speed up the market's growth and benefit both the platform owner and the complementors.

Reviewing the literature[10], a significant proportion of the extant research on platform owner's entry focuses on the competition between the platform owner and its

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[10] We followed Levy and Ellis (2006)'s input-processing-output approach to conduct the literature review. First, we initiated our search in the journals included in the AIS Basket of Eight and the ABS Information Management division lists. We performed a keyword search to identify studies using the phrases "platform owner's entry", "platform entry", and "platform enter complementary market" in their title. We then narrowed down the selection to papers focusing on the platform owner's entry to a complementary market by analyzing the research questions and dataset used in the papers (Booth et al. 2022). Second, we summarized the remaining papers along multiple dimensions such as the studied platform context, the entry mode, the targeted market characteristics, and the entry's consequences and implications (Webster and Watson 2002). Finally, two key observations emerged from the summaries that motivated our research. First, we found that past studies have mainly focused on pure digital innovation platforms (e.g. Android, iOS) or retail platforms (e.g. Amazon Marketplace), while little attention has been paid to platforms that engage the innovation of both physical and digital artifacts.Second, studies showed

complementors. The literature examines how the platform owner appropriates value from the market by launching a similar offering as complementors (Wen and Zhu 2019; Lan et al. 2019; Zhu and Liu 2018; Edelman and Lai 2016; Cennamo et al. 2016; Jiang et al. 2011). The platform owner is typically in a good position to appropriate value from a chosen complementary market. The platform owner can, for instance, exploit its privileged position to identify the most promising complementary markets regarding sales or user growth and by imitating successful complementors, the platform owner can then quickly gain market share and generate profits (Priem 2007; Zhu and Liu 2018). This is often facilitated by the platform owner's capacity to shape the platform ecosystem's governance to privilege its own complements (Edelman and Lai 2016; Priem 2007). For example, platform-owned complements may receive prioritized display, competitive bundle pricing, or add-on services such as fast delivery that help them compete with third-party complements (Zhu and Liu 2018). Moreover, the platform owner's entry may alter consumers' expectations and purchasing behavior (Edelman and Lai 2016). The intensified competition makes factors such as development capability, financing, and innovation rates even more critical for the success of individual complements on the market (Casadesus-Masanell and Yoffie 2007). As a result, complementors sometimes exit the entered market or redirect their efforts to other similar complementary markets on other platforms (Zhu 2019). In sum, this stream of literature posits that the platform owner's entry typically increases competition in the complementary market, squeezing complementors' profits, which, in turn, reduces third-party investments into the complementary market (Zhu and Liu 2018). Furthermore, the more predatory approach the owner takes, the more it can spill over to other complementary markets, which risks jeopardizing the trust between the platform owner and its complementors in general (Rietveld et al. 2019; Wareham et al. 2014).

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contrasting findings concerning whether the platform owner's entry would motivate complementor innovation or discourage complementors from investing in the market. This triggered us to speculate that this might be due to the timing of entry with respect to the launch of a platform. Therefore, we decided to make Amazon Alexa (home IoT platform) the empirical context and to focus on examining the effects of early and late entry conducted by the platform owner.

Another, yet smaller, body of literature recognizes the value creation aspects of platform owner's entry into a complementary market. The platform's participation in the complementary market can increase the consumers' appreciation of the platform and stimulate quality improvements, innovation, and positive co-specialization among complementors (Priem 2007; Gawer and Henderson 2007; Gawer and Cusumano 2002). First, the platform owner's participation can improve the platform's reputation among consumers (Cennamo and Santaló 2019), and the existence of first-party complements can positively influence the consumers' perceptions of the viability of complements in a particular category (Roger and Vasconcelos 2014). In this regard, increased platform reputation may benefit all platform participants (Cusumano et al. 2019; Hagiu and Spulber 2013; Rietveld et al. 2019). Second, the reputation improvement can induce market expansion effects as the platform's presence in the complementary market stimulates innate curiosity from the demand side (Li and Agarwal 2017). Together, the platform and the entered complementary market may become more visible and viable in consumers' eyes. The spillover of consumer attention, in turn, boosts the growth of the complementary market, benefitting complementors by increasing the total market size.

4.2.2 The timing of entry into complementary markets

Extant research primarily examines platform owner's entry and competition in relatively mature complementary markets (e.g., Foerderer et al. 2018; Zhu 2019; Zhu and Liu 2018; Jiang et al. 2011; Wen and Zhu 2019; Cennamo et al. 2016; Edelman and Lai 2016). Such markets have an established portfolio of available products and, as a result, consumers are often well-informed about the services offered by complementors. For instance, in Zhu and Liu's (2018) study of the Amazon Marketplace, the sample included 163,853 incumbent products in 22 product categories. In the Foerderer et al.'s (2018) study, the sample consisted of 1,266 available complements in Android's photography category. Entering such mature markets can thus become a relatively predictable endeavor to platform owners.

There are a few studies that examine early timing of platform owner's entry (Gawer and Henderson 2007; Lan et al. 2019) when markets represent a new form of complementary activity (Aldrich and Fiol 1994; Santos and Eisenhardt 2009). Such markets exhibit fleeting market structures accompanied by a low level of institutionalization and high degree of ambiguity (Hannah and Eisenhardt 2018; Aldrich and Fiol 1994; Eisenhardt 1989a; Rindova and Fombrun 2001). Because "technologies, products, and processes are 'untested and incompletely understood'" (Navis and Glynn 2010; Tushman and Anderson 1986), early complementors often face challenges such as lack of a clear and coherent identity of their services (Navis and Glynn 2010). Furthermore, there are minimal exemplars that complementors wishing to make an early entry to the market can learn from, meaning that there is an "extreme ambiguity about opportunities and customer demand" (McDonald and Eisenhardt 2020, p. 485), which requires the complementors to learn quickly as the market unfolds. Given the high ambiguity and uncertainty that the complementors may face at an early stage, an early market entry by the platform owner may improve market viability in the eyes of complementors and thus accelerate the instantiation of the market novelty (McDonald and Eisenhardt's 2020). The sooner the platform can achieve this goal affects how fast the novel platform services can be recognized and adopted by consumers.

Complementors may hesitate to invest in an early market due to the lack of consumer attention and knowledge about consumer preferences. This weakens the complementors' ability to identify market opportunities and to make useful extensions to the platform.   The platform owner may therefore attempt to draw consumer attention to the emerging complementary market and feed complementors with user data to encourage third-party complementors to enter the market early (Chen et al. 2010; Bingham and Eisenhardt 2011; Gregory et al. 2021). The platform owner's presence in the market may add credibility to the complementary market in the eyes of consumers and provide the promotional spillover effects. This may enhance third-party complements' popularity among consumers, and consequently, signal the viability of the complementary market to other third-party complementors considering entering the

market (Hukal et al. 2020). Thus, we may expect the popularity of third-party complements to increase after the platform owner's early entry.

First, news about a platform owner's entry should draw consumer attention to the new type of complementary services (Assaad and Gomez 2011). In turn, this can trigger an attention spillover effect as consumers may try out novel complementary products beyond the platform owner's first-party offering (Li and Agarwal 2017; Liu et al. 2014). Second, the adoption of complements often relies on expectations of usefulness and quality (Cennamo and Santolo 2019). To this end, the platform owner's participation in the market lends its complements increased credibility as useful services and reduces consumers' worries about sudden discontinuation of the complementary market. Third, given the lack of institutionalized market structure and dominant design(s), it is unlikely that the first-party complement alone can satisfy the variety of consumer preferences in the market. Therefore, the platform owner's promotion of its own product does not necessarily result in a zero-sum game with third-party complements in the early stage of the market development. Instead, the existing complements in the market may gain from the increased and more varied consumer demand and the promotional activities related to the market.

In view of the (a) divergent directions in the extant literature and (b) the reasons speaking in favor of timing of entry as a significant factor, we designed an empirical study that examines the timing of platform owner's entry and its impact on the popularity of complements among customers.

4.3 Hypothesis Development

Complementors who wish to take part in a nascent complementary market are hurdled by the limited knowledge and understanding on consumers and the kind of complements they may want. The lack of successful exemplars and consumer feedback weaken complementors' ability to identify market opportunities and to make useful extensions to the platform core. Therefore, generating consumer enthusiasm for

particular complements and feeding complementors with user data is among critical tasks that the platform can do to encourage third-party complementors to enter the market early (Chen et al. 2010; Bingham and Eisenhardt 2011; Gregory et al. 2021). With the added credibility and the promotional spillover effects that may come along with a platform owner's presence, the owner's entry to a nascent complementary market could also enhance third-party complements' popularity among consumers, and consequently, signal the viability of the complementary market to other third-party complementors considering to enter the market (Hukal et al. 2020)

4.3.1 The popularity of complements

We investigate the impact of platform owner's early entry on consumer attention to complements in the entered market using the number of consumer reviews submitted to each complement as a proxy for complements' popularity among consumers (Halckenhaeusser et al. 2020; Foerderer et al. 2018; Yin et al. 2014). We expect the popularity of third-party complements to increase in the market due to following reasons.

First, news about the platform owner's entry should draw consumer attention to complementary services in a nascent market that consumers would not be otherwise aware (Assaad and Gomez 2011). This can triggers a consumer attention spillover in the entered complementary market and induce some consumers to try out novel complementary products (Li and Agarwal 2017; Liu et al. 2014). Second, the consumer adoption of complement often rely on *ex ante* expectation of the usefulness and the quality of a certain complementary service (Cennamo and Santolo 2019). To this end, the platform owner's participation in the market lends the complement increased credibility as useful services. This reduces consumers' worries about the sudden discontinuation of the complementary market or the withdrawal of an adopted complement. Third, given the lack of institutionalized market structure and dominant design(s), it is unlikely that the first-party complement can satisfy all potential consumer demands. Therefore, the platform owner's promotion of its own product after an early enter does not necessarily result in a zero-sum game with the other

complements. Instead, the existing complements in a nascent complementary market may gain from increased and more varied consumer demand and other activities related to the market such as cross-posting or comparison reviews. We thus hypothesize:

H1:   Platform owner's early entry to a complementary market increases the popularity of complements among consumers in the post-entry period.

4.3.2 The heterogenous impact on different complements

We further hypothesize a heterogenous impact of platform owner's early entry based on a the characteristics of complements and complementors that affect the magnitude of improvement of a complement's popularity from the entry (Rietveld and Eggers 2018).

Functional specificity

Complements to a digital platform can substantially differ in terms of the complexity of their design, which typically relates to the scope of its features affecting how easy a novel complement is to understand. Drawing upon Tiwana (2018), we use the term *functional specificity* to capture the degree of heterogeneity between subfunctions of a complement. A specialized complement offers a highly focused functionality that, all other things being equal, should be easier to understand for consumers. This should be important factor in nascent markets because of the lack of prior experience of the category of complements among consumers. In contrast, a broad complement means that the complement offers a range of different functionalities, which often require more effort to understand and configure for personal use. For example, a camera app offers a focused core functionality of taking photos that complements a smartphone in an easy-to-understand way. The app may incorporate some additional features such as a panorama mode, night view, and filters, but these are relatively easy to comprehend within the overall context of photo taking. In this regard, the app offers synergistic specificity (Schilling 2000), in that its sub-functionalities express synergy towards the

main function. In contrast, Snapchat app has photo taking as one of its core features, but it also allows various modifications such as adding cartoon elements and different photo frames, while adding another layer of diverse functions related to sharing content in social media or even launching paid advertisements for business purposes.

Foerderer et al. (2018) show the positive cross-promotion effects and the benefits from broader access consumer insights when complementors have a range of different services in a portfolio in a mature market. However, in a nascent market that is still considered as highly uncertain and unstable by end users, complements that offers high functional specificity are easier to understand may thus become more likely adopted by consumers as their usefulness is easier to grasp (Cennamo and Santolo 2019). In a nascent complementary market, with no prior experiences of the new complementary services, consumers may prefer to secure their investment by starting with simple and straightforward products. By contrast, the broadness and diversity of functions offered by a complement might be an important concern especially when end users are lacking prior experience from complements in the market. In this regard, a broader portfolio of features may be disadvantageous if it blurs the complement's focal functionality. We thus hypothesize:

> *H2:   Platform owner's early entry to a complementary market increases the popularity of complements with high functional specificity more than the popularity of the functionally broad complements.*

Furthermore, given the novelty of the smart home services as an unprecedent market to the consumers, the experiences and resources that the developer possess certainly make differences on the success odds. Though the young entrepreneur firms tend to have high proportion of investment on R&D in an emerging market (Reinganum 1983; Czarnitzki and Kraft 2004). Their competition power against firms with long years of existence appears to be relatively weak due to the high risks of investing too much on R&D (Coad et al. 2016; Balasubramanian and Lee 2008), lack of dynamic capabilities to

adapt to the unfolding market structure (King and Tucci 2002), and less marketing and promotion resources.

> *H3: In a nascent complementary market, complementors with more years of experiences are more likely to attract consumers after the platform owner enters.*

4.4 Research Design

4.4.1 Empirical context

We investigate three entries by Amazon into the Alexa's voice assistant smart home market. The Alexa voice assistant enables consumers to use voice commands to control various home appliances and digital services. For example, users can say "Alexa, lower the beam of bedroom light" to remotely control their bedroom lightings, or say "Alexa, play Spotify" to turn on their playlist while cooking. Alexa Skills are complements created by third-party developers to extend Alexa's capabilities in voice-controlling varying types of home services such as ordering groceries, checking front door, turning on home entertainment devices, and controlling connected smart furniture. At the end of 2020[11], Alexa Skills had connected one million smart home gadgets for the Alexa users worldwide . However, given the novelty of smart home interaction to both developers and consumers, Amazon saw initially a slow growth in its complementary markets. At the end of 2015, there were merely 130 active complements available in the overall market, which grew to 10,000 by the end of 2017 and to over 50,000 by 2021. Also, the demand for different types of complements grew at an uneven pace.

Games & Trivia was initially the fastest growing complementary market on Alexa. In June 2018, it accounted for 18.5% of all available complements followed by Education, Music & Audio, Movies, and Lifestyle that each accounted for approximately 12% of complements. However, the release of complements into these categories often represented adaptations from other types of platforms rather than novel

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[11] Amazon's annual report 2020. https://www.annualreports.com/HostedData/AnnualReports/PDF/NASDAQ_AMZN_2020.pdf

inventions specific to Alexa (Ghazawneh and Henfridsson 2015). In contrast, complements related to the Smart Home appliances and services grew at a much slower pace, with only 3.5% of complements falling into this category at the end of 2018. The category was new, largely born out of the Amazon Echo smart speakers themselves and many emerging consumer products related to the category such as cleaning robots, smart home surveillance gadgets, furniture, and utility controls were still at their early stage of development. As a result, Amazon experienced relatively slow progress on the complementary market that would seem central to the Alexa platform's long-term success.

4.4.2 Data

The data used in our research were collected from the Smart Home category of Alexa Skills in Amazon's US and UK stores between June 2017 and September 2019. During this time window, there were three entry events by Amazon: the acquisition of Blink Home in December 2017, Ring in February 2018, and Eero in February 2019[12] . We identify the first two as early entries and third one as a late entry for two reasons. First, according to the survey data, until 2017, very few consumers had used the smart speaker to interact with the smart home devices, indicating a low market penetration among consumers[13] . Second, the rank of smart home category in terms of the proportion of all Alexa complements was at the very bottom (3.5%) in 2018, yet it gradually climbed to a middle position (10.3%) in 2021. We use data only on complements active in the Alexa store at least six months before the entry event. Complements that joined after the entry, potentially having more platform knowledge are not included to avoid overestimating the impact of the entry. Since the development of a smart home complement often involves innovation and co-configuration of digital and physical artifacts, we also consider the complexity of a complement in terms of the degree of its

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[12] To ensure that there were not any other major acquisitions made by Amazon in its Alexa ecosystem, we cross-validated Amazon's business activities from December 2015 to November 2021 using multiple sources such as Wikipedia (list of mergers and acquisitions by Amazon), MICROACQUIRE (Amazon Acquisitions), and Crunchbase (Amazon, Amazon Alexa Fund, The Alexa Accelerator).
[13] Smart Speaker consumer Adoption Report 2018, by voicebot.ai

connections to multiple home devices and to platform's core technology (i.e., Alexa Echo Smart Speaker).

4.4.2.1 Dependent Variable

To investigate the impact of platform owner's early entry on consumer attention, we follow a common approach in the literature and use the number of consumer reviews submitted to each complement as a proxy for complements' popularity among consumers (Halckenhaeusser et al. 2020; Barlow et al. 2019; Foerderer et al. 2018; Yin et al. 2014). We exclude complements that have unchanged number of reviews for more than four months as this indicates that the complement has likely become dormant in the market. The dependent variable is log transformed to account for its substantially skewed distribution.

4.4.2.2 Independent and Control Variables

In addition to standard treatment and time-period indicators used for difference-in-differences estimation, we use functional specificity to measure the heterogeneity of entry effects based on the complexity of services offered by a complement. The functional specificity uses a scale consisting of three mutually exclusive categories: specialized, suite, and integration. Starting from the most simple, 'specialized' complements control a single (set of) device(s). For instance, Avatar smart light allows users to manipulate one or several Avatar light bulbs with Alexa. 'Suite' indicates that the complement is designed to operate multiple types of devices from the same manufacturer, typically from the complementor itself. For instance, TP-Link KASA can control different devices such as lights, camera, switches, sockets, and wireless routers from the same brand. Finally, 'integration' indicates that the complement can control devices from multiple manufacturers which makes it the most functionally diverse category. For instance, the Harmony is essentially an integration system that enables Alexa to be connected to lights, speakers, and smart TVs regardless of the manufacturer.

Second, to account for the varying development difficulties of smart home services, we adopted a grounded approach to further categorize complements into 12 specific service subcategories as shown in Table 5. First, we drew on the functional

description of each complement that is published on Alexa skill's home page. This step allowed us to decipher the complement purposes the same way as if this complement is viewed by any random Alexa user. Second, for those complements which only provided a very brief introduction on its home page, we traced its service type by triangulating information from the complementors' (i.e., developers) official websites. Third, for those complements which seem to have very broad functionality, we manually enabled it and tested it with Alexa. Lastly, we determined the complement's subcategory by analyzing the descriptions and clustering complements with a focus on functionality (e.g., smart lights and plugs) or purpose in the smart home environment (e.g., entertainment).

Table 5. Alexa Smart Home Complement Subcategories

Subcategory	Description	Complements examples
Climate Control	Thermostats, fans, air conditioning, air quality monitors and purifiers	tado°; Ecobee plus; Midea Air; Awair Glow
Electric Appliances (I)	Inner home appliances such as ovens, kettles and cookers	LaundaryNFC; Appkettle; Coffee Machine
Electric Appliances (II)	Outside appliances such as irrigation and water controllers	Rachio; Eco watering; RainCloud
Entertainment and Communication	Entertainment devices such as TV, audio, speakers, and telecom devices	TV Remote; Polycom; play-Fi; Vizio SmartCase.
Furniture	Indoor furniture such as shades, beds, sofas, and mirrors	MySmartBlinds; SOMA Smart Shades
Garage	Remote and smart garage controllers	Mighty Mule; Tailwind; Garageio
Home Assistance	Utility monitors, location trackers, situational advice, and pet care devices	Flo; tracMo; Baby sleep coaching; How to Geek; Petnet SmartFeeder.
Home Integration	Hybrid integration of comprehensive smart home environment	Smart life; Yonomi;
Home Surveillance	Cameras, sensors, and alarm systems	Blink smart home; Alarm.com; Scout Alarm
Light and Plug	Lightning, sockets, switches, and plugs	Hue; Wemo; Vivitar; eFamilyCloud
Robotics	Cleaning robots and massage robots	iRobot Home; Roborock home

Wireless Connection	WiFi system and routers	Luma wife; Asus router

Third, to account for complements' platform-specific investments (Zhu and Liu 2018), we measure *interface coupling* that indicates the degree to which the complement is specifically connected with the platform core (i.e., Echo smart speakers). 'Tight coupling' indicates that the complement is directly and solely connected to Echo. For instance, Avatar and TP-Link are tightly coupled to Echo as a central command station. By contrast, 'loose coupling' indicates that an intermediary technology exists in between the complement and the platform core. The Harmony belongs to this category with a middleware device called Harmony Hub. The performance of such intermediate device may enhance or hinder consumer experience of using platform's core technology and it may also present a threat to platform's core product as a potential alternative central control station to consumers.

Lastly, we include eight complement level controls that have been found to bear influence of complements. We include the complements' star *rating score* (1 to 5) that controls for the innovation quality of complements (Foerderer 2020; Wen and Zhu 2019; Foerderer et al. 2018). The number of *languages* a complement is enabled to control for the broadness of potential market. The number of *helpful votes* given to the consumer review to indicate the quality of consumers' contribution and interaction with the complement. The larger number of helpful votes received by a complement imply deeper level of consumer engagement. Complementor' *portfolio* is the number of complements released by the same company (Li et al. 2013) that together with the *age of complementor* act as a proxy for technological experience (Foerderer 2020). Complementor age is calculated by subtracting it from 2018, that is, the year when Amazon first entered the market, from the year when the complementor firm was established (the variable has been log transformed by adding one to the calculated age). Finally, we include few other controls such as complementor's *size* measured as the number of employees, *region*, which is the geographic location of the complementor, and the *IPO* status that indicates whether the company is public or private.

4.4.3 Research model

To estimate the impact of Amazon's early entries into a complementary market on its Alexa platform, we adopt the two-way fixed effects (TWFE) difference-in-differences (DID) model on panel data of 332 Alexa smart home complements at the individual complement level. The main analysis focuses on a 12-month time window, ranging from six months before to six months after the platform's entry into the target complementary market (cf. Foerderer et al. 2018). The late entry is used as a contrast to validate our results. Equation 1 shows the model specification used for estimation.

$$Y_{igt} = \alpha_{ig} + \lambda_{it} + \delta T_{igt} + w_{igt} + G_g + T_t + \varepsilon_{igt} \qquad \text{(Equation 1)}$$

Y_{igt} represents the dependent variable, that is, the number of reviews received by complement i, in the market g at time point t. α_{ig} is the treatment identifier, which equals to one if complement i is from entered market and equals to zero otherwise. λ_{it} is a period indicator, which distinguishes observations from before and after the platform entry. The interaction term δT_{igt} captures the difference between the effect of the platform owners' entry on the affected complements and on the non-affected complements. w_{igt} represents control variables, that is, rating score, languages, helpful votes, portfolio, the age of the complementor, size, regions, and IPO status. While the evolving development capability of a complementor and the accumulated knowledge of the platform over time could affect the performance of a complement in the long run, we use the one-year observation window to hold the influence of such factors constant and control for any remaining unobserved heterogeneity among complements and time-periods using fixed effects (Foerderer et al. 2018). Hence, G_g and T_t capture complement and time-period fixed effects (Bertrand et al. 2004; Wing et al. 2018; Lechner 2010). ε_{igt} is the error term.

4.5 Results

We first check that the number of reviews accumulated by complements does not influence the entry decision and is hence exogenous, and then present the results of the

analysis on the impact of the entry on complement popularity.

4.5.1 Motivation of early and late entry

To first investigate the exogeneity of Amazon's entry to Alexa complementary markets, we conduct a logit regression analysis using complements' data covering six months before the announcement of entry to observe any overall pattern describing the entries. As shown in Table 6, the outcome variable is binary depending on whether the complement belongs to the entered subcategory of the smart home market or not. Specifically, models (1) to (4) present results for complements from the Home Surveillance subcategory to the rest of complements, and the models (5) to (8) present results for complements from the Wireless Connection subcategory to other complements. The six months' period provides a reasonable time window where platform owners may assess entry market options. The information captured in the independent variables used in this analysis are readily available to platform owners, and can be thus considered as potentially influential factors for platform owner's entry target evaluation.

The results shown in Table 6 reveal a few things about Amazon's entry patterns to the smart home complementary markets. First and most importantly, the number of reviews received by complements seems to be non-influential for both early entry and late entry. This finding supports the strict exogeneity in our main analysis where we aim to investigate entry's effect on the number of complements' reviews. Second, the complement's average rating score has a significant but opposite impact on Amazon's entry decision in early and late entry scenarios. Model (4) reveals that 1% increase in complements' rating score may reduce the ratio of Amazon's early entry over non-entry by factor of 2.4, while the model (8) shows the opposite by increasing such ratio by 0.92 for late entry. Regarding the functional specificity of complements, the target of platform owner's early entry (i.e., Home Surveillance) shows greater possibility for developers to release suite-type complements where profits can be captured by having several home-branded physical devices connected to Amazon Echo. By contrast, the market category targeted by late entry (i.e., Wireless Connection) does not show such

potential because complements in this sector mostly have just a router or booster connected to the platform core.

Table 6. Platform Owner's Early and Late Entry Patterns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Early Entry	Early Entry	Early Entry	Early Entry	Late Entry	Late Entry	Late Entry	Late Entry
No. of reviews	0.104*	0.012	-0.025	-0.072	-0.142	-0.096	-0.047	-0.032
	(0.04)	(0.04)	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.09)
rating score		-1.567***	-2.329***	-2.405***		0.977***	0.982***	0.918***
		(0.29)	(0.57)	(0.57)		(0.16)	(0.16)	(0.16)
suite			1.896*	1.900*				
			(0.81)	(0.81)				
integration			-0.398	-0.366				
			(0.79)	(0.73)				
loose coupling			0.787	0.620			0.384	0.359
			(0.46)	(0.41)			(0.35)	(0.37)
languages			-0.101**	-0.067			-0.100	-0.125*
			(0.03)	(0.03)			(0.05)	(0.05)
helpful vote			-0.001	-0.001			-0.000	-0.000
			(0.00)	(0.00)			(0.00)	(0.00)
portfolio				0.034				-0.027
				(0.114)				(0.058)
age				-0.000				-0.002**
				(0.00)				(0.00)
_cons	-2.372*	-0.472	-0.170	-0.378	-2.901***	-4.083***	-3.963***	-3.587***
	(1.13)	(1.30)	(1.73)	(1.69)	(0.43)	(0.49)	(0.51)	(0.49)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n	828	828	828	828	1776	1776	1776	1776
pseudo-r^2	0.004	0.063	0.186	0.197	0.006	0.029	0.034	0.047

Notes. Standard errors are clustered on the subcategories of complements and are reported in the parenthesis. Model (1) to model (8) adopts observation window six months prior to platform owner's entry. The baseline includes complements with the specialized functional diversity and close coupling to platform core. For the sake of brevity, complemntors' attributes such as size and IPO status are not reported.   the Time effect includes month dummies. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

The findings show that Amazon's early entry to the Home Surveillance market is likely not motivated to capture the extant value on the market, which had not yet become a reputable category of complements among consumers. Considering this together with the entry target's high potential in enabling the suite type of services, and its diverse links to consumers' domestic needs, it makes intuitively sense that Amazon' early entry to the Home Surveillance market could be aimed at boosting the popularity and attracting consumer attention to the market that was developing slowly as compared to other complementary markets on the platform. This is further supported by anecdotal evidence. For example, Amazon has disclosed to The Verge that they bought Blink because "we already know customers love their home security cameras and monitoring systems. We are excited to welcome their (i.e., Blink) team and invent together on behalf of customers."[14] By contrast, the Wireless Connection market targeted by Amazon's late entry suggests much clearer opportunity to capture value and enhance platform's control of a critical intermediate market. For example, in the case of the late entry with Eero, the importance of gaining consumers' data and improving the overall connected home experiences was widely discussed in the media. As a critical connector between Amazon Echo and the variety of devices out there, mesh WiFi system could serve as a valuable control point in Alexa's competition with Google Nest Wifi and Google-led smart home ecosystem [15].

4.5.2 The impact of early entry on complement popularity

We apply the Propensity Score Matching (PSM) and Coarsened Exact Matching methods (CEM) to find appropriate control complements to those that are affected by Amazon's entry. As an equal percent bias reducing model (Rubin 1976; Angrist and Pischke 2009), PSM helps to correct the estimation effects by using the similar treated and control observations upon controlling for the confounding factors (Rosenbaum and Rubin 1983; Rosenbaum & Rubin 1985; Becker and Ichino 2002). Following

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[14] Kastrenakes, J (2017). "Amazon Buys Smart Camera and Doorbell Startup Blink" https://www.theverge.com/circuitbreaker/2017/12/22/16810516/amazon-blink-acquisition-smart-camera-doorbell-company
[15] Nguten, N(2019). "Amazon Bought A Router Company You've Never Heard of. It's A Huge Deal." https://www.buzzfeednews.com/article/nicolenguyen/amazon-acquisition-eero-routers-privacy.

Michalopoulos et al. (2004), we use factors listed in Table 5 and base matching on the following covariate: functional specificity, interface coupling, complement's rating score, languages, helpful vote, portfolio, and the age of complementor (Stuart and Rubin 2007). As shown in Figure 3, the matched treated and control complements show a very similar distribution of the propensity score which implies similar likelihood of becoming an entry target   (Garrido et al. 2014). The bias between the matched samples across most covariates is reduced to below 10% (see appendix 2). The CEM employs an alternate logic with no assumptions or prior knowledge about the entry pattern (Iacus et al. 2011) and is superior when the observed dataset is relatively small (Bapna et al. 2016). Following Bapna et al. (2016); we implement the coarsening procedures using, functional specificity, interface coupling, language, complementor's size, region, and IPO status which yields the lowest L1 multivariate distance (0.1389) compared to other combinations of covariates (see appendix 3).

Figure 3. Propensity Score Distribution of Unmatched and Matched Complements

Propensity Score of the Unmatched Complements

Propensity Score of the Matched Complements
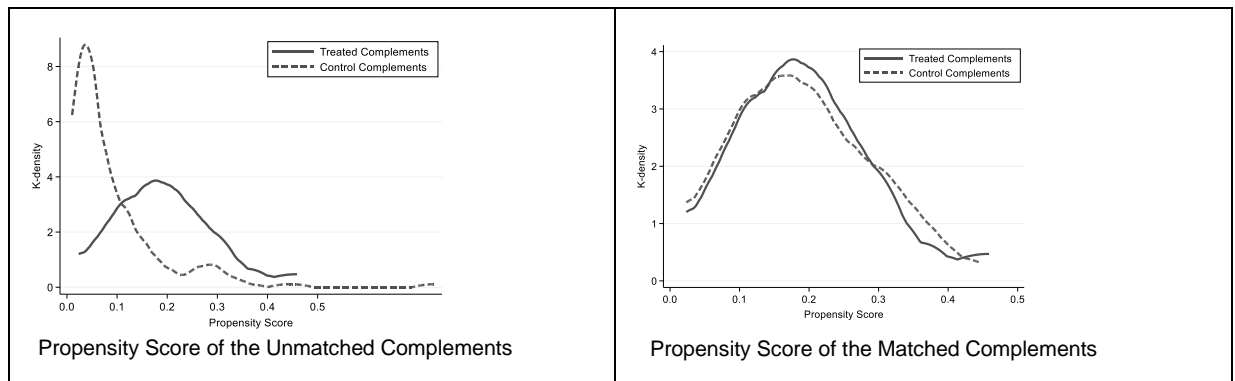
Note. PSM is applied with the nearest-neighbor (n=4) caliper matching using four nearest neighbours to gain the minimum mean square error (Abadie et al. 2004). The caliper used is 0.01, which is calculated as $\pi \leq 0.25\sigma_{pscore}$ (σ_{pscore} is the standard error of the predicted propensity score). Which means we are looking for the nearest four comparable complements that are having less than 1% propensity score difference to the treated unit.

Table 7 reports the result of the DID estimation using the matched dataset. The results in column 1 show 32% increase in the number of reviews received by Home Surveillance complements after Amazon's entry. The estimated popularity improvement is slightly higher with the CEM matched sample as shown in column 5, but the effects are significant and of similar magnitude regardless of the type of matching used. With respect to heterogeneous impact of complements' functional

specificity, columns 2 and 6 display the similar degree of additional improvement received by complements that offer specialized functionality to consumers. However, the extra improvement on complement's popularity is not significant for complements that offer broader functionality.

Table 7. Impact of Platform Owner's Early Entry on Complements' Popularity

	PSM				CEM			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Popularity	*Functional specificity*			*Popularity*	*Functional specificity*		
		Specialized	Suite	Integral		Specialized	Suite	Integral
Affected complements	0.719***	0.734***	0.880***	0.376***	0.632**	0.721**	0.262	0.303**
	(0.05)	(0.06)	(0.10)	(0.07)	(0.21)	(0.23)	(0.03)	(0.10)
Affected complements *Post entry	0.322***	0.522***	0.075	0.002	0.527*	0.445*	0.810	0.336
	(0.05)	(0.08)	(0.08)	(0.04)	(0.19)	(0.20)	(0.72)	(0.42)
Constant	2.985***	2.626***	3.412***	-0.163	0.996	1.140	-0.598	0.401
	(0.11)	(0.13)	(0.22)	(1.14)	(0.99)	(1.11)	(0.40)	(0.29)
Complement FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.576	0.568	0.654	0.533	0.410	0.414	0.813	0.575
n	900	492	288	120	397	338	35	24

Notes. All models have controlls for individual complement attributes such as the monthly star rating and the helpful vote. Robust standard errors in parentheses. Models (2)-(4) and (6)-(8) are grouped regression based on different viriations of the functional specificity * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.6 Further Analysis and Robustness Checks

4.6.1 Late entry

To observe the impact of Amazon's late entry in the Wireless Connection subcategory of smart home complementary market, we compare the changes on the number of reviews received by complements in the Climate Control subcategory. We use the subcategory as the control group because the two subcategories show very similar patterns in terms of the complements' reviews, rating score, helpful votes, portfolio,

and size. Nearly all complements in both subcategories show high level of functional specificity. The only difference presented between the Wireless Connection category and the Climate Control category is the complements' languages (diff=0.857, SE=0.385) and the age of complementors (diff=-27.875, SE= 5.623). Estimating the model presented in Equation 1 using data from the two subcategories around Amazon's late entry, we find that the popularity improvement on the affected complements is not statistically significant.

4.6.2 Randomly selected control group and manipulated treatment window

We also assessed the random selection method in forming the control group to the affected complements for both early and late entry. Among the pool of 323 smart home complements, excluding the entered subcategory (Home Surveillance with 36 complements and Wireless Connection with 17 complements), we allow the control group to include the randomly selected half (50%) and quarter (25%) of complements from the pool. We then apply the DID model to investigate the entry's impacts. The results reported in Table 8 show that the improved popularity gained by the Home Surveillance complements from early entry is around 27%, which is consistent with the 32% increase shown in the main analysis. Also, the late entry's non-significant impact on complement popularity is again confirmed as shown in columns 5 and 6.

We then combine the randomly selected control group with a manipulated treatment window where we set the entry event to 3 months before and after the actual entry time. The complements' popularity improvement effects are no longer significant in the early entry's case shown in columns 3 and 4. For platform owner's late entry, the forward results still hold, and the backward analysis indicates some disadvantages of the affected complements even before Amazon enters. This finding might be associated to Amazon's non-interest in the entry's target capability in attracting consumers' attention, but in its potential to enhance platform control. This argument is also supported by some Google Trends evidence, where the early entry shock of buying Blink Home indeed greatly promoted the brand's social mention afterwards, but such popularity boost was not displayed in Amazon's late purchase of Eero.

Table 8. DID with Random Selected Control Complements

	Early Entry				Late entry			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Half-random	Quarter-random	3 months backward	3 months forward	Half-random	Quarter-random	3 months backward	3 months forward
Affect complements	0.511***	0.514***	0.341***	0.372***	0.417***	0.363***	0.435***	0.336***
	(0.02)	(0.04)	(0.04)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)
Affect complements *Post entry	0.269***	0.264***	0.334	0.200	-0.091	-0.016	-0.126*	-0.051
	(0.06)	(0.06)	(0.19)	(0.23)	(0.05)	(0.04)	(0.05)	(0.04)
Constant	1.717***	2.002***	2.150***	2.079***	2.146***	1.728***	2.041***	2.000***
	(0.08)	(0.11)	(0.13)	(0.07)	(0.06)	(0.07)	(0.04)	(0.05)
Complement FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.364	0.394	0.404	0.334	0.315	0.308	0.347	0.239
n	1451	819	890	1715	1659	902	3288	3349
F	247.9	158.3	171.5	259.6	53.2	27.9	122.5	73.7

Notes. All models have controlled for the complements' star rating and helpful vote. Column (1) and (5) apply half-cut random selection from the complements' pool and column (2) and (6) apply the 25% random selection from the complements' pool. Robust standard errors in parentheses. Model (3) (4) (7) (8) is using a half-cut random selection [*] $p < 0.10$, [**] $p < 0.05$, [***] $p < 0.01$.

4.6.3 The age of complementor

To further extend our knowledge of platform owner's early entry, Table 9 shows the analysis results with respect to four complementor age brackets. The findings in columns 1–4 are consistent with the received wisdom that developers with longer years of operation are better positioned to benefit from increased consumers' attention due to the platform owner's entry. However, the column 5 also indicates that young startup developers could also benefit from the improved market popularity if their offerings are functional specific. In this regard, platform's early entry could be seen as an opportunity for younger complementors to free-ride on the improved market viability.

Table 9. Impact of Complementors' Age on Complements' Popularity in Early Entry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Complements' popularity				Functional Specificity - Specialized			
Age	(0,3]	(3,6]	(6,16]	(16,118]	(0,3]	(3,6]	(6,16]	(16,118]

Affect complements	0.905***	0.795***	0.473***	0.709***	0.806***	0.936***	0.262**	0.377***
	(0.11)	(0.08)	(0.08)	(0.07)	(0.12)	(0.14)	(0.08)	(0.08)
Affect complements *Post entry	0.118	0.197*	0.512***	0.557***	0.595***	-0.034	0.127	0.708***
	(0.12)	(0.09)	(0.08)	(0.08)	(0.14)	(0.13)	(0.07)	(0.08)
Constant	1.856***	2.703***	3.047***	2.988***	2.569***	2.939***	3.551***	4.495***
	(0.21)	(0.21)	(0.17)	(0.19)	(0.25)	(0.32)	(0.33)	(0.32)
R^2	0.634	0.546	0.588	0.651	0.814	0.603	0.697	0.823
n	156	360	276	312	84	168	96	120
F	17.3	29.3	26.3	39.2	21.5	16.5	13.2	34.7

4.6.4. The triple difference model

In the previous sections, we have tested the heterogenous effects made by the complements' functional specificity and complementors' age by using the sectioned data. In this part, we aim to complement this research design with a triple difference model (Hamermesh and Trejo 2000). The intuition of applying the triple difference model is to add a factor that might be a common determinant for the treated and control units. And thus, further exclude the bias of the treatment effect on the treatment and control units. The revised interaction term between the newly added factor and the previous DID identifier now becomes a more robust estimator for the entry's treatment effects considering the difference made by the common factor in addition to time and place (Berck and Villas-Boas 2016). According to the statistics showed in Table 10, the advantageous effects played by complements' functional specificity and the complementors' age are again approved.

Table 10. Heterogenous Impact of Early Entry Using Triple Difference Model

	(1) Complements' functional specificity	(2) Complementors' Age
Post	1.019***	0.832***
	(0.068)	(0.054)
Entry*Post	-0.091	0.140***
	(0.066)	(0.043)
Device*Post	-0.328***	

	(0.059)	
Tight coupling∗Post		
Age∗Post		0.154***
		(0.029)
Specialized∗Entry∗Post	0.549***	
	(0.091)	
Tight coupling∗Entry∗Post		
Age∗Entry∗Post		-0.143***
		(0.043)
Overall R2	0.003	0.007
n	1088	1088
F	62.98***	57.53***

4.6.5 Lagged dependent variables model

We further improve the robustness of our analysis by adding lagged dependent variables as a control (Ashenfelter 1978; Ashenfelter and Card 1985). The baseline model (Equation 1) assumes that the unobserved factors in our analysis should remain time-invariant. Such an assumption is held for some factors such as the complementor's developmental capacity, which would not alter significantly given our study's short observation period. However, a potential problem could be that the dependent variable itself may address some confounding effects that cannot be subsumed as other omitted variables. For instance, the complements' historical popularity, measured through consumer reviews, often underlines the complement's overall attractiveness. Such past popularity may determine complements' future popularity, despite the platform owner's intervention. To tackle such correlation concern, in Equation 3, we include the one-period lag of dependent variable using coefficient η. Following Angrist and Pischke (2009), we concurrently adopt both lagged dependent variables and unobserved individual effects rather than dispense the time invariant assumption.

In addition, considering that Y_{gt-1} may correlate with ε_{gt} because of their common relationship with ε_{gt-1}. We also apply Y_{gt-2} as an instrumental variable to Y_{gt-1} in our analysis. However, such correlation concern seems not to be eliminated because complements' popularity can have specific accumulative effects from one period to the next period. Therefore, using the lagged dependent variable to

the greatest extent provides reassurance to our analysis. We expect to observe broadly similar casual effects under alternative assumptions.

$$Y_{gt} = \alpha_g + \lambda_t + \delta D_{gt} + \eta Y_{gt-1} + \varepsilon_{gt}$$
(Equation 2)

Table 11 reports the results based on estimating a model in Equation 3. Columns 1 and 3 of Table 11 include the first order of lagged dependent variable, and the column 2 and 4 use the second-order lag of the dependent variable as an instrument variable to the first-order lag to setoff serial correlation. Using columns 1 and 2, we are able to observe the impact of the platform owner's entry on the number of home surveillance complements. The results reveal that the home surveillance market generally receives 16 percent more complements than the counterfactual case without platform entry. This increase in the number of complements is relatively consistent with our main finding in Table 7. Moreover, in columns 3 and 4, we report the impact of Amazon's entry on complements' popularity. Measured in the number of reviews, we observe that home surveillance complements generally receive 7% more consumer reviews than light & plug complements after the platform enters. Such magnitude of popularity improvement is less than reported in Table 7, thus narrowing the overestimated effects in our previous analysis (Guryan 2004).

Table 11. Impacts of Early Entry using the Lagged Model

	First-order lagged dependent variable			Second-order lagged dependent variable		
	(1) Popularity	(2) Functional specificity	(3) Complement ors' age	(4) Popularity	(5) Functional specificity	(6) Complement ors' age
Post	0.152*** (0.029)	0.184*** (0.037)	0.161*** (0.030)	0.219*** (0.035)	0.326*** (0.046)	0.227*** (0.038)
Entered∗ Post	0.032 (0.020)	-0.016 (0.030)	0.030 (0.022)	0.065** (0.025)	-0.034 (0.039)	0.061** (0.027)
Mod∗Post		-0.086** (0.029)	0.023* (0.015)		-0.152*** (0.035)	0.051** (0.019)
Mod∗ Entry∗Post		0.048* (0.045)	-0.061** (0.022)		0.157** (0.056)	-0.105*** (0.028)
Time Effect	Yes		Yes	Yes		

Observation Effect	Yes			Yes	Yes		
Overall R2	0.979	0.983	0.982	0.948	0.952	0.953
F	398.09***	369.45***	310.41***	205.84***	179.33	163.19
Obs	1110	1026	983	1038	960	922

4.7 Discussion

The paper sets out to compare platform owner's early and late entry into complementary markets. Our analysis of Amazon's entry into the home surveillance market of the Alexa platform confirms that timing matters as platform owners enter complementary markets. In particular, early entry into complementary markets creates considerable consumer attention, especially benefitting complementors that offer specialized functionality. Table 12 summarizes our key findings.

Table 12. Summary of Key Findings

Findings	Early Entry	Late Entry	Interpretation
Platform owner's entry to a complementary market will promote the complements' popularity among consumers in the post-entry period.	True	False	▪ Early entry is an effective platform strategy in promoting the viability and popularity of complementary market among its intended consumers.
Complements with high functional specificity are more likely to attract consumers after the platform owner enters.	True	N/A	▪ Complements with high degree of functional specificity contributes more to the the complementary market's viability and popularity.
Complementors with more years of experience are more likely to attract consumers after the platform owner enters.	True	N/A	▪ Developers with more experiences have higher chances to attract by consumers in a nascent complementary market.

First, a platform owner's early entry draws more consumer attention to a complementary than late entry. Early entry increases the market's perceived viability among early adopters. In turn, complementors come to the market, enabling the complementary market to prosper since more services demonstrate the usefulness of the platform to early adopters. While this seems to contradict Wen and Zhu (2019), who

find platform owners' entry to disincentivize complementors from participating in the complementary market, we propose that the early timing explains this seeming contradiction. In the case when consumers have limited experience, the platform owner's entry serves as an important source of customer enthusiasm about the novel market and its ecosystem (cf. Anthony et al. 2016; McDonald and Eisenhardt 2020). In this regard, nascent markets are driven by a value creation logic rather than the value capture one present in mature markets. One might speculate that third-party complementors view the platform owner's entry less threatening and more as a signal of the market's viability. In other words, the timing of platform owner's entry defines whether the entry incentivizes or disincentivizes third-party complementors to participate in the market (cf. Mitchell 1989). Entering a complementary market at its early stages can be a positive signal to complementors considering entering the market. whereas entering at a later stage suggests platform owner's intention to capture value that would otherwise go to the complementors.

Second, our analysis of heterogeneous entry effects reveals that high functional specificity significantly influences whether the complementor can seize the increased interest from early adopters (cf. Tiwana 2018). At an early stage, complementary markets present not only considerable novelty but also unfamiliarity and uncertainty about the value of individual complements to consumers, who are likely to try out complements with sub-functionality that achieves synergy towards the main function (Schilling 2000).

Furthermore, our results are consistent to the well-known facts that complementors with longer years of existence are in an advantageous position to win the favor of consumers upon platform' early entry, due to their high adaptive capabilities to the unfolding market structure (King and Tucci 2002) and rich experiences and resources to level platform benefits (Foerderer 2020). However, consistent with prior work (e.g., Coad et al. 2016; Czarnitzki and Kraft 2004), our results show that young developer firms can mitigate this effect as long as their offerings have specialized functional specificity.

Overall, the findings offer new insights into the platform owner's entry and complementor reactions to it in early stage complementary markets. Given the increasing market visibility and viability in the eyes of the consumers after the platform owner's entry, rather than emphasizing the richness of their services and technology portfolio, incumbent complementors may be better off by promoting their most specialized services and technologies to seize the benefits of the increased consumer attention. By contrast, entrepreneurial complementors can particularly benefit from the entry if they can position themselves as leading edge innovators with functionally simple complements. An entrepreneurial complement may be able to 'freeride' on the market expansion created by the platform owner's entry to a nascent complementary market.

4.8 Implications

This research note contributes novel insights about the timing of platform entry into complementary markets. In particular, we reconcile divergent views in studies of platform owner's entry into complementary markets (Rietveld and Schilling 2020) by comparing the effects of early and late timing. Rooted in the platform owner's power over its ecosystems, one stream of literature considers platform's entry into complementary markets as a competitive action (Wen and Zhu 2019; Zhu and Liu 2018; Jiang et a., 2011). This line of research recognizes the platform owner's capabilities in ex-ante estimating the complementary market's demand. Such capability helps developing and releasing complementary products that become "blockbusters" in the entered market as the platform owner benefits from access to consumer data and platform resources (Adner et al. 2019). However, another strand of studies on platform owner's entry into complementary markets sheds light on the post-entry innovation spur from complementors (Foerderer et al. 2018) and how platform owners motivate value co-creation through shared platform resources (Gawer and Henderson 2007).

In this regard, our research reflects the notion that a platform's entry strategy should be reflective of the developmental stage of its ecosystem (cf. Rietveld and Schilling 2020). At an early stage, platform owner's entry signals its commitment to

growing the prosperity and the popularity of that market, thus incentivizing the release of more complementary services in that market category. Moreover, the platform owner's participation attracts consumer attention to the new market, which further provides complementors with richer consumer knowledge and a more vigorous developmental environment. The results reveal the competitive advantage of complements' specialization and complementors' young age in attracting consumers in a new market.

Lastly, our selection of Amazon's Alexa as our empirical setting responds to Rietveld and Schilling's (2020) call for diversity of empirical contexts in platform research. Alexa has received some attention from scholars who focus on the user experiences of AI conversations, or the digital forensics when using virtual assistance devices (Sciuto et al. 2018; Chung et al. 2017). Still, the smart home environment epitomizes an emergent type of complementary market and serves a relevant and distinct setting for platform research.

Appendix of chapter 4

Appendix 1.

Table 13. Empirical Studies of Platform Owners Enter Complementary Markets

Study	Topic	Scenario	Methods	Findings
Basak and Petrakis (2021)	Entry Strategy	Enter to market which presents the network externalities	Economic modelling	▪ The desirability of entry to market that presents network externalities is influenced by the degree of product compatibility, differentiation, and the cost of entry.
Park et al. (2020)	Entry Strategy	TV enters to newspaper industry where subscribers can be single-home (either newspaper or TV) and multi-	Economic modelling + Empirical testing	▪ Newspapers that have more single-home consumers will have lower subscription prices, circulation, and advertising rates

		home (both newspaper and TV)		compared to newspapers that face multi-homing consumers. ▪ TV advertising rates are lower in markets with more single-homing consumers.
Chintaka nanda and Macintyre (2014)	Entry Timing using Real Options	Entry to markets considering the network intensity, market uncertainty, and the presence of dominant designs	Theory development	▪ Growth options (or early entry) are mainly enhanced during periods of high market uncertainty. ▪ The presence of a dominant design encourages deferral options (or late entry) where markets have high network intensity.
Zhu and Iansiti (2012)	Entry and competition dynamics	Enter and compete with incumbent platform	Theory development and empirical testing	▪ The market dynamics of platform competition that involves indirect network effects are jointly determined by many factors including the installed based, the quality level, and the consumers' expectation.
Zhu and Liu (2018)	Amazon entered retail markets on Amazon.com.	Late entry ▪ Amazon provides first-party goods on Amazon marketplace in 2013, 13 years after launching the Amazon marketplace; ▪ Entry affected 4398 products in four categories:	Multiple Regression	▪ Profit squeeze for complementors ▪ Less investment in platform-specific knowledge

		electronics & computers; Home, Garden & Tools; Toys,Kids & Games; and Sports & Outdoors.		
Foerderer et al. (2018)	Google entered the photography app category in the Android store.	Late entry ▪ Google released Google Photo app in 2015, 7 years after launching the Google play store. ▪ Entry affected 1266 apps in the photograph category.	Difference-in-differences	▪ Increased complementors' innovation ▪ Improved ratings of complements
Wen and Zhu (2019)	Google entered Android app markets.	Late entry ▪ Google released apps in 2015, 7 years after launching the Google play store. ▪ Entry affected 3986 apps in categories of Tools, Entertainment, and Tools and Tools or Productivity.	Difference-in-differences	▪ Reduced innovation among complementors in the entered market. ▪ Complementors raise the prices for the affected apps. ▪ Complementors shift innovation to unaffected and new app categories.
Gawer and Henderson (2007)	Intel entered connector markets.	Early entry ▪ Intel entered 17 complementary markets during 1990-2004. ▪ Intel entries have aims to form a platform ecosystem around its core products.	Qualitative	▪ Creation of shared intellectual property

Lan et al. (2019)	Open-source platform owners entered open-source software markets.	Initiation participation of complementors ▪ 53 US public firms launched 231 Open Source Software (OSS) platforms during 1998-2004. ▪ The observation period is one year after OSS launch.	Nero-inflated Negative Binomial Regression	▪ Deterred the entry of complementors
Cennamo et al. (2016)	Game console providers' first-party games.	Repetitive Entry ▪ 5865 video game titles released by 14 video game console providers across generations of console devices	Multiple regression	▪ Complementors' free-ride and less investment on focus genre. ▪ Growing platform offerings drive out complementors.
Edelman and Lai (2016)	Google's display of Google Flight Search services (GFS) on its search engine.	Late entry ▪ Google entered the search engine business by launching the Google Flight Service (GFS) listings in 2011. ▪ Google has 14 years experiences in search engine industry	Difference-in-differences	▪ Altered consumers' click composition between organic ads and paid ads for other Online Travel Agents.
Jiang et al. (2011)	Amazon provides first-party goods on Amazon.com.	Late entry ▪ Modelling Amazon's entry to the mid-tail markets with "cherry-picking" strategy in Amazon marketplace.	Two stage game-theoretical model	▪ Complementors hide and manipulate the actual demand for their products.

Seamans and Zhu (2014)	Craigslist's entry to the newspaper industry	Late entry ▪ Craigslist becomes the online classified-ads provider in 1996. ▪ The classified-ads was an established business for local newspapers.	Difference in differences	▪ Craigslist's entry reduces the attractiveness of a newspaper to their complementors (i.e. classified advertisers) as an alternative channel to reach subscribers. ▪ Affected newspapers have lower incentive to subsidize the subscriber side. ▪ Affected newspapers may tend to differentiate further from its competitors on the subscriber side, charge higher subscription price, and choose to not offer free online content.

Appendix 2

Table 14. Mean Difference Test on PSM Covariates

Variable	Unmatched Matched	Mean		% reduction		t-test		V(T) /V(C)
		Treated	Control	%bias	|bias|	t	p>|t|	
Star rating (t-5)	U	2.9753	3.6976	-60.8	90	-2.11	0.036	0.87
	M	3.1272	3.0547	6.1		0.16	0.872	0.70
Star rating (t-4)	U	2.9354	3.6952	-64.1	97.2	-2.27	0.025	0.96
	M	3.0842	3.0631	1.8		0.05	0.963	0.78
Star rating (t-3)	U	1.0474	1.1687	-28.6	49.6	-1.48	0.141	1.05
	M	1.0835	1.0224	14.4		0.51	0.610	0.58
Star rating (t-2)	U	1.0694	1.1672	-25.0	79.5	-1.23	0.220	0.80
	M	1.0684	1.0884	-5.1		-0.19	0.849	0.78
Star rating (t-1)	U	1.0568	1.1575	-26.3	87.0	-1.32	0.190	0.87
	M	1.0553	1.0685	-3.4		-0.13	0.900	0.82
Functional specificity: Specialized	U	0.3	0.53555	-48.7	100.0	-2.43	0.016	.
	M	0.31034	0.31034	0.0		0.00	1.000	.
Functional specificity: Suite	U	0.56667	0.27014	62.4	88.4	3.36	0.001	.

	M	0.55172	0.51724	7.3		0.26	0.797	.
Functional specificity: Integral	U	0.13333	0.19431	-16.4	43.5	-0.80	0.425	.
	M	0.13793	0.17241	-9.3		-0.36	0.723	.
Tight coupling	U	0.8	0.7346	15.4	100.0	0.76	0.445	.
	M	0.7931	0.7931	0.0		0.00	1.000	.
portfolio	U	1.2333	1.3934	-27.8	56.9	-1.23	0.219	0.39*
	M	1.2414	1.3103	-12.0		-0.53	0.595	0.65
Age	U	18.5	11.788	35.8	60.3	1.43	0.154	1.63
	M	10.111	12.778	-14.2		-0.45	0.657	0.98

Appendix 3

Table 15. Coarsened Exact Matching Results

Multivariate L1 distance: 0.13888889							
Univariate imbalance:							
	L1	mean	min	25%	50%	75%	max
languages	0.02778	-0.10185	0	0	-1	0	-2
Functional specificity	8.0e-17	-4.4e-16	0	0	0	0	0
Functional coupling	0	0	0	0	0	0	0
size	8.0e-17	-8.9e-16	0	0	0	0	0
region	6.9e-17	-8.9e-16	0	0	0	0	0
IPO	3.5e-18	0	0	0	0	0	0

CHAPTER 5. APPLYING HUMAN PSYCHOLOGICAL MOTIVES IN DESIGNING PLATFORM'S SCALING STRATEGY

Abstract

New platforms that launch in a market have an imperative objective to scale their consumer base. Informed by the same-side network effects, the volume of consumers acquired by a platform substantially determines how the platform is perceived as attractive and useful to its potential users. Complementing the prior work, which has extensively studied different techniques adopted in growing the platform's consumer base after platform launch, this study investigates how human psychological motives can be incorporated and leveraged in driving successful platform scaling. We apply a single case analysis on Pinduoduo (PDD)—the second-largest and fastest-growing e-commerce platform in China. By investigating the platform consumers' participation in PDD's lottery akin scaling techniques ("cut-to-free" and "cut-to-cash"), this research reveals several mechanisms of engaging psychological motives in promoting both the "referral sending" and "referral responding" activities. Overall, this research contributes intersectional knowledge to platform strategy and psychology.

Key words: digital platforms; platform scaling; same-side network effects; platform strategy; psychological motives

5.1 Introduction

Scaling a platform's user base has always been a critical challenge for platform owners (Huang et al., 2017). Often referred to as a two-sided market, platforms serve as an intermediate party among multiple sides of users who must possess a

strong capacity to attract the critical mass of users so that to generate and sustain platform value (Anderson et al., 2014; Eisenmann et al., 2011; Caillaud and Julien 2003). Prior studies on platform scaling have given great emphasis on investigating the use of various techniques in driving the same-side and cross-side network effects that eventually enable a platform to experience the self-reinforced growth loop (Parker et al., 2016; Anderson et al., 2014; Zhu and Iansiti 2012; Evans and Schmalensee 2010; Hagiu, 2006; Caillaud and Julien 2003; Rochet and Tirole 2003). A variety of techniques have been found effective in growing a platform's user base, such as subsidy to the side of users whom the counter side highly values privileged access (Parker and Van Alstyne 2014; Caillaud and Julien 2003; Rochet and Tirole 2003) or seed the initial value unit among a small group of users and gradually enlarge platform coverage (Parker et al., 2016).

However, two important areas of concern that have been overlooked by prior research are the effective conduct of the platform scaling strategy (Afuah, 2013) and the sustained use of the scaling technique (Parker et al., 2016). To add new knowledge on these two aspects, this research follows the single case analysis approach to underline some new thoughts on the platform's scaling strategy. In particular, this research explores the possibility of incorporating individuals' behavioural motives into the effective conduct of platform scaling.

The case understudied in this research is Pinduoduo (PDD)--the second-largest e-commerce platform in China. Established in the year 2015, when the online commerce market in China has long been a duopolistic field dominated by Alibaba's Taobao and Tmall (founded in 2003) and JD.com (founded in 2007), PDD's inception in this market was not optimistically viewed by the public and the investors because the two leading players have been so solidly established with the very stable seller and consumer base. Despite many failed attempts taken by other entrants in this market, PDD surprisingly grew to the third-largest platform, which has equal GMV with JD.com in just three years since its launch and successfully went to its IPO in the year 2019.

Speaking of PDD's huge success, its creative conduct of the scaling tactic,

which extensively leverages the human's behavioural motives and instincts, has been widely acknowledged as a killer weapon that enabled PDD to drag consumers from those established rivals. In the brief term, PDD attracted consumers by subsidizing platform adoption using financial incentives. However, what has been done differently by PDD was setting such subsidy into a lottery akin game that pertains to inducing effects on encouraging active participation. Meanwhile, the way to win this luck lottery is substantively attached to the players' active pursuit of more participants from their social circles, which eventually kicks in the same-side network growth. To explore the unique prowess of PDD's scaling success, the question asked by this research is "*why and how incorporating human behavioural instincts can make a platform's consumer scaling strategy highly effective and sustainable*".

Answering the above question yields some important implications for understanding platform strategy in its social context. To start, different from the known scaling techniques such as pricing, subsidy, and marquee users, the scaling technique studied in this research incorporates motivations stimulated by individuals' behavioural instincts. Therefore, the referral scheme embeds greater consumers' self-motivation to sustain itself once they join the platform. Besides, the behavioural instincts applied on the receivers' side utilize the consumers' social network, which reflects the platform's impact on individuals' social lives. This attribute seems to be increasingly relevant as more platforms emerged in recent years that are closely associated with people's daily life activities such as food ordering.

The structure of this paper is as follows. First, the theoretical background section will contain the mainstream studies on platform scaling and the interplay of psychology and digital platforms. Second, the research context and data collection process will be discussed, followed by an illustration of the data analysis procedures. Third, an in-depth discussion will be given on the interplay of behavioural motives and platform scaling. This step aims to identify and articulate the strategic mechanisms that are informed by the behavioural psychology body of knowledge.

Last, this research will be closed with a brief scratch on the limitations and future research opportunities.

5.2 Theoretical Foundation

5.2.1 Scaling platform's user base

Platform scaling is a broad sphere of research that studies a wide range of techniques, tools, and methods for growing the platform's user base. Often referred to as one of the key platform's objectives to bring "on board" different types of platforms users, platform scaling forms one of the imperative platform strategic concerns about platform growth and platform competition (Zhu et al., 2021; Huang et al., 2017; Henfridsson and Bygstad 2013; Parker and Van Alstyne 2005). The prominence of attracting a massive number of platform users lies in the sided nature of platform interactions among various interrelated and interdependent entities (Kretschmer et al., 2022; McIntyre et al., 2021). The capability of platforms to attract participants who value mutual access with their counterparties substantially determines how useful the platform is perceived by its extant and potential users (Cozzolino et al., 2021). Furthermore, demonstrating and delivering platform usefulness to at least a small proportion of platform users pertains to a vital impact on platform survival at the early times of platform launch (Parker et al., 2016).

Given the importance of having a vast volume of platform users, digital platforms have a profound tradition of protecting their survival by rapidly growing one side or both sides of platform participants after platform launch (Stummer et al., 2018; Schirrmacher et al., 2017; Parker and van Alstyne 2014). Once the initial value units can demonstrate substantive attractiveness to a small set of platform users, these obtained platform user base will serve as an engine to kick off the network effects that further appeal to a greater number of platform users in the same kind or the different kind (Parker et al., 2016; Evans and Schmalensee 2010). Eventually, platforms may turn to lock in the acquired user base as a key platform asset to fortify the platform's rivalry with other competing platforms (Parker and van Alstyne 2014). Taking Uber as an example, when Uber was first introduced to

the market as a new form of cab-hailing service in 2011, it faced tough protest resistance from the established taxi industry. Consumers at that time tended to perform a low level of adoption due to unfamiliarity with Uber and already-formed preferences for transportation. Therefore, to demonstrate the new ridesharing platform's viability to consumers, Uber sponsored some tech events in Silicon Valley and gave free rides to those tech influencers, who later became the word-of-mouth agents that spread Uber's popularity to the wider community. When Uber set up its business in more cities and countries, it extensively utilized such a subsidization strategy on the consumer side. It lets the rising consumers' demands convince the drivers adoption on the platform. In 2018, Uber still incurred an average 58 cents loss per ride by having such a subsidy scheme (Rushe, 2019).

Informed by the triangular pattern of affiliation that platforms form with platform consumers and platform complementors (McIntyre et al., 2021; Liu et al., 2022; Parker et al., 2017; Eisenmann and Parker 2009), platform owners need to carefully design and adjust their strategic approaches in attracting either side or both sides of platform users. Decision on the amount of investment put into attracting different sides of platform users often poses a trade-off between efficiency and effectiveness (Huber et al., 2017). Focusing on bringing both sides might grant high efficiency to form platform interactions at the ecosystem level. The divided resources allocated to appealing to both sides of users might only create temporary success but lessen the effectiveness in securing users' retention on a platform. On the other hand, attracting one side of platform users may entail a more promising user acquisition. But the postponed engagement with the other side may curb the efficiency in exhibiting platform value, thus deteriorating platform growth. In addition, such a one-sided scaling technique requires platform owners to delicately select the right side, which has sufficient fraction power to attract the counterparty.

There are ample techniques that have been found useful to scale the platform's user base at the early time of platform launch. Among those techniques and methods, one widely discussed strategy is the platform's pricing strategy (Tan et al., 2020; Parker and Van Alstyne, 2014; Hagiu, 2006; Caillaud and Jullie, 2003).

The pricing structure concerns the platform's charges on different users' sides to balance platform utility and capture profits. For instance, Caillaud and Jullie (2003) and Rochet and Tirole's (2003) divide-and-conquer pricing strategy represents one of the commonly used pricing tactics on two-sided platforms, where the equilibrium is prone to the price-sensitive side in return for the premium charges gained from the other side. In addition to such money loss and gain tradition, providing add-on benefits that can generate ripple traffics to the platform's main product is another common tactic. Parker and Van Alstyne (2005) suggested that though giving some free treats may incur initial negative profits, the long-term returns that recouped from the channelled users' demands to the premium platform's products or services still pay back a higher margin.

Furthermore, Parker et al. (2016) once mentioned eight tactics that can help to captivate platform users, especially when platforms face the chick-and-egg challenge at the early stage of platform launch (Caillaud and Jullie 2003). These tactics consist of, the "follow-the-rabbit strategy" in which the platform interactions are enacted by transplanting an established offline businesses into a digital form; the "piggyback strategy" that draws on the user base of an existed platform; the "seeding strategy" which often involves platform's self-production of value units to a set of early platform adopters; the "single-side strategy" which forms a business around one type of platform users and gradually extends to the multi-sided mode; the "producer evangelism strategy" that leverages the value of content producer or opinion influencers and brings their customers to become early troop of platform consumers; the "big-bang adoption strategy" which endorses the mass marketing strategy to create simultaneous on-board of multiple sides of platform users; and the "micro market strategy" where platforms starts form a micro-community of users who have already formed the localized interactions and expands the scale of interrelationship complexity by appealing more nodes to the network.

To build a sense of the diverse scaling strategies that platforms have adopted to nourish their early user base growth, Table 16 presents the user growth techniques applied by some leading platforms in several industries. The purpose of this table

is to reflect on the variety of techniques that could be adopted by platforms to enact the network growth.

Table 16. Examples of Platform's Scaling Strategies Applied at The Platform Launch Stage[16]

Platform	Platform types	Scaling strategy	Explanations
Facebook	Social network	Micromarket	Facebook started as a closed community in Harvard University and gradually expands to cross-campus connections.
Wechat	Social network	Piggyback	Wechat gained its initial user base from QQ which is another social network site developed by Tencent.
Uber	Transport	Subsidy	Uber provided free riding and discounts to consumers to create fractions to attract drivers.
Didi	Transport	Subsidy	Didi subsidizes riders with coupons and cash rewards.
Amazon	Commerce	Follow the rabbit	Amazon builds on its successful retailing business model to open to independent sellers.
Taobao	Commerce	Seeding	Taobao seeded early sellers' installation with no service charges or commission fee.
Xbox	Gaming	Marquee	Microsoft bought Bungie and made Halo an exclusive game on the platform.
PayPal	Payment	Subsidy	Paypal provides cash incentives to newly joined customers.
Zhihu	Knowledge sharing	Seeding	Zhihu seeded some opinions leaders on the platform and directed their followers to become platform users.
Stack Overflow	Knowledge sharing	Micromarket	Stack Overflow started as a question-answer hub form programmers and consecutively open to more topics.
Dropbox	Document sharing	Referral	Early users share a download link to others and both senders and receivers enjoy extra storage space.
Hotmail	Communication	Referral	Early users send Hotmail message with "Dear, you can have a free Hotmail as I do"

One interesting observation from Table 16 is that not all of these scaling techniques applied in growing the user base in the early days are sustained into the platform's long-term development. While such discontinuity of the scaling

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[16] The resource of information consists of examples used in Parker et al. (2016), Gawer et al. (2019), and the platform related publications such as web blogs and news.

techniques used in the early days might cause minimum harm when platforms switch to a more operations-focused mode. Many platforms have to extend the scaling techniques to be part of their operational routines. For instance, Fakebook's initial reliance on the micro-community naturally faded once the users joined the platforms. Also, Taobao started to charge commission fees to the installed sellers once the consumer resources were steadily formulated on the platform. Such departing from the platform's scaling strategy and operation strategy receives minimum resistance from the platform users because the platforms and the endorsed parties hold the same ink of interests. To specify, Facebook and its users search for and benefit from the greater reach scale. Sellers who were provided with a free installation fee at early times can be quickly and often self-motivated to switch to the profit-making mode by boosting sales on the platform.

However, in some other platform contexts, the cessation of the platform's scaling techniques endorsed to early platform adopters might cause immediate abandonment of platform services. Especially when there are other competing platforms alluring for the same user base and the users encounter zero or very low switching costs to joining the rivalry platforms. After years of operation since its lunch, Uber still needs to offer monetary incentives to motivate users' active engagement with the platform.

One explanation for such unstoppable provision of platform benefits is that the initial hooks applied to appeal to platform users' side are material based. Therefore, taking out the originally presented benefits as promised will deteriorate users' emotions and create a mental impression that the platform no longer values them as they were before. One immediate consequence of platforms following such a direct reward-giving strategy is that consumers may opportunistically behave and take advantage of multi-homing on several substitutive platforms. A widely acknowledged example is the "price war" between Uber and Didi in the Chinese market. Since Uber entered China in 2014, these two platforms have invested a massive amount of money in buying platform users. The only difference is that Uber heavily focused on providing extremely low charges to consumers. Didi asked for

slightly higher riders' prices and kept a relatively equal amount of the payment to the drivers. Despite the $2 billion burnt and the dominant consumer shares Ubser held from 2014 to 2016, the price battle eventually dragged Uber to a tough decision: it might need to shrink the drivers' revenue to cover the huge expenses[17]. Though the absolute revenue made by drivers on both platforms was still very close, the relative reduction on Uber certainly upset the divers, which enforced Uber to admit to the unbearable expenses and exit the market.

Such price competition and heavy subsidization adopted by many platforms invoke the discussion on platform strategy's effectiveness and suitability (Parker et al., 2016). Especially for platforms that think of using the subsidization strategy to realize the genuine acquisition of platform consumers, there is a critical concern about designing and implementing its subsidy scheme in the most effective and sustainable way.

5.2.2 Application of psychology on digital platforms

As a distinct area of research that broadly concerns the intertwined complexity of digital technologies, organisations, and human beings, information systems possess ample possibilities to refer to other disciplines, such as sociology and psychology. As said by Kock (2009), psychology, a school that concerns human cognition and behaviour, presents great power to many counterintuitive behaviours toward technology "because many of the evolved instincts that influence our behaviour are below our level of conscious awareness" (Kock 2009, p395).

One of the earliest incidents that drew psychological controversy on digital platforms was the emotional contagion experiment conducted by Facebook in 2012. In the experiment, Facebook was randomly tweeting to 700,000 platform users some posts written in either a positive or negative tone of language, consequently monitoring the mode of content posted by these users afterwards. This experiment aimed to assess how the provision of emotional posts might influence users' feelings and online posting behaviour. Though the final statistics did not reveal

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[17] Kharpal, A. 2016. "5 reasons why Uber sold its chia business to Didi Chuxing," https://www.cnbc.com/2016/08/01/5-reasons-why-uber-sold-its-china-business-to-didi-chuxing.html

significant emotional contagion between the content viewed by platform users and the content they posted, the experiment itself ignited a public debate on the illegitimate rights of platforms in experimenting with their users without being given users' consent. More importantly, a broader area of concern that emerged from this experiment is the platform owners' potential interests and prospective capability to intervene with users' emotions by pushing feeds and tracking users' activities on a platform (Stark, 2018). In 2017, according to a document leaked from Facebook, Facebook, in fact, had reaped some profits by selling the extrapolation of teenage users' emotional moods to advertisers (Tiku, 2017).

In recent years, an emerging group of research has focused on studying the interrelation of psychology and behaviour in the design and management of digital platforms. The first strand of research in this domain draws on the human being's psychological inertia to inform the effective design of platform activities and interactions (Liu et al., 2022; Burtch et al., 2018; von Krogh et al., 2012; Yin et al., 2014). For instance, Liu et al. (2022) studied how the platform user's motivation to participate in platform activities could be boosted by engaging the reciprocity-based platform user interaction. According to this research on a sport and health-oriented platform, compared to a purely financial-based platform incentive that leverages the self-interests tendency, platform users are more likely to accomplish sports goals on a platform if their achievement can simultaneously trigger some peer-to-peer gifts giving interactions. Similarly, in Burtch et al. (2018), they ran a randomized experiment to investigate platform users' behaviour in writing product reviews. Results showed that where financial incentives might stimulate a higher response rate in terms of the volume of reviews generated, the creation of social norms that help to legitimize the review writing behaviour can encourage a deeper level of engagement---writing a longer review with much detail.

The second stream relates to the cognitive processing influences applied when users interact with the platform and other platform users. To specify, Yin, Bond and Zhang (2014) found that the emotions indicated in the platform's user-generated content (e.g., online reviews) will significantly impact the extent to which the

content will be considered useful and helpful by other platform users. Particularly, the extremely negative emotion expressed tend to make the platform content more reliable and trustworthy than the positive appraisals (Cao et al., 2011; Kuan et al., 2011), which has widely acknowledged the platform users' negativity bias in evaluating the peer-based information disclosed on a platform (Wu, 2013).

Built around the socio-technical feature of platforms (Chai and Kim 2012), the third stream of research highlights the individualized psychological sense-making of the platform resources and platform technologies. For example, Cummings and Dennis (2018) examine how users of an enterprise social media platform translate others' profile information into a source of constructing social capital (e.g., trust) before meeting each other in person. In Wan et al. (2017)'s research of users' engagement on an online content-sharing platform, they found that the donation function that allows content viewers to give money to the content producers will reflect the level of viewers' emotional attachment to producers. In return, the emotional attachment built from the donating behaviour will further reinforce consecutive donation giving and enhance consumers' stickiness to the platform.

5.3 Research Design

5.3.1 Research question

Following the theoretical foundation section, the motivation of this research is broadly built from the following three pillars. First, the platform as a new entrant needs an innovative creation and implementation of the scaling technique to effectively enact the early platform's user value. Second, there is a tendency that the material allure offered through subsidy to these early platform consumers may entail a certain level of unsustainability. This means the platforms often need to keep offering these benefits with high costs to retain platform users. Or find a smooth way to gradually reduce the investment, which tends not to cause user friction or negative feelings about the platform. Third, this emerging stream of

study seeks a better design of platform activities and strategy by drawing on the field of psychology and behaviour. Exploring human motives and instincts in participating in platform activities inspires a new angle for developing an effective and sustainable platform strategy. The question that aims to be answered by this research is: *how and why the psychological and behavioural motives may be incorporated to enact an effective and sustainable platform's scaling strategy in growing its consumer base.*

5.3.2 Case description

The case studied in this research is Pinduoduo, the fastest-growing and one of the top three leading e-commerce platforms in China. Back in September 2015, when PDD was launched, this platform was not optimistically favoured by investors and the public. Because at that time, Alibaba and JD.com, two long-existing dominant players in online commerce, had already taken more than 80% of market shares nationwide[18]. Given this, thriving in such a market was a foreseeable tough mission for any new entrants. Many pioneer businesses that entered with the niche market strategy, such as VIP.com for the high-end products and Mogujie for the cosmetics products, were all turned to become trivial players that did not make any significant differences to this duopoly market.

Given the tough competition faced by PDD, it eventually turned out to be a notably successful player in this market. To specify, it took PDD just four years to reach one trillion Gross Merchandise Value (measured in RMB), compared to the 14 years spent by its main competitor—Alibaba. In terms of the user base scaling, the number of annual active users on PDD was about 245 million by 2017, 788.4 million by 2020, and reached 868.7 million by 2021[19], which counts for 62% of the

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18. According to the Annual Report of E-Commerce Statistics 2015, the e-commerce industry generates total trading amount of 18.3 trillion RMB in 2015. Among it, TMall accounts for 57.4%, followed by JingDong.com with 23.4%, Vipshop with 3.2%, Suning.com with 3.0%, and other six platforms with around 1% share respectively.

[19] The information was obtained from Pinduoduo's Annual Report 2021. Key highlights of Pinduduo's 2021fiscal year report is available at https://www.globenewswire.com/news-release/2022/03/21/2406560/0/en/Pinduoduo-Announces-Fourth-Quarter-2021-and-Fiscal-Year-2021-Unaudited-Financial-Results.html

Chinese population. In comparison, the active annual users on Alibaba (which consists of Taobao and Tmall) is around 811 million[20], and on JD.com is about 569.7 million[21]. PDD is certainly the third largest and fastest-growing e-commerce platform with just six years of operation.

Reflecting on PDD's development trajectory, several clever things were done by PDD that made it outstanding from those giant competitors. First, rather than cover massive categories of e-commerce goods, PDD set its core business to focus on agricultural products. This proposition enabled PDD to release the market potential of many less affluent rural areas. In addition, focusing on daily necessities such as portray, fruits, and vegetables is also a smart tune to reach frequent users' visits. Users are promised the lowest price of all agricultural goods sold on a platform by directly connecting farmers' products and end consumers. As an exceptionally successful new entrant platform in the e-commerce market in China, PDD's scaling strategy applied in appealing to consumers from those well-established competitors is posting intrinsic value to academics and practitioners.

5.3.3 The scaling technique

Apart from the astute platform proposition, PDD's success is widely acknowledged by its user scaling strategy. PDD has followed the subsidization technique as the core by offering financial rewards to platform adopters. However, the conduct of PDD's subsidy is posting substantial differences from what we have understood as a typical subsidy scheme. Specifically, there are two main unique features of PDD's subsidy scheme. First, the benefits subsidized on the consumer side are not guaranteed to every single person. It is akin to the lottery in that consumers would face the unknown probability of getting the subsidy rewards. Specially, there are two forms of rewards: 1) the immediate monetary reward from a lucky red pocket;

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[20] The number of Alibaba's active annual users based on its 2020 annual report ended on March 31st 2021, thus should be only considered as a rough estimation for its annual active users by the end of 2021. https://doc.irasia.com/listco/hk/alibabagroup/annual/2021/ar2021.pdf
[21] JD.com Annual Report 2021. https://ir.jd.com/news-releases/news-release-details/jdcom-announces-fourth-quarter-and-full-year-2021-results

2) the indirect monetary reward from purchasing any product for free. Second, PDD also employs the traditional referral scheme differently. Where both the platform referrers and referees can have a certain amount of money rewards, the invitation code receivers on PDD are made to "help" the senders to obtain the abovementioned two forms of subsidy benefits successfully.

Figure 4 below presents two different platform subsidies for platform consumers using the referral scheme. Here, we take Uber and Pinduoduo as two illustrative examples. When consumers log on to the PDD app, a pop-up lucky red pocket will lead them to the "cut-to-cash" game (see Figure 4). The amount of the final cash reward ranges from 100 Yuan to 1000 Yuan. On the main page of this lucky pocket, there is a progress bar showing the "gap" to the final cash reward. Below this bar is a consumer link intended to be shared by the consumers among their social circles. Accordingly, people who receive this shared link can press a "price cut" function and help the senders to shrink that "gap" by a random amount of money. In the other "cut-to-free" scheme, the consumers will need to pick a product they want to purchase with zero costs. The "gap" of money needs to be slashed, which equals the price of the wanted product. Then, the following steps of sharing the links to friends and monitoring the progress are quite similar to that in the "cut-to-cash" game.

Figure 4. Examples of Platform's Subsidy Through User Referral Scheme

| Uber's Referral Scheme | Pinduoduo's Referral Scheme |
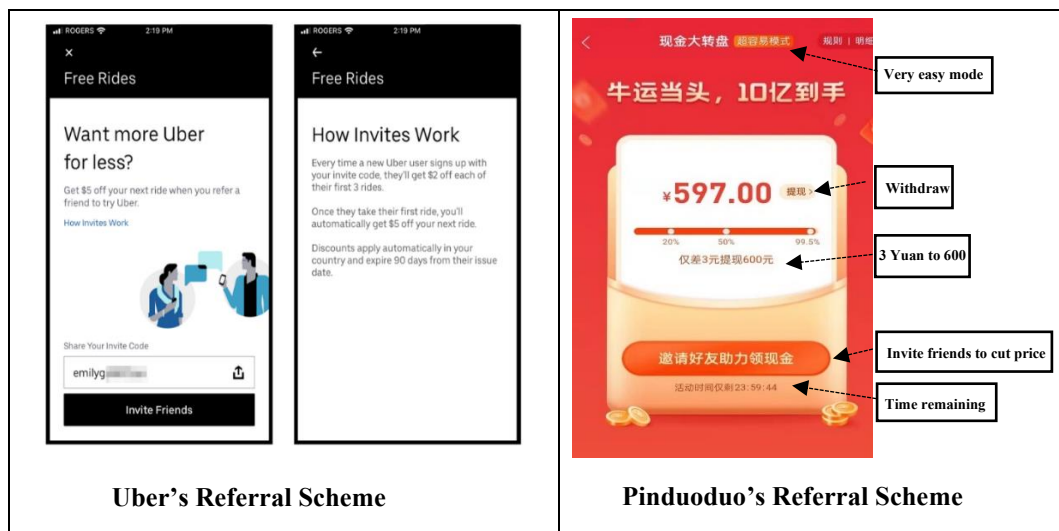
Often, there is 24 hours time limit for a consumer to narrow the gap money to its intended target. Otherwise, the link and the game will expire, and the consumer will receive zero rewards. This feature is advantageous to a 90-day time window because it calls for the urgency of taking immediate action. There are often no immediate actions for the conventional coupon scheme, and the invitation codes can remain inactive for a long period. One direct consequence is that the acquired consumers might take advantage of whatever is offered by the platform but rarely spread the promotion code to others. The detailed procedures that need to be completed by the referrers and referees in accomplishing such a referral scheme are presented with two user activity diagrams respectively (see Figure 8 and Figure 9 in Appendix of Chapter 5).

In brief, there are five major differences between the subsidy schemes employed by Uber and PDD. First, the invitation medium issued by Uber is a character-based code, whereas the Pinduoduo is a clickable web link which does not require a copy-and-paste operation. Second, a requisite condition of Uber's referral scheme is that the receivers of the referral message must be new users and must complete the platform's sign-up procedures. In contrast, PDD's referral message receivers can choose to open the link via a webpage and do not have to register with the platform necessarily. Third, building on the last point, it is the sender's responsibility to judge the receivers' eligibility (i.e., new user), which can greatly reduce the senders' likelihood of acting. Fourth, to make Uber's subsidy rewards useful, receivers and senders must generate at least one platform order (i.e., take a ride with Uber) and pay the money, excluding the rewarded discount. On Pinduoduo, the outcome of a completed referral activity is immediate free products or withdrawable cash, which does not incur any additional user payment. Fifth, given the 24 hours limit on PDD, senders will certainly feel a stronger sense of urgency to act and monitor the progress. While on Uber, it is very difficult for the senders to acknowledge the receivers' use of the code.

5.3.4 Method and data collection

Given the exploratory nature of the research question, this research will follow Yin's (2003) single-case analysis approach. Using a single case allows the researchers to explore a phenomenon and its significance with various data sources (Baxter and Jack 2008). Also, investigating a single case in detail foster a deep understanding of the complexity of the understudied phenomenon in terms of its subjective and dynamic creation of meaning (Crabree and Miller 1999; Baxter and Jack 2008).

Guided by the novelty of the platform strategy understudied, this research follows Urquhart (2013), Geering (2007), and Mohlmann et al. (2021) for the data collection and analysis approach. The data collection expands into two waves. The first round aims to understand the understudied phenomenon and inform the sampling strategy to be applied in the second wave. A detailed discussion on the focus of each wave's data collection is displayed in Table 17. The first wave involves collecting public data from multiple sources, such as blogs, video-sharing sites, and content publishing sites. The primary goal is to set a ground for the general users' opinions and experiences with the PDD's scaling strategy. In the second wave, 30 platform consumers are invited for a semi-structured interview for about 35 to 45 minutes. All the recruited platform users have conducted or participated in at least one price-cut activity. 37% of them are identified as regular players who would send out the price-cut invitation every one or two months, and 97% of interviewees remained responsive to others' requests. Regarding the overall activeness of such a scaling scheme, people who joined platforms immediately after the platform launch do not present significant differences from those who just joined in the recent two years. It indicates that the attractiveness of price-cut games does not vanish as time passes and still applies in attracting platforms after years of platform launch. In the third wave, 42 additional platform consumers were invited. Some of these interviewees were recruited based on the recommendations given by previous interviewees. In this round, we particularly lowered the income and social status bar and increased the age range to over 30s, because we found that people in middle age with less prestige income levels tend to be more active in participating

in the price cut game.

Table 17. Waves of Data Collection

Activity	Approaches	Aims
Data Collection – Wave 1		
Understand general platform users' behaviour and experiences	**Collect** anecdotal and real user experiences posted on multiple social sites (e.g., social media; knowledge/video sharing platforms; short video streaming platforms). **Participate** platform's money-slash activities.	**Understand** platform processes and different promotion mechanisms. **Identify** hilarious and extreme user experiences. **Gain** initial sense on public's attitudes on the platform.
Data Collection – Wave 2		
Explore platform users' participation of the price-cut referral scheme	**Apply** sample strategy according to demographic and social features (e.g., education; occupation; age; economic status). **Interview** 30 platform users.	**Understand** individual' s general activities on the platform and past money-slash experiences. **Compare** individual attitudes against public's attitude.
Data Collection – Wave 3		
Revise recruitment strategy to include more active platform users	**Follow** snow-balling strategy to recruit interviewees **Shift** recruitment strategy with emphasis on the increased age group, intensified platform engagement, and lowered social economic status **Redesign** interview questions based on findings from round 1 **Interview** 42 platform users.	**Gather** opinions from the other side of money-slash activity. **Compensate** the weaknesses of interviews from round 1. **Emphasize** on exploring different aspects of money-slash activities **Generate** new insights on money-slash

5.4 Discussion

5.4.1 Sending referral message

The purpose of this section is to discover the psychological and behavioural motives that are applied in encouraging the commencement of referral scheme—platform users sending invitation links to their friends. Based on the findings that emerged from data analysis, this section will discuss three prominent mechanisms where psychological instincts can play roles in designing the platform's referral scaling strategy.

5.4.1.1 Framing of the referral scheme

The first unique application of psychology and behavioural trait in PDD's referral scaling scheme is about framing the platform strategy. The prospect theory developed by Kahneman and Tversky (1979) offers great insights to explain why the employment of PDD's referral scheme might be more effective in stimulating consumer participation. As one of the earliest works in the field of irrational economics, Kahneman and Tversky's (1979) experimental study on individuals' decision-making presented 14 different variations of decisions made under uncertainty and risks, in which the utility theory that corresponds to the pursuit of the maximum expected value often failed to predict the actual decision-making outcomes. One key takeaway from their research is that different framings of a specific event could perceptually manipulate people's evaluation of an event's probability and overall warfare. The function of value is "generally concave for gains and commonly convex for losses" (Kahneman and Tversky 1979). Furthermore, individuals are generally more alert to the identical degree of changes in the loss scenario than that in the gain scenario.

As shown in Figure 4, the referral message's tone used in the conventional referral scheme is mostly oriented in the gain scenario. Given the null status in which both senders and receivers will gain nothing in the end, the receivers and senders need to complete certain tasks to receive the referral rewards. Despite the potential additional costs incurred in completing the platform's referral scheme, both the senders and receivers would lose nothing if no actions were taken.

In contrast, the way that PDD frames its referral scheme follows the opposite logic. Given the end outcome that platform users will receive a certain amount of rewards once they complete the referral activities, the null status—which is taking no actions, already involves a sense of loss. As shown in Figure 4, 597 out of 600 Yuan are saved into the referral senders' accounts without any actions taken. In this regard, not sending out referral invitations will be perceived as the potential loss of this virtually gained money. Ironically, in such a loss scenario, platforms

pay nothing if referral senders decide not to proceed to send out invitations. But the referral senders' impulse to take action is much stronger than that in the referral scheme framed with a gain scenario.

Besides, the different framing of Uber's and PDD's scaling scheme could also be explained by the use of the reference point (Kahneman and Tversky 1979), which indicates the psychological tendency where individuals' attention can be unconsciously directed to the deviations of changes over the absolute magnitude of changes (Helson, 1964). In the conventional referral scheme, the reference points perceived by senders are roughly five, where no actions are taken. Furthermore, given the requisite condition where the receivers must generate at least one platform transaction, the ratio of the needed efforts in relation to the likelihood of receiving these five units of rewards is further lowered. In comparison, for PDD's referral scheme, the needed efforts from the senders only constitute a small proportion compared to the volume of rewards granted by platforms. Together with the least loads of effort needed from the receivers' side, the ratio of the total investment concerning the hopefulness of receiving the final reward is, by all means, very alluring and promising to the referral senders.

Figure 5. Framing Mechanisms Applied in the Scaling Strategy

Sample scripts	Focus of senders' interpretation of the referral scheme	Mechanisms Engaged
I was not so believing in this game at the beginning even though I heard many people have successfully received the money. My attitude changed until I witnessed the whole process done by of my close friends. And then I thought, I was not that hard as I imagined.	Assessing the gap to the final reward Interpreting the small gap as a personal luck Estimating the needed efforts Estimating the viability of implementation	**Aversion of loss** - Personal luck - Identity-based asset - Benefits of platform rewards - Relative loss to others' gain
You know, some guys published their money slash on bilibili (a short video share platform). Though someone said it is a fraud, but there are many people who indeed receive the money in the end.	Connecting benefits of referral scheme to the value of a wishing product Self-convincement on the urgency of action	
	Assessing the volume of platform rewards to other known cases; awareness to personal luck Aversion of losing the platform benefits that is granted to a certain type of platform user identify	**Reference point** - Gap to the final reward - Required level of efforts - Acquired personal resources - Benchmark value to personal needs
	Aversion of losing free gifting	- Successful cases
	Confirming the likelihood of completion using peer evidence Tendency of lose aversion	

Figure 5 presents the mechanisms applied in the PDD's referral scheme. Overall, the referral scaling technique used by PDD greatly leverages the power of "aversion of loss" and the "reference point" that are influential to individuals'

decision-making, especially in a scenario which involves uncertainty. To specify, loss aversion is enhanced through four types of benefits that platform users perceive. First, platform users tend to interpret the big amount of lucky money given by the platform as a stroke of personal luck. This attribute is reinforced by the design of the referral scheme where the amount of reward in each game is a random number ranging from 100 to 1000. Second, with some pre-knowledge about the platform's referral scheme, platform users are largely aware of the premium benefits as new users. Therefore, they interpret such identity-based benefits as valuable personal assets that they tend to avoid wasting. Third, when the rewards are seemingly provided as a free gift without any expenses, platform users tend to proceed and participate. Last, the meaning of "loss" is also relative to others' gain. Which indicates, when people are aware of the benefits received by people who are in similar conditions as themselves, they tend to legitimize their own's deservedness to obtain the benefits.

Second, the application of the reference point is also a deliberately applied element in the PDD's framing of its referral scheme. Several factors are involved when platform users consider their participation activity. Specifically, while the referral senders constantly judge the money gap deviated from the end goal, the degree to which the rewards are guaranteed to the senders is broadly compared against other successful examples. In this sense, users tend to overlook the uncertainty in the chance-based event and overestimate the likelihood of receiving platform rewards. To conclude, given that successfully receiving rewards from PDD's referral scheme is, in fact, a chance-based event, the "aversion of loss" nudged platform users' motivation to take immediate action, and the engagement of such "reference point" deliberately improved platform users' confidence in successfully receiving the final rewards.

5.4.1.2 Illusion of control

Informed by the chance-based design of PDD's referral reward, it resembles great

similarity to gambling akin games such as lottery and horse racing. Despite the uncertainty, people who regularly participate in these games often have more or less confidence in playing the system and getting closer to the winning number (Rogers, 1998). Regular players often follow common practices, such as formulating prediction rules based on past winning numbers, or forming a complex calculation system consisting of hot numbers, cold numbers, cooling off, and warmup period. It is not rare to see a horse racing fan analyze a long sheet of reports as a stockbroker staring at monitors. The regular players of gambling games have a sophisticated set of beliefs and techniques that, to a large or small extent, make them believe in their chance of winning (Webley et al.,1997). Such beliefs of winning the chances become more prevalent if the players believe they can somehow control the possibility by employing certain "skills" (Rogers, 1998). For example, students of horse racing who once won with a specific type of clue will reinforce using that type of clue in consecutive games. Similarly, in card games, people believe in some ticks, such as analyzing the opponents' facial expressions and bluffing opponents at the right time. The engagement of some skills or the rule systems formulated by players in such chance-based games fundamentally reinforces the players' sense of control, which further leads them to overestimate their chance of winning (Langer, 1975).

Speaking of PDD's referral scheme, it is quite similar to the gambling game based on uncertainty and alluring rewards. Consistently, several features of the referral scheme design direct the players to believe that they have much control over all such chance-based events. Figure 6 lists some evidence from the platform users.

Figure 6. The Illusion of Control Applied in the Scaling Strategy

Sample scripts	Focus of senders' interpretation of the referral scheme	Mechanisms Engaged
I heard that the game is quite friendly to the new users like me. It is in general only needs to recruit around 20 or 30 people.	Wide spread social comments Self-confidence on the rules of the game	**Illusion of control**
Last time, I did get a 500 free money with the help of friends from my student hall. It took some time, but I knew these number of people should be quite enough to suffice the requirement	Follow the personal experiences Positive reinforcement of past experiences	**Manifestations:** - Progress monitoring - Contingent estimation of the needed efforts
I know that for such as new platform, it eagerly needs consumers and high platform adoption, the game could not be so hard, otherwise no one would play it.	Speculation on the platform characteristics Inferences to the level of difficulty	**Sources:** - Personal experiences - Experiences from others - Knowledge and understanding of platform business - Social impressions and rumours
You can see that each of the invited person will slash the money to some amount. So, I can roughly guess how many more people is needed	Platform feedbacks the progress of the game Real-time estimation on the needed activities Self-determining and estimating the required efforts	
One of my colleagues successfully got 100yuan red pocket this morning with the help of couple of people from our office, so I just followed her and did the same thing.	Copying others' success strategy	
It is known that new users can certainly slash more money, so I successfully made it by sending the links to my parents and a couple of close friends because I knew they haven't used the app yet.	Understanding of the referral scheme design and success clues Self-controlled activities of following the clues Positive reinforcement from previous experience	
According to one of my friends, it only takes no more than several hours, so I just decided to try it, and if it turned so hard, I would just abandon it.	Flexibility of opt-out	

According to Figure 6, the illusion of control embedded in PDD's referral scheme design could be understood from two aspects. The first aspect deals with the manifestations of the sense of control. One critical component that directs the platform users to think that they are leading the game process is the platform's feedback and the reporting of the game's progress. The real-time progress report positively reinforces the users' continuity of action because they can instantly see the rewards made from their efforts.

Second, the illusion of control also represents through the users' self-belief that they could estimate and constantly re-estimate the needed efforts. The effort estimation describes the individuals' subjective evaluation of the amount of energy needed to gain the expected platform rewards. As platform users send more invitation links and update their progress of receiving the rewards, they build more concrete views on the needed efforts. Given the fixed result of the outcome, i.e., price slash to zero, a certain amount of red pocket money, referral senders tend to feel that they are making an informed decision regarding whether the current status deserves more investment, such as time, energy, and the use of social credit. Last, given the nature of the chance-based event, the motivation for initiating a referral invitation is reinforced by the flexibility feature that platform users can decide to pause the game if seeing no hope.

Regarding the sources of such a sense of control, platform users often draw on their own past experiences or the learnt success experience from others. Besides, some general understanding of the platform's business rules also plays a part. When platform users believe that certain behaviours are welcomed or demanded, they become more likely to perform that behaviour, even if it involves uncertainty. Last, the social comments and rumours that serve as a source for false impressions are also useful in improving users' sense of control. This feature greatly resembles the strategy of lottery firms to propagandize those jacket pot winners in the media, to create a public impression that anyone can become the next big winner.

5.4.2 Responding to referral message

This section will discuss the responding party's motives for participating in the referral scheme. In order for the platform's referral scheme to be effective, apart from adopting the right mechanisms that motivate the users' active sending of the referral message, deliberately boosting the other side's response rate also pertains to the great importance.

5.4.2.1 Reciprocity and social pressure

As said by Karl Marx: man is the sum of his social relations. The formation of social relations is a developmental process where individuals need to interact with others and the environment. In such a process, individuals' behaviour is constantly bounded by different rules, norms, and obligations (Emerson, 1976; Blau 1964). The fundamental incentive for individuals to voluntarily apply these social expectations is built on the common agreement that social relationships are meant to "evolve over time into trusting, loyal, and mutual commitments" (Cropanzo and Michell 2005).

In PDD's referral scheme, reciprocity is one of the key influential forces driving users' participation behaviour. The notion of reciprocity is grounded in the nature of individuals' interdependence with other individuals and their surrounding

environment (Gouldner, 1960). As one of the key principles in the social exchange theory, reciprocity explains the stability of the social interaction system where one's gratification needs are often contingently depending on other parties' reactions (Gouldner, 1960). The social interaction shall steadily move towards a mutual benefiting condition because whenever one party shows kindness or satisfies the other party's needs, the benefactors are supposed to offer a similar level of kindness to maintain the social balance (Gergen, 1969). In other words, "if a social system is to be stable, there must always be some 'mutuality of gratification'" (Gouldner, 1960). Such mutual benefits motivate individuals to perform beneficial behaviour to others because their investment is expected to be rewarded from long-term social interactions (Malinowski, 1932).

Drawing on the reciprocity principle, the effectiveness of PDD's referral scheme could be understood from two aspects. First, it allows the counterparty's reciprocity to have a tangible and visible value. Rather than sharing a referral message without knowing whether the receivers would have used it or not, senders of PDD's referral message will instantly see how much money has been reduced by which receiver. This way, the receivers have stronger motivation because the senders will immediately recognise their efforts. Second, PDD's referral scheme requires no costs from the receivers except for a couple clicks. The simplicity of action naturally reassures the immediate response compared to other referral schemes that often have some prerequisite conditions (e.g., the referrers' rewards will only be activated after the receivers sign-up and generate a transaction via the platform). In this regard, the referral scheme of PDD is increasingly functioning as a powerful medium where one party could convey or signal their intentions of establishing the mutual good with the other party without inuring any material-based expenses.

Around 75% of interviewees in our research were initially drawn to the PDD platform by price cut requests sent by their friends or families. Figure 7 lists several evidence of the receivers' motivations to participate in the price-cut referral requests. The motivations of the referral receivers are built from two parts:

reciprocity and social pressure

Figure 7. The Reciprocity and Social Pressure Applied in the Scaling Strategy

Sample scripts	Focus of receivers' interpretation of the referral scheme	Mechanisms Engaged
I always say yes to these requests because I know that I might also need them to do this for me someday	Set a buffer for the same treat in the future	**Reciprocity** - Interpret referral message as a form of help or favour - In return of the same treatment in the future - Bring tangible benefits to the senders - Show emotional care to the senders - Show social respect to the senders - Maintain mutual trust
The link was sent by a high school mate, who hasn't been contacting for quite a long time. It feels good and funny to interact again in such way.	Way of social interaction Connection to less closed friends	
It doesn't cost me anything, I have the app installed on my phone anyway, so I just helped her to save some money	Low participation costs Response is interpreted as a help Benefits others with tangible return	
I am not always responding to all these links especially for those that I can quickly recognize as "sent to the group" message. I only do that if they asked me to do in-person, for instance, leave a private message.	Selective responses Pressure of response if being asked in-person	
It's just a little favor, I know the senders will see who have responded to her links, even though it isn't a big deal, I just don't want her to be disappointed about me.	Response is interpreted as a favour Pressure of being noticed by senders Associates to the emotional care of the senders	**Social pressure** - Social pressure as being noticed or monitored by others - Social pressure set by the culture and norms - Social pressure from the hierarchy - Interpreted as an extension of social interaction
You know, the links were sent through Wechat, you can only say no or ignore if you'd never talk to that person on Wechat. Otherwise, you would feel so embarrassed to pick up conversation if you ignored your friends' requests.	Associates response to social interaction politeness Referral message is part of or an extension of the virtual social interaction	
You cannot just ignore that if they are the parents or your supervisor. I always do that for my boss. How to say…Its kind of necessary	Social pressure from cultural norms Respect to the elders Social pressure from hierarchy	
You know, they sent it to me because they consider me as real friends. They know that I will always help them	Empathy Social trust	

First, without negotiating on the absolute fulfilment of the requests, the respondents consider their repones as a necessary buffer zone for the possibility of asking the same requests in the future (Molm, 2000). Even though the respondents may not have previous experiences of asking such favours or are unsure about the likelihood of doing so in the future, a common mentality revealed by platform users is "there is no certain thing you might need to ask a favour from that person in this way or another, so why not keeping such good interaction along the way." Second, the respondents' reciprocity action is enhanced by their emotional judgement of the benefits of their behaviour. For example, some respondents view their response action as a kind of help that can bring a tangible good deed to others. Furthermore, some receivers tend to attach more intangible returns of doing so as a way to show respect, protect senders' feelings, or maintain the mutual trust.

Besides, the sense of social reinforcement also plays an important role in increasing the receivers' action rate. The first source of social reinforcement is due to the design of the referral scheme, where the receivers are aware of the senders' real-time notice of their reaction. The immediate recognition of the receivers' action is an important factor that reinforces the repones rate. Because in this way, the

receivers know that their willingness to contribute to the senders' good deeds will be immediately recognized. Second, social reinforcement also comes from the cultural norms that are attached to the social bind, which describes the relationships that are built by close social connections, such as by physical closeness (e.g., classmates, colleagues), social status hierarchy (e.g., employers and employees), and family relations (e.g., family members). The social binds very often enforce receivers' compliance. The last source of social pressure emerged from using social channels to send referral messages. When the request is delivered through the social network sites (e.g., Wechat), it is natural to be unconsciously interpreted as part of the social conversation and thus hard to be ignored by the receivers.

Last, the perceptual urgency of responding to the senders' requests reinforces the receivers' responses to comply with social obligations. Because the PDD's referral link would only be valid for 24 hours. When time expires, the senders can no longer continue the game and must initiate a new invitation link. This feature is more effective than allowing platform users a 90-day time window because it calls for the senders and receivers to achieve the most effective two-way conversation. According to our data, senders sometimes pressure the receivers to respond by having a private words with them before sharing the links. Also, receivers who are often willing to comply with the referral scheme are motivated by the immediate recognition of the good deeds to the counterparty and consider it a convenient social contact point in maintaining interpersonal closeness.

5.5 Implications

As the intersectional research of platform strategy and psychology, this study reveals several interesting features of the platform's referral-based scaling technique design. Drawing on the engaged psychological motives, this research not only concerns how platform users' participation behaviour could be strongly encouraged by designing referral as a lottery akin game. But also, such a chance-based design of the referral scheme offers some potential implications for the

suitability of the platform scaling strategy.

5.5.1 Design of platform's scaling strategy

The lottery akin platform's referral-based scaling technique discussed in this research provides several interesting implications for the platform scaling strategy design. Overall, one key argument made by this research is that the platform users' active participation in the platform's scaling scheme could be deliberately fertilised by incorporating proper psychological stimulus.

The first set of psychological motives is built around the consumers' perceptions of the urgency of sending a referral message through the employment of the "loss-oriented" framing of the referral scheme. Instead of offering platform rewards in the form of gain (e.g., receiving a discount), creating a sense of potential loss if no actions are taken will make consumers more aware of the rewards' value. Once the consumers' mind is manipulated to focus on what they might lose, they are more likely to take responsibility and actions to avert the loss consequence.

The second set of psychological motives that makes PDD's referral scheme so effective in stimulating senders' action is around the creation of the illusion of control. This factor is particularly imperative for a chance-based event, where players often hold an inaccurate sense of control that tends to overlook the essence of probability and overestimate the chance of winning. Similar to the gambler's mental activities, regular players of gambling such as lottery and horse racing, often formulate their own set of logic that involves a sophisticated combination of many different tricks and techniques.

To build such a sense of control, the design of the platform's referral scheme should enable: 1) the gaining of self-confidence in estimating the likelihood of receiving rewards; 2) the provision of instant feedback on the progress of receiving rewards. The first element could be realized from many sources, such as self-gained knowledge from someone's past experiences. Alternatively, such estimation capability could also be gained by learning from others' successes. A key factor here is that the platforms should try to open many venues and cultivate an atmosphere

where people are directed to build their confidence about winning the referral rewards.

Third, in contrast to the conventional referral scheme, where the senders of the referral scheme would hardly know about the other party's responses. Platforms should build a function that provides the senders with a real-time report of their progress in receiving the reward money. This feature, together with the 24 hours limitation, greatly made the platform users think that they are taking the main lead to adjust their participation strategy contingently. Knowing the current status will let the senders feel that they are making an informed decision on their following activities.

The fourth set of psychological motives is built around the receivers' responses to the referral request. Successfully motivating the receivers' reaction is a critical factor that can make the employed scaling strategy an overwhelming phenomenon in attracting new platform users quickly. In this regard, the referral scheme could be designed by involving the elements of reciprocity and social reinforcement. First, reciprocity represents the design of referral where the senders could immediately acknowledge the receivers' responses as a signal of intention to offer good deeds. Guided by this proposition, the receives' action is greatly motivated by the idea that they might need help from others someday. Especially when the receivers' response is deeply attached to the immediate tangible benefits that the senders need, they tend to present a greater level of empathy and consider their reactions as a form of "help" and "favour" to the other party. Also, such a "doing good to others" mentality makes the receivers think that their responses show respect and care for the senders' feelings. Second, the social reinforcement factors could also be leveraged by the platform's design of its scaling strategy. Specifically, making the referral message part of people's social interaction can improve the receivers' response rate. Means to achieve this is by integrating and encouraging the share of referral invitations through people's social media sites.

5.5.2 Sustainability of platform strategy

The lottery akin based referral scheme discussed in this research also pertains to potential contribution to the debate on the sustainability of platform strategy.

First, many scaling techniques used so far require the platform owners to take active initiation and investment. Though the referral scheme involves some inferences to the referral senders' social networks, the design of the conventional referral scheme remains less effective in terms of encouraging senders' self-motivation in seeking new users. In contrast, for PDD's referral scheme, informed by the learnt success clue that new platform users often can "cut" more volume of money in such referral scheme, the senders who initiated the referral link would take strong self-incentive to actively look for those who have not adopted or used the platform yet. In this way, on behalf of platform owners, consumers take the main lead in searching for more potential users. Furthermore, this attribute leverages the individual's social network to achieve consumer segmentation. Despite the types of consumers that are targeted by platforms, letting the consumers quickly find another consumer enables the platform to enjoy the greatest extent in utilizing the social cluster effects.

Second, drawing on the public's wide interest in the notion of "luck", the successful cases of PDD's price cut game could quickly trigger the domino effects within a community to attract more players. For such a chance-based event, the circulation of a success story on social media or physically from person to person can significantly manipulate the individuals' perception of the chance of a win and induce their participation. This feature is largely consistent with the lottery firm's practice of periodically making the jacket pot winner a headline in the local newspaper.

Last, it is also a commonly recognized phenomenon that the platforms' benefits of scaling the platform's user base often cannot last indefinitely. The platform may stop offering the rewards once it thinks the critical mass of users is obtained. And consequently, hurt platform consumers' emotional feelings about the platform. In this regard, PDD's employment of the lottery akin referral reward

might provide a potential resolution because receiving the rewards in PDD's referral scheme is designed as a chance-based event. People who do not make it sometimes interpret it as a lack of personal luck. According to our interview, even though some people might never successfully obtain such lucky money on PDD, they tend not to assert the platform's activity as a fraud because they know that there are certainly some successful cases on their friends or families.

5.6 Future Research

The referral-based scaling technique discussed in this research demonstrated the possibility of incorporating psychological motives into the design of the platform strategy. Future studies can further expand this strand of platform strategy research in the following ways. First, the breadth of interdisciplinary insights could be expanded with more fields such as "psychology, psychoanalysis, behaviours, psychometric, physiological, and social perspectives" (Rogers, 1998). Second, the psychological mechanisms' effects could be testified and quantified through quantitative-oriented methods such as experiments and questionnaires. The magnitude of the mechanisms identified in this research encompasses the potential to be quantitively measured. So that the platform practitioners can be informed with more specific knowledge regarding the effects played by different psychological motives. Last, the generalizability of the lottery akin referral game discussed in this research could be tested across different geographical and cultural contexts. There are many significant cultural differences between the eastern and the western regarding the norms of social interactions that could potentially mediate the effective incorporation of the psychological instincts.

Appendix of Chapter 5

Figure 8. User Activity Diagram of Uber's Referral Scheme
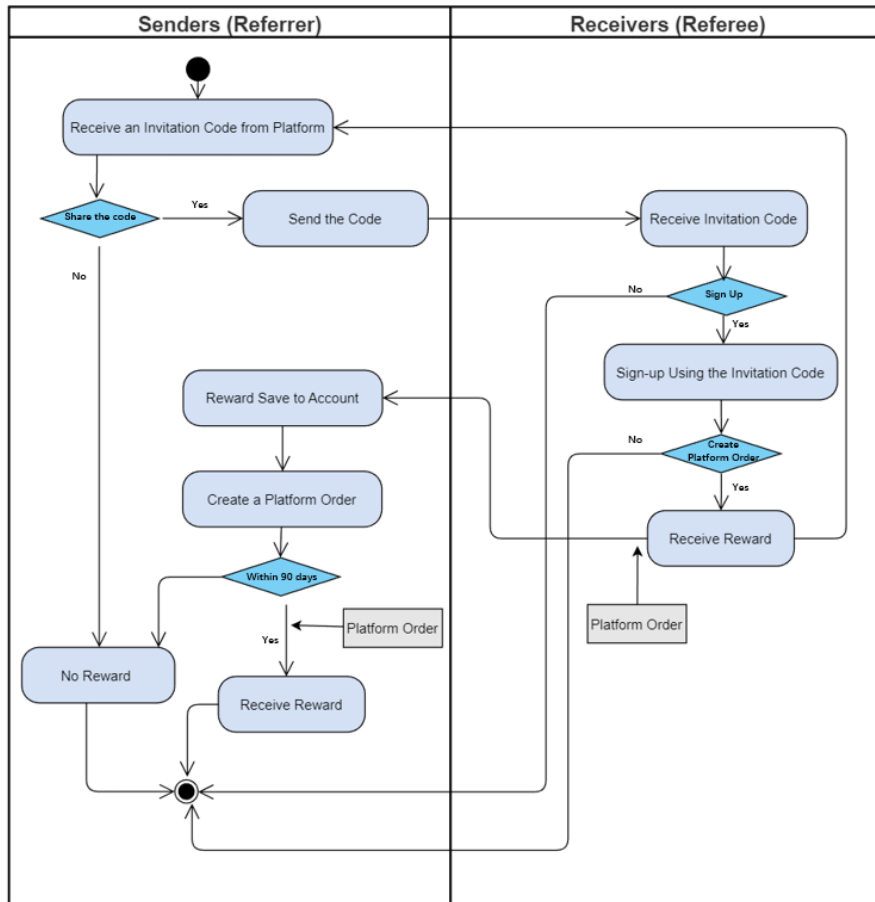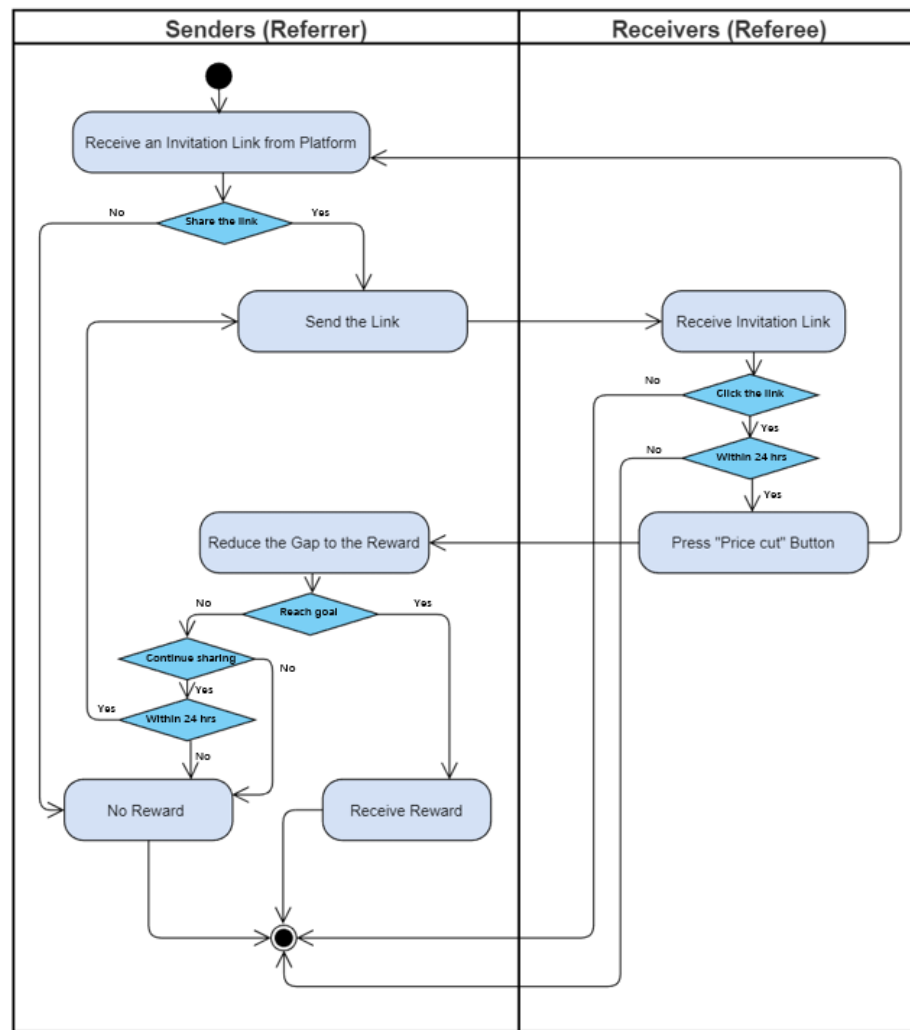
Figure 9. User Activity Diagram of Pinduoduo's Referral Scheme

CHAPTER 6. BLOCKCHAIN NETWORK AS A PLATFORM: CONCEPTUALISING ITS ADAPTED LAYERED ARCHITECTURE DESIGN

Abstract

Digital platform as an organising logic has prominently reshaped the innovation activities in many sectors. Previous studies have extensively investigated the digital platforms from two views: economic view (i.e. as a sided marketplace) and engineering view (i.e. as an innovation infrastructure). Blockchain – a digital artefact that connects the distributed ledgers – resembles great overlaps and specifics to digital platforms. Building on this aspect, I first demarcate the Blockchain Product as a Platform (BPaaP) informed by the economic view and the Blockchain network as a platform (BNaaP) inspired by the engineering view. Given the scant of research around BNaaP, this research aims to depict the BNaaP's architectural design by drawing on the layered design of digital technologies. Using Ping An Group as a case, this research applies the thematic analysis method in analysing online open data. As the main contribution, this research proposes the Adapted Layered Architecture of BNaaP that consists of (1) three design layers (foundation layer, interaction layer, and application layer); (2) adapted business scenarios; and (3) environmental factors. The suggested architectural design implies the BNaaP's internal synergistic collaboration among layers and the external adaptability to different business contexts. Overall, this research provides a novel angle to understand the Blockchain phenomenon and brings insightful implications to Blockchain practitioners.

6.1 Introduction

Digital platforms that enable the value co-creation of multiple parties that are

otherwise not connected have prominently reshaped our economy and daily life (Jacobides et al. 2019) (Tiwana et al. 2010). Blockchain, as an emerging digital solution, resembles great similarities and distinctiveness to digital platforms. Specifically, past studies on digital platforms have well established two salient views: platform as a marketplace (i.e. economic view) (Rochet and Tirole 2006) (Armstrong 2006) and platform as an innovation infrastructure (i.e. engineering view) (Gawer 2014) (Clark 1985). The economic view emphasises the platform's effectiveness in enabling transactions among multiple parties that are otherwise disconnected. Blockchain echoes this view through its collaborative nature of the distributed ledgers and its subject to the network effects. Alternatively, the engineering view discusses how a platform can incorporate heterogeneous innovation while maintaining unity (Karhu et al. 2020). In this regard, establishing a Blockchain platform requires synergistic co-creation within its design structure and entails high adaptability to different contextual scenarios. Informed by the economic view and engineering view are two possible pathways of studying Blockchain. The first strand considers Blockchain as a marketplace that enables value exchange among multiple parties. Very often, participants in the Blockchain market have a certain degree of a joint agreement on Blockchain product's value. This article defines this stream as Blockchain Product as a Platform (BPaaP). Examples include cryptocurrencies such as Bitcoin, Facebook's Libra, digital tokens, and the Initial Coin Offering (ICO). Platform participants are bounded by the common recognition of the digital product's exchange value and the collective objective to continually grow the value of Blockchain product. The other stream proposes that the Blockchain's usefulness is not embedded in its transaction value but more emerged from its architectural design as an organisation logic. Shedding light on Blockchain's enablement of building and sustaining a network, this article defines this type of Blockchain as Blockchain Network as a Platform (BNaaP). Instead of focusing on digital asset transactions, BNaaP grants more efforts in articulating the overarching design of the Blockchain network. In other words, despite what products are transmitted through Blockchain, BNaaP emphasises on

how Blockchain platform is established with multiple levels of complexity and is adapted to different business scenarios where platform participants may have diverse value exchange expectations. Motivated by the importance of BNaaP as an organisation logic, this article aims to establish the fundamental ground of the architecture design of BNaaP. The case understudied is Ping An Group's Oneconnect Blockchain solution. I use the thematic analysis method to analyse online data and obtain some humanistic insights on BNaaP. The proposed Adapted Layered Architecture serves as a starting point that inspires future research on BNaaP specifics. It also provides insightful implications to practitioners who wish to utilise Blockchain to ignite business transformation.

6.2 Related Literature

6.2.1 Digital platforms

The platform has been widely recognised and applied as an organisation structure that enables multiple parties to exchange value and incorporate external parties' innovation. The different sides of participants, governance rules and regulations, and various platform resources form the platform ecosystem (Jockbides et al. 2019; Tiwana 2018). Prior studies on platforms have been mainly built on two streams. The first stream is founded on the market nature of platforms. This economic view considers the platform as a mediator that facilitates transactions among multiple types of otherwise not connected users. Such user connection tradition is widely revealed by the two-sided or multi-sided organisation of platforms (Rochet and Tirole 2006). Catalysed by such sided-platform organisation is the network effects, which indicate the reinforced traction of growing one side of the platform users (e.g. app users) in attracting the other side (e.g. app developers). The platform's usefulness to each user is most likely to increase as more people join from the same side or the other side (Armstrong 2006; Rysman 2009). Another popular stream of platform research is built on the engineering view. Unlike the economic tradition that highlights the transactional feature, the engineering view discusses how

platforms can be a resource pool that facilitates external parties' innovation activities (Clark 1985; Jockbides et al. 2019). In this regard, platforms often consist of a core product, on top of which are a set of platform resources (e.g. Application Programming Interfaces, Software Development Kits, and development guidelines) that aim to enable innovation from heterogenous developers (Meyer and Lehnerd 1997). The arm-length distance between platform owners and platform participants enables platforms to grow in generativity that extends the platform core product's usefulness. For example, to augment the Android operating system's generativity, Google has issued many platform resources to different participants such as the Google APIs and SDKs to developers, the hardware-abstraction layer, compatibility test suite, and MADA (mobile application distribution agreement) to Android device manufacturers, and some other user tools such as Android studio. In this regard, a platform can be viewed as a digital infrastructure that fulfils the core requirements of its intended users and entails flexibilities to be modified, updated, and adapted (Wheelwright and Clark 1992).

Digital platforms, as a design hierarchy, are greatly dependent on and enabled by the capabilities of digital technologies. Yoo, Henfridsson, and Lyytinen (2010) suggest that different from the integral design hierarchy, which entails closely binded interdependency among different components and in between the product's functionality and its physical embodiment, the digital technologies are featured by reprogrammability and data homogeneity. First, the reprogrammability implies the possible separation of the technology's functional logic and its physical embodiment. As long as the users agree on the digital resource's general meaning, they have much freedom to decide how they would like these resources to produce and perform. Users can combine different types of digital recourses to serve their user cases. Alternatively, they may re-engineer the usefulness of digital assets by modifying source codes. Second, the data homogeneity ensures the consistency of digital data across devices and networks. It means digital data that was installed and altered on one device can be seamlessly synchronised in multiple places. The data-homogeneity enables the wider transmission of digital information and ensures the

unrestricted user innovation on multiple devices.

The objective of exploring the Blockchain platform's design architecture brings the engineering view more relevant to this study. Inspired by Yoo et al. (2010), this research will depict the Blockchain platforms' architecture design by drawing on the layered architecture design of digital technology. The layered architecture lays the foundation to view the Blockchain network as an integrated digital artefact formed of multiple functioning layers (Teece 1980). Inside each layer are many sub-systems and modules that correspond to different types of utilities.

6.2.2 Blockchain platforms

Since the debut of Bitcoin, Blockchain technology has gradually influenced business activities in many different sectors such as finance, manufacture, and public management. Widely known as a database formed by the distributed ledgers, Blockchain in nature resembles several common attributes to platforms regarding its features of connecting isolated entities and facilitating digital exchange (Zheng et al 2017). However, Blockchain also exhibits many features that make it go beyond the scope of a sided-platform.

First, as a distributed ledger organisation, Blockchain presents the dissolved boundary of the same-side and cross-side network effects. Participants who contribute a new block to the existing chain are also users who benefit from the chain's increased usefulness. Because the ledger records all types of participants' activities (e.g. add transactions and modify information) on the network and publish these records to each participant (Nofer et al 2017), adding a new member or a new block to the chain network always implies a higher degree of information richness to each node (Nofer et al 2017) . More conservatively speaking, though some cross-side leverage relationship may exist (e.g. block contributor and block beneficiary), its significance on a Blockchain platform is much less than that on a typical sided platform.

Second, different from digital platforms where governance rules and

practices are mostly performed by a central party, that is, platform owners, Blockchain allows decentralised governance (Van Pelt et al 2021). The modification and alteration of Blockchain must pass the authentication of all members on the chain. There is no single entity that can enforce the dominant power to decide what can or cannot be done (Beck et al 2018). Besides, because participants in a chain network have a common agreement on disclosing information in return for a collective efficiency, a single entity can rarely manipulate the information asymmetry and make the entire Blockchain to privilege its own business. Such distributed governance and eliminated central dominance highlight the Blockchain platform's distinct differences from the conventional digital platforms.

Third, following decentralised governance, another benefit realised by Blockchain is digital trust. All data shared on the Blockchain network is encrypted. Members' rights to read and modify can be classified with classified deciphering keys. Therefore, participants, in general, have fewer concerns in hiding or manipulating the data integrity. Also, with the full records of the chain activities, the Blockchain entails high traceability which means that any intentional sabotage of chain integrity can be traced to its sources.

Upon establishing the overlaps and different features presented by digital platforms and Blockchain platforms, this article has introduced two meaningful Blockchain pathways: BPaaP and BNaaP. The BPaaP relies on the transaction nature of Blockchain platforms; the BNaaP offers an early emphasis on the value of Blockchain architecture as an organising logic. With ample empirical examples around BPaaP (e.g. Bitcoin and Facebook's Libra), this research aims to shed light on the unique value of BNaaP. To offer some fundamental groundings to this research stream, I will investigate the architectural design of BNaaP. The depicted framework aims to open new venues for future research and offer blueprint guidance to practitioners.

6.3 Methodology

To investigate the architecture design of the BNaaP, this research will conduct a case study. As an explorative research, the data used in this research mainly consists of internet-based qualitative data. The thematic analysis method will be applied to gain insights from online data. It is noted that the case study "is not a methodological choice but a choice of what is to be studied" (Stake 2006). Given the early spread of Blockchain and the scant empirical evidence, doing a case study has substantial usefulness to acquire new experiences, humanistic understanding, and knowledge about this theme (Stake 1978; Boyatzis 1998). In this regard, an in-depth exploration of the single case helps understand the Blockchain architecture's complexity and particularity (Stake 1995; Simons 2009). The case selected in this study aims to constitute a representative member of larger organisation groups (Patton 1990). And the knowledge gained from this single case is deemed to provide naturalistic generalisability (Stake 1978).

This research follows Braun and Clarke's (2008) thematic analysis method to analyse online qualitative data. By definition, the thematic analysis "is a method for identifying, analysing, and reporting patterns (themes) within data" (Braun and Clarke's 2008). In other words, it offers the possibility to capture the meaning of data by identifying different themes and their associations from the data.

Adopting the thematic analysis method fulfils the objective of this study in the following two ways: First, the thematic analysis does not hold a committed subscription to the development of a theory. According to Braun and Clarke (2008), for an under-researched area, rather than theory building, the thematic analysis can capture predominant and important themes in relation to the available dataset. Applying this method may sacrifice the depth of analysis, but the overall description and articulation will be well captured and maintained (Braun and Clarke's 2008; Simons 2009). Second, the thematic analysis entails some allowance for the researchers to preconceive a certain degree of coding direction informed by other theories. This feature demarcates thematic analysis from the grounded theory,

which often implies the delayed literature engagement (Urquhart 2013). In this research, some insights from the platform literature essentially help to sensitise themes and interpret the Blockchain network architecture. Therefore, applying thematic analysis with wide references to platform studies well fulfils the research objectives.

6.4 Data and Analysis

Blockchain technology has received rapid development in the past five years in China. In line with digital technology's prominence, the National Strategic Development department strongly emphasises the Blockchain's vital influence on the future economy. To highlight, the National Plan for Information Technology during the Period of the Thirteenth Five-Year Plan (2016-2020) remarked Blockchain as a frontier weapon for the new wave of national development and competition. Over the years, some national authorities and relevant institutions gradually issued a series of documents, guidance, regulations, and industry standards to incentivise Blockchain innovation.

The case studied in this research is Ping An Insurance (Group) Company of China, Ltd. Established in 1988, it is one of the largest financial service providers in mainland China and ranked 29th in Fortune Global 500 in 2019. As a financial institution with a highly diversified business portfolio, Ping An Group has always adhered to the "finance + technology + ecosystem" principle. In recent years, Ping An Group has extensively innovated with different digital technologies. It revolutionized the bank operations using Artificial Intelligence technologies that helped to build an open banking system and connect bank users, clients, and business partners. This AI banking intelligently managed business operations and monitored risks at a larger scale. Besides, Ping An Group also launched its OneConnect subsidiary. With 161 patents, the OneConnect's Blockchain solution has seen successful deployment in many business sectors such as finance, cross-border trade, estates, automobile, healthcare, and smart-city. The OneConnect's Blockchain solution is designed as an infrastructure that facilitates business

activities on a network basis, thus serving as a valuable empirical case to this study. Guided by the thematic analysis method, this study primarily obtained data from Ping An Group's online official publications. The dataset includes (a) 12 annual and semiannual reports from 2014 to 2019 published by Ping An Group – these documents precisely reveal the firm's trajectory of digital advancement over the years; (b) 27 newsletters and 4 "white page" documents published by Ping An's OneConnect Research Institution – these documents provide detailed insights, particularly on the development, deployment, and regulations around the Blockchain application; (c) multiple media data sources, including 7 online interviews and public speech clips from Ping An's Co-CEO and Chief Innovation Officer; and (d) 32 articles published by media and research organisations such as Bloomberg, OECD, China Academy of Information and Communications Technology, and International Data Corporation (IDC). These documents supplement an alternative angle to assess the Blockchain's application in different industries and its business impacts. The thematic analysis of the collected data is applied with the six-step analysis suggested by Braun and Clarke (2008). First, media data in video forms are transcribed into scripts. All collected data are cleaned and saved into Nvivo software and are read twice by the researcher to gain initial sensitisation. Second, each document is analysed with open coding strategies. Nodes are coded to data blocks whenever they are implying "basic segment, or element of the raw data or information that can be assessed in a meaningful way regarding the phenomenon" (Braun and Clarke 2008). This step results in 45 first-level nodes and 29 sub-level nodes. Third, the coded nodes obtained in the second step are reviewed and sorted into 14 potential themes, which can best capture coded data's core meaning. Up to this stage, a thematic map draft is made with relationships and associations of all themes. Before moving on to the theme refinement, two graduate students are involved as research assistants to read all documents independently and review all the nodes. Fourth, the researcher revisits all coded data and the proposed themes. This stage mainly investigates the internal homogeneity within each theme and the external heterogeneity among themes

(Patton 1990). Besides, this stage also engages the evaluation of the theme's "accurate representation" of the entire dataset (Braun and Clarke 2008). Fifth, each theme's essence and the thematic map are re-assessed with several iterations of data review. In the last step, the thematic map is finalised. Themes are defined, interpreted, and discussed with data extracts.

6.5 Results

Figure 10 presents the proposed architectural design of BNaaP. The term "layered" describes how the Blockchain platform is developed and managed. The term "adapted" implies its applicability and adaptability when implemented in different business scenarios. In the following, I will explain each conceptualisation construct with empirical evidence.

6.5.1 Foundation layer

The foundation layer describes the technical specifications that are necessary for establishing a Blockchain platform. Three subordinate layers are included. First, the technological layer deals with hardware and software solutions that substantially enable Blockchain functionalities. For example, the requestresponse module deals with the ongoing tension between the block size and processing transactions' speed. A larger block size enables high throughput. However, when transaction volume is low, such a large block design often leads to high latency. Ping An's "smart block" solution adopts the blockless structure, which can achieve almost real-time responses without reducing transaction throughput.

Second, the functional layer involves digital solutions that aim to ensure the integrity, authenticity, and accountability of chain functionality and operation. For instance, in the cryptography module, Ping An patents its 3D zeroknowledge proof technology, which can verify data and statements within three milliseconds without revealing the real information enclosed in the block. Besides, at the functional layer, the management of digital keys is also a critical task in sustaining Blockchain operation. It determines whether the Blockchain can maintain its operation quality with a high level of security.

Third, the operational layer deals with Blockchain's usefulness and effectiveness in supporting different user needs. This layer consists of some deployment tools and management tools. For example, OneConect's Blockchain invented many primary and add-on business-specific functionalities for a different category of users. Specifically, it enables customised asset record format, allows asset liquidation based on users' changing status, and monitors abnormalities with the user-defined Web interfaces. Compared to the technological and functional layers, the operational layer focuses more on the business operation aspect and the user-interface design.

6.5.2 Interaction layer

While the foundation layer ensures the well-functioning of the Blockchain, the interaction layer embodies the possibility of forming a Blockchain platform using some boundary resources. Three types of boundary resources are involved. The general APIs allow a chain to quickly incorporate some commonly used functionalities such as identity management and digital contract. The industry APIs are groups of interfaces that are designed to fit the needs of a specific industry. It allows some industry-level services to be incorporated instantaneously. For example, in the international trading context, such APIs may involve orders, invoices, and logistics. The third interactive element is the cross-chain APIs. This type of APIs is widely engaged when a Blockchain network wants to connect with an external Blockchain network. Overall, the foundation layer ensures the usefulness of the interaction layer. And the interaction layer extends the capabilities and scalability of the foundation layer.

6.5.3 Application layer

The application layer describes the possible means and complexity when deploying a Blockchain network. Companies and consumers can decide to join an existing Blockchain network by instantaneously attaching themselves to the Blockchain nodes. Alternatively, they can operationalise the foundation layer and the interactive layer to initiate a new Blockchain network. Depending on the business needs, joining an existing Blockchain network will benefit the joined party with

pre-existed network value. Because the incumbent Blockchain network has already acquired a large number of relevant business partners, built relatively mature procedures, and tested its operational efficiency and security standards. Nevertheless, creating a new Blockchain network may be necessary if no existing chain fits the business requirements. Moreover, enterprises may also consider building a new Blockchain platform as a means of leveraging and reengineering the network value of their business circles.

6.5.4 Adapted business scenario

Conceptualising the BNaaP architecture is not completely done if we omit the varying implementation business scenarios. The business scenarios indicate the purposes and contexts of the Blockchain network. Because the types of business activities, the potential capacity of the network, and the required standards and regulations will all affect the operation and management of the Blockchain platform. For example, Ping An Group helped Hong Kong Monetary Authority to establish an eTradeConnect Blockchain platform. This platform involved 12 international banks from the Hong Kong region and an independent trading platform (we.Trade) in Europe. The Blockchain platform's global orientation required Ping An to ensure that all designs at the foundation and interaction layer were complying with both parties' legal obligations. However, in the other case, Ping An's Blockchain platform was used by a Chinese local government to achieve faster document transmission and communication with those connected organisations. In such a context, the Blockchain's compliance to international legal obligations became less relevant. The Blockchain's flexibility in adapting to users with different levels of technical knowhow and distinct habits of sharing documents became a central challenge.

6.5.5 Environmental factors

The environmental factor is a critical element that influences the establishment and growth of Blockchain platforms. This factor contains multiple parties that are either directly or indirectly engaged in the Blockchain development. Informed by the Ping An's Blockchain network, environmental factors' impacts can be grouped into four

categories: (1) Monitor. While encrypted data is only readable for the trading parties on the chain, the national monitoring authority may have full access to view all the trading information. (2) Regulate. The Cyberspace Administration of China has issued a series of Blockchain-relevant regularities that have enforcement power to all Blockchain applications. (3) Arbitrate. On Ping An Blockchain, signing an electronic contract is under the supervision of the National Notarization and Judicial Departments. If there is any dispute, the notary department will intervene. (4) Certificate. The data security suite adopted by Ping An Blockchain has obtained the National Certification of Level 3 Information Security Protection provided by the Ministry of Public Security.

Besides, it is worth noting that the development and growth of the Blockchain platform also recursively feedbacks fresh insights into the environmental factors' alteration and improvement. For instance, Ping An's 3D zero-knowledge proof technology and its crypto-controlled data sharing technology significantly accelerate the modification of Blockchain security regulations at the industrial level.

Figure 10. The Adapted Layered Architecture of Blockchain Network as a Platform (BNaaP).
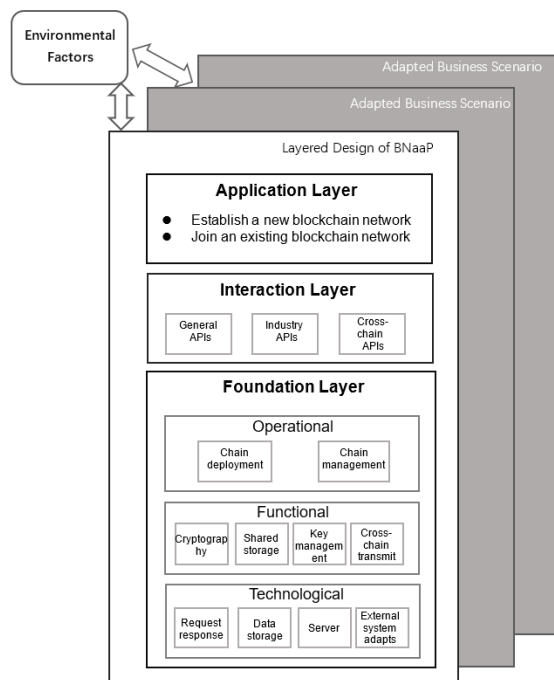
6.6 Conclusion

Inspired by the similarities and differences of digital platforms and Blockchain network, this study, for the first time, suggests two potential pathways of viewing and studying Blockchain phenomenon: BPaaP and BNaaP. Given the scant attention to the BNaaP, this research aims to arouse interests towards this stream by investigating its architectural design (Henfridsson et al., 2014). The proposed Adapted Layered Architecture of BNaaP depicts a blueprint to practitioners who wish to leverage the power of Blockchain in igniting digital business transformation. Besides, it also serves as a starting point for future research to explore the formation and implementation of BNaaP from multiple aspects, including but not limited to the technical challenges, governance issues, business adaption considerations, and the bilateral relationship with environmental factors.

However, this research also presents some limitations. First, the data used in this research contains online open data published by the understudied case company. The officiality of these materials ensures data authentication and validity. Future improvement may involve an attempt to gain more first-party insights from interviews. Second, the aims of gaining knowledge on the overarching design of BNaaP neglect the importance and complexity of the "adapting" processes. Future studies can approach this aspect by adopting the process view to study Blockchain's adaption tactics and specifics in relation to different business factors.

CHAPTER 7. CONCLUSION

7.1 Summary of Three Studies

Given the ultimate power horse that network effects can bring to a new platform, managers and entrepreneurs who wish to tip a platform must find the correct set of strategies that usher the explosion of complementary innovation and consumers and conceive a platform architecture which can potentially catalyse ecosystem-wide value growth. Motivated by such strategic objectives often held by nascent platforms, this dissertation presents three empirical studies. Each tackles one aspect of kicking off the network growth in a digital platform.

In chapter four, this dissertation considers the platform owner's entry to the complementary market as a strategic mechanism to boost platform complementarity innovation. The substantiality of this research is strongly motivated by clarifying or possibly reconciling the conflictual opinions made by previous research on this topic (Gawer and Henderson, 2007; Foerderer et al., 2018; Wen and Zhu, 2019; Lan et al., 2019; Zhu and Liu 2018; Edelman and Lai 2016; Cennamo et al.,2016). Inspired by the component view of deciphering platform strategy mentioned in chapter three, assumptions were made that the hitherto divergent opinions may attribute to the negligence of the timing of entry. Taking Amazon Alexa as an empirical case, the first paper of this thesis reveals that the entry occurs at the early stage of complementary market development, where the least market value has been tipped, can generate positive market expansion effects and maximumly attract consumers' attention to the novel services offered by the platform. The analysis also suggests the diminishing of such market viability improvement effects if platform owners make the entry movement at the relatively late stage of complementary market development.

Chapter five focuses on growing the consumer base, which is the other critical side of players on nascent platforms. In recognition of the wide usage of subsidy in initiating platform consumer growth (Tan et al., 2020; Parker and Van Alstyne, 2014; Hagiu, 2006; Caillaud and Jullie, 2003), this paper concerns how

the referral scheme applied among platform consumers could be implemented with the most efficacy and sustainability. By tracing the early growth of Pinduoduo's user base, this study greatly trumpets the incorporation of behavioural motives in the design of platform strategy. Specifically, the referral scheme should be framed in a way that creates loss aversion impulses in consumers. The tendency of individuals to fully complete the referral steps is greatly determined by the level of control they perceive during the processes. Last, as a form of social interaction that requires two parties' actions (i.e., referral sender and referral receiver), the referral scheme should resemble and employ certain social drivers, such as social norms and reciprocity, to encourage individuals' likelihood of acting.

Last, the third paper of this thesis discusses the architecture design of the platform ecosystem when a new technology stands in the centre of the platform. Known as distributed ledgers, the Blockchain has seen increasing popularity in many business sectors nowadays. This study draws on the layered module architecture design. It explores how such design logic could be employed by PingAn group to transform its banking services into a platform-based business ecosystem. Having Blockchain as the core technology, the foundation layer that touches on the necessary technological enablement serves as the basis of the platform ecosystem. On top of it, there is an interaction layer containing varying resources and tools that make platform services accessible to external parties who eventually wish to utilize the platform's products and services to achieve certain business goals. The layered setting of the platform structure is highly adaptive and extensible to include different business functions and, thus, entails a high potential to attract more business units to join the platform ecosystem.

7.2 Implications for Theory

This thesis contributes to the development of platform strategy literature in two ways. The first theoretical highlight of this thesis is the invention of the component view, which is considered a highly constructive and practical tool for platform

strategy studies. Prior research has emerged two major views of platform strategy. The business view emphasizes the dynamic changing status of the platform as an economic entity in a given market and concerns many business challenges which are not significantly departed from non-platform businesses. Typical questions discussed in the business stream include entering a new market, growing the consumer base, improving the diversity and quality of products and services, and integrating upper and lower players and rivals. Unlike the business view, the other strand of platform strategy studies tends to harvest on the complexity of governance in a platform. This stream of research gains its theoretical validity from the arm's length relationship between platform owners and participants. Typical examples of research questions in this stream are the design and use of boundary resources, the level of platform openness and platform unity, the partitioning of decision rights among participants, and the appropriate employment of control and constrain mechanisms in a platform.

The extant two views well depict two arenas of platform strategy research but lack the power to help develop a platform strategy study that provides unique contributions and relevant implications. In recognising such a gap, this thesis first proposes the component view as a useful lens to comprehend existing studies and find a potential new way of contributing. Specifically, the component view identified five major elements in all strategy research. They are the strategy mechanisms, the platform type, the developmental stage of a platform at the time of strategy implementation, the targeted entities, and the implementation consequences and impacts. Past studies that claimed to have novel contributions more or less attempted to distinguish themselves from one or more of these five elements, explicitly or implicitly. More importantly, apart from adopting this view in verifying the particularity of a study, it is even more crucial for a study to be clear on these elements while claiming their implications. One downside ramification of the unclarity of these elements is the possible conflictual conclusions made on the same platform strategy mechanism, which may not necessarily attribute to the actual complexity of the strategy itself but to the different background

circumstances.

The second strand of theoretical implications emerges from the three empirical studies. By investigating how platform owners can grow the complementary market by entering that market, the first paper reconciles the current divergent opinions on this topic found by previous research (Foerderer et al., 2018; Wen and Zhu, 2019; Lan et al., 2019; Zhu and Liu, 2018). Besides, incorporating behavioural motives in scaling the platform user base responds to Afuah (2013), which suggests that the network effects are not only about the size but also the structure and its conduct. As one early research that sheds light on the psychological motives in platform strategy design, this study also contributes interesting insights into the same-side network growth of platforms (Lieu et al.,2022; Tan et al., 2020; Boudreau and Jeppesen, 2015; Chu and Manchanda, 2016). Last, building on McIntyre et al. (2021) that actuates the role of technology in driving platform dynamics and growth, the adapted layered architecture of PingAn bank's Blockchain platform illustrates how such advanced technology could be mingled as a core in cultivating a platform ecosystem.

7.3 Implications for Managerial Practices

This dissertation receives its original spark from tackling key challenges faced by platforms at their early stage of growth. As said by Cusumano, Gawer, and Yoffie in the book *The Business of Platforms* (2019), "launching a platform and solving the chick-and-egg problem is probably the most difficult challenge for platform strategies." (p71). Therefore, each of the three empirical studies included in this thesis has a specific purpose of solving one aspect of the key challenges faced by new platforms. Thus, aim to provide some profound implications to platform managers and entrepreneurs.

The first study pitches in the growth of young platforms from the growing the platform complements' point of view. This research emphasises the crucial impact of timing, where platform owners introduce their products in the complementary

market at the early phase of market growth may trigger an expansion effect that enlarges the market for all players; the late entry is often associated with the platform's intention of capturing immediate profits with various forms of platform owner privileges. In addition, this research also yields some clues to complementors who co-exist with platform owners in that relatively new platform complementary market: make their complementary offerings with the most specialised functionality that entails the minimum initial costs and configuration efforts.

Second, regarding scaling the platform consumer base at an early phase, it is equally important for platform managers to understand which side to subsidize and how. Tactics in doing so could be very complicated as there are many moving parts on a platform. Platform owners should remain creative and bold enough to constantly seek more effective and efficient means. In this regard, taking bits of insights from humanity's point of view and grounding platform strategy to leverage human nature may give special sparks to platform managers and entrepreneurs.

Last, with the continuous advancement of digital technologies, it is foreseeable that the business world will witness more diverse cases where the platformarization serves as a key logic for transforming conventional organizations. The Blockchain ecosystem studied in this thesis only showcases one of the many possibilities.

7.4 Limitations

Last, this thesis has some limitations that should be considered when interpreting the findings. The first set of limitations is about the research methodologies adopted. Although chapter four has applied multiple econometric techniques to rule out the potential bias of the platform owner's entry and the complements' popularity, the relatively small sample size of this study still means that it is not possible to definitively exclude a possible association between these two variables. The findings of this study are based on the assumption that Amazon, as a leading player in the home IoT sector, showed a similar level of interest in both early- and late-

entered markets and used its entry timing strategically to influence market growth. In addition, credits to the findings made in chapter five could be further improved by running a well-designed experiment.

The second set of limitations relates to the boundary conditions of the platform contexts this thesis has studied. Amazon Alexa, as a newly emerged home IoT platform that combines elements of physical and digital innovation, findings from this research should be carefully generalized to other platform contexts, such as those pure software innovation platforms and transaction platforms. Moreover, the behavioural motives engaged in Pinduoduo's scaling strategy are not separable from its unique geographical basis. Implications made by this study may only pose relevance to some South Asia regions that resemble great similarity and comparability to China.

Despite these limitations, this thesis offers novel and relevant insights on platform strategy in growing nascent digital platforms from three aspects: promoting complementary markets, scaling user base, and cultivating platform ecosystem development. The diverse combination of research methods and contexts involved in this thesis aims to open up more venues for future interdisciplinary studies that draw on information systems, management, and psychology.

References

Abadie, A., Drukker, D., Herr, JL., and Imbens. GW. 2004. "Implementing Matching Estimators For Average Treatment Effects in Stata," *The Stata Journal* (4:3), pp. 290-311.

Adner, R. 2017. "Ecosystem as Structure: An Actionable Construct for Strategy," *Journal of Management* (43:1), pp. 39-58.

Adner, R., Puranam,P., & Zhu, F. 2019. "What Is Different About Digital Strategy? From Quantitative To Qualitative Change," *Strategy Science*, (4:4), pp. 253-261.

Afuah, A. 2013. "Are Network Effects Really About Size? The Role of Structure and Conduct," *Strategic Management Journal* (34), pp.257–273.

Aldrich, H. E. and C. M. Fiol. 1994. "Fools rush in? The institutional context of industry creation." *Academy of Management Review* (19:4): pp. 645-670.

Anderson EG., Chandrasekaran A., Davis-Blake A., Parker, G.2018. "Managing Distributed Product Development Projects: Integration Strategies for Time-Zone and Language Barriers. *Information Systems Research* (29:1), pp.42–69.

Anderson, EG., Parker, G., Tan B. 2014. "Platform Performance Investment in the Presence of Network Externalities," *Information Systems Research* (25:1), pp152–172.

Angrist, JD., Pischke, JS. 2009. "Mostly Harmless Econometrics: An Empiricist's Companion*,"* Princeton University Press. Chapter 5.

Anthony, C. Nelson, A.J. and Tripsas, M. 2016. " 'Who Are You?...I really Wanna Know': Product Meaning and Competitive Positioning in the Nascent Synthesizer Industry," *Strategy Science*(1:3), pp. 163-183.

Armstrong, M. 2006. "Competition in Two-Sided Markets," *RAND Journal of Economics(*37), pp. 668–691.

Arthur, W. B. 1989. "Competing Technologies, Increasing Returns, and Lock-in By Historical Small Events," *Economic Journal* (London)(99), pp.116–131.

Ashenfelter, O.A. 1978. "Estimating the Effect of Training Programs on Earnings." *Review of Economics and Statistics* (60:1), pp. 47-57.

Ashenfelter, O.A. & Card, D. 1985. "Using the Longitudinal Structure of Earnings to Estimate the Effect of Training Programs ." *Review of economics and Statistics* (67:4), pp. 648-660.

Assaad, W., Gomez, J.M. 2011 "Social Network in Marketing (Social Media Marketing) Opportunities and Risks," *International Journal of Managing Public Sector Information and Communication Technologies* (2:1), pp. 13-22.

Bakos, Y., and Halaburda, H. 2020. "Platform Competition with Multihoming on Both Sides: Subsidize or Not?," *Management Science* (66:12), pp. 5599–5607.

Bapna,R., Gupta, A., Ray,G., and Singh,S. 2016. "Research Note: IT Outsourcing And The Impact Of Advisors On Clients And Vendors," *Information System Research* (27:3), pp.636-647.

Basak, D., and Petrakis, E. 2021. "Social Efficiency of Entry: Implications of Network Externalities," *Journal of Economics & Management Strategy* (30:4), pp. 820–829.

Balasubramanian, N., Lee, J., 2008. "Firm age and innovation," *Industrial and Corporate Change* (17:5), pp. 1019–1047.

Barlow, M. A., Verhaal, J. C., and Angus, R. W. 2019. "Optimal Distinctiveness, Strategic Categorization, and Product Market Entry on the Google Play App Platform," *Strategic Management Journal*(40:8), pp.1219-1242.

Baldwin C.Y., and Woodard C.J. 2009. "The Architecture of Platforms: A Unified View, " Gawer A, (ed). Platforms, Markets and Innovation, United Kingdom, Edward Elgar Publishing, pp.19–44.

Baldwin C.Y., and Woodard C.J. 2000. "The Architecture of Platforms: A Unified View," available at SSRN Electronic Journal DOI:10.2139/ssrn.1265155

Barua, A., and Mukherjee, R. 2021. "Multi-Homing Revisited: Level of Adoption and Competitive Strategies," *MIS Quarterly* (45:2), pp. 897–924.

Baxter, P., and Jack, S. 2008. "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers," *The Qualitative Report* (13:4), pp. 544-559.

Beck, R., Muller-Bloch,c., and King, J. 2018. "Governance in the Blockchain Economy: A Framework and Reseach Agenda," *Journal of the Association for Information*

Systems (19:10)

Becker, SO., Ichino,A. 2002. "Estimation of Average Treatment Effects Based on Propensity Scores," *The Stata Journal* (2:4), pp. 358-377.

Berck, P., Villas-Boas, S.B. 2016. "A Note On The Triple Difference In Economic Models," *Applied Economics Letters* (23:4), pp 239-242.

Bertrand, M. 2004. "How Much Should We Trust Difference in Difference Estimates," *The Quarterly Journal of Economics* (119:1): 249–275.

Bingham, C. B., and K. M. Eisenhardt. 2011. ''Rational heuristics: The 'simple rules' that strategists learn from process experience.'' *Strategic Management Journal*, (32:13), pp.1437–1464.

Blau, P. M. 1964. "Exchange and Power in Social Life," New York: John Wiley.

Booth, A., Sutton Anthea, Clowes,M., St James, M.M. (2022). "Systematic Approach to a Successful Literature Review," 3rd Edition, Sage Publication Ltd.

Boudreau K. J. 2010. "Open Platform Strategies and Innovation: Granting Access vs. Devolving Control," *Management Science* (56:10), pp. 1849–1872.

Boudreau, K. J. 2012. "Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation," *Organization Science* (23:5), pp. 1213-1522.

Boudreau, K. J., and Hagiu, A. 2008. "Platform Rules: Multi-Sided Platforms as Regulators," Working Paper, Harvard Business School

Boudreau, K. J., and Jeppesen, L. B. 2015. "Unpaid Crowd Complementors: The Platform Network Effect Mirage," *Strategic Management Journal* (36:12), pp. 1761–1777.

Boyatzis, R. 1998. "Transforming Qualitative Information: Thematic Analysis and Code Development," Thousand Oaks, CA: Sage.

Braun, V and Clarke, V. 2008. "Using Thematic Analysis in Psychology," *Qualitative Research in Psychology* (3:2) pp. 77–101.

Burtch, G., Hong, Y., Bapna, R., Griskevicius, V. 2018. "Stimulating Online Reviews by Combining Financial Incentives and Social Norms," *Management Science* (64:5), pp. 2065-2082.

Caillaud, B, and B Julien. 2003, Chicken & Egg: Competition Among Intermediation Service Providers, *Rand Journal of Economics* (34:2),pp. 309-328.

Cao, Q., Duan, W. J., and Gan, Q. W. 2011. "Exploring Determinants of Voting for the 'Helpfulness' of Online User Reviews: A Text Mining Approach," *Decision Support Systems* (50:2), pp. 511-521.

Casadesus-Masanell, R and Yoffie, D.B. 2007. "Wintel: Cooperation and Conflict," *Management Science* (53:4): 584-598.

Cennamo, C., Santaló,J. 2019. "Generativity Tension and Value Creation in Platform Ecosystems," *Organization Science* (30:3), pp. 617-641.

Cennamo, C., Gu, Y., Zhu, F. 2016. "Value Co-Creation and Capture in the Creative Industry: The U.S. Home video Game Market," Working paper.

Cennamo, C., Ozalp, H., and Kretschmer, T. 2018. "Platform Architecture and Quality Trade-Offs of Multihoming Complements," *Information Systems Research* (29:2), pp. 461–478.

Chai, S., and Kim, M. 2012. "A Socio-Technical Approach to Knowledge Contribution Behavior: An Empirical Investigation of Social Networking Sites Users," *International Journal of Information Management* (32:2), pp. 118–126.

Chatterjee, C. and Wernerfelt, B. 1991. "The Link Between Resources and Type of Diversification: Theory and Evidence," *Strategic Management Journal (*12:1), pp. 33-48.

Chen, E. L., R. Katila, R. McDonald, and K. M. Eisenhardt 2010 ''Life in the Fast Lane: Origins of Competitive Interaction in New vs. Established Markets.'' *Strategic Management Journal,* (31:13): 1527–1547.

Chen, L., Tong, T. W., Tang, S., and Han, N. 2022. "Governance and Design of Digital Platforms: A Review and Future Research Directions on a Meta-Organization," *Journal of Management* (48:1), pp. 147–184.

Chintakananda, A., & McIntyre, D. 2014. "Market Entry in the Presence of Network Effects: A Real Options Perspective," *Journal of Management* (40:6), pp. 1535–1552.

Chu, J., and Manchanda, P. 2016. "Quantifying Cross and Direct Network Effects in Online Consumer-to-Consumer Platforms. Marketing Science," (35:6), pp. 870-893.

Chung, H., Park, J., Lee, S. 2017. "Digital Forensic Approaches For Amazon Alexa Ecosystem," *Digital Investigation* (22): s15-s25.

Ciborra, C. U. 1996. "The Platform Organization: Recombining Strategies, Structures, and Surprises," Organization Science (7:2), pp.103–118.

Clark, K. 1985. "The Interaction of Design Hierarchies and Market Concepts in Technological Evolution," *Research Policy*(14:5), pp. 235–251.

Coad, A., Segarra, A., Teruel, M. 2016. "Innovation and Firm Growth: Does Firm Age Play a Role?" *Research Policy* (45:2), pp. 387-400.

Copi, I.M., Cohen, C., and Rodych, V. 2019. "Introduction to Logic," Fifteenth Edition, Routledge New York.

Constantinides, P., Henfridsson, O., and Parker, G. 2018. "Platforms and Infrastructures in the Digital Age," *Information Systems Research* (29:2), pp. 381-400.

Cozzolino, A., Corbo, L., and Aversa, P. 2021. "Digital Platform-Based Ecosystems: The Evolution of Collaboration and Competition between Incumbent Producers and Entrant Platforms," *Journal of Business Research* (126), pp. 385–400.

Crabtree, B and Miller,W (Eds.) 1999. "Doing Qualitative Research," 2nd edition. London: Sage

Cropanzano, R., and Mitchell, M. S. 2005. "Social Exchange Theory: An Interdisciplinary Review," *Journal of Management* (31:6), pp. 874–900.

Cummings, J., Dennis, A. R., and Indiana University. 2018. "Virtual First Impressions Matter: The Effect of Enterprise Social Networking Sites on Impression Formation in Virtual Teams," *MIS Quarterly* (42:3), pp. 697–717.

Cusumano, M. A., and A. Gawer. 2002. "The Elements of Platform Leadership," *MIT Sloan Management Review* (43:3), pp. 51–58.

Cusumano, M,A., Gawer, A., and Yoffie, D.B. 2019. "The Business of Platforms," United Kingdom, HarperCollins Publishers.

Czarnitzki, D., Kraft, K., 2004. "An Empirical Test of the Asymmetric Models on Innovative Activity: Who Invests More into R&D, the Incumbent or the Shallenger?" *Journal of Economic Behavior & Organization* (54:2), pp.153–173.

Eaton, B., Elaluf-Calderwood S., Yoo, Y. 2015. "Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System," *MIS Quarterly* (39:1), pp. 217-243.

Edelman, B., and Lai, Z. 2016."Design of Search Engine Services: channel Interdependence in Search Engine Results," *Journal of Marketing Research* (53:6), pp. 881-900.

Eisenhardt, K. M. 1989a. "Building Theories from Case Study Research." *Academy of Management Review* (14:4), pp. 532-550.

Eisenmann, T., Parker, G, Van Alstyne, M. 2011. "Platform Envelopment," *Strategic Management Journal* (32:12), pp. 1270–1285.

Eisenmann, T., Parker, G., and Van Alstyne, M. 2006. "Strategies for Two-Sided Markets," Harvard Business Review.

Eisenmann, T., Parker, G. 2009. "Opening Platforms: How, When and Why" Platform, Markets and Innovation.

Emerson, R. M. 1976. "Social Exchange Theory," *Annual Review of Sociology* (2),pp. 335-362.

Ennan,E and Richter,A. 2010. "The Whole Is More Than the Sum of Its Parts--Or Is It? A Review of the Empirical Literature on Complementarities in Organizations," *Journal of Management* (36:1), pp. 207-233.

Evans, D.S. 2009. "How Catalysts Ignite: The Economics of Platform-Based Start-Ups." In Platforms, Markets and Innovation, Gawer A (ed). Edward Elgar: Cheltenham.

Evans, D.S., and Schmalensee, R. 2010. "Failure to Launch: Critical Mass in Platform Businesses," *Review of Network Economics* (9:4), article 1.

Evans, D.S., and Schmalensee, R. 2016. "Matchmakers: The New Economics of Multisided Platforms," Harvard Business Review Press.

Fath, G., and Sarvary, M. 2003. "Adoption Dynamics in Buyer-Side Exchanges," *Quantitative Marketing and Economics* (1:3), pp. 305–335.

Foerderer, J. 2020. "Interfirm Exchange and Innovation in Platform Ecosystems: Evidence from Apple's Worldwide Developers Conference," *Management Science* (66:10), pp. 4772–4787.

Foerderer, J., Kude, T., Mithas, S., and Heinzl, A. 2018. "Does Platform Owner's Entry Crowd out Innovation? Evidence from Google Photos," *Information Systems Research* (29:2), pp. 444-460.

Foerderer, J., Lueker, N., and Heinzl, A. 2021. "And the Winner Is …? The Desirable and Undesirable Effects of Platform Awards," *Information Systems Research*, Article in Advance, pp. 1-18.

Garrido, M.M. Kelly, A.S., Paris,J., Roza,K., Meier,D., Marrison, R.S., D Albridge, M. 2014. "Methods for Constructing and Assessing Propensity Score," *Health Services Research* (49:5), pp. 1701-1720.

Gawer, A 2014. "Bridging Differing Perspective on Technological Platforms: Toward an Integrative Framework," *Research Policy* (43:7) pp. 1239–1249.

Gawer, A., and Cusumano, M. 2014. "Industry Platforms and Ecosystem Innovation," *Journal of Product Innovation Management* (31:3) pp 417-433.

Gawer, A., and Henderson, R. 2007. "Platform Owner Entry and Innovation in Complementary Markets: Evidence from Intel," *Journal of Economics & Management Strategy* (16:1), pp. 1–34.

Gergen, K. J. 1969. "The Psychology of Behavioral Exchange," Reading, MA: Addison-Wesley.

Gerring, J. 2007. Case Study Research Principles and Practices, Cambridge, UK: Cambridge University Press.

Ghazawneh A. 2012. "Towards A Boundary Resources Theory Of Software Platforms," Jönköping University, JIBS Dissertation Series No. 085.

Ghazawneh, A., and Henfridsson, O. 2013. "Balancing Platform Control and External Contribution in Third-Party Development: The Boundary Resources Model," *Information Systems Journal* (23:2) pp. 173-192.

Ghazawneh A, Henfridsson O. 2015. "A Paradigmatic Analysis of Digital Application Marketplaces," *Journal of Information Technology* (30:3), pp. 198–208.

Gouldner, A. W. 1960. "The Norm of Reciprocity: A Preliminary Statement," *American Sociological Review* (25:2), pp. 161–178.

Gregory, R. W., Henfridsson, O., Kaganer, E., and Kyriakou, S. H. 2021. "The Role of Artificial Intelligence and Data Network Effects for Creating User Value," *Academy of Management Review* (46:3), pp. 534–551.

Gu, G., Zhu, F. 2021. "Trust and Disintermediation: Evidence From an Online Freelance Marketplace," *Management Science* (67:2), pp. 794-807.

Gulati, R., Puranam, P., and Tushman, M. 2012. "Meta-Organization Design: Rethinking Design in Interorganizational and Community Contexts," *Strategic Management Journal* (33:6), pp. 571–586.

Guryan, J. 2004. "Desegregation and Black Dropout Rates," *American Economic Review* (94:4), pp. 9191-943.

Hagiu, A. 2006, "Pricing and Commitment by Two-Sided Platforms," *Rand Journal of Economics* (37:3), pp 720-737.

Hagiu, Andrei. "Strategic Decisions for Multisided Platforms." MIT Sloan Management Review (55:2)

Hagiu, A., & Wright, J. 2015. "Multi-Sided Platforms," *International Journal of Industrial Organization* (43), pp. 162–174.

Hagiu A, Spulber D. 2013. "First-Party Content and Coordination in Two-Sided Markets," *Management Science* (59:4), pp. 933–949.

Halckenhaeusser, A., Foerderer Jens., Heinzl, A. 2020. "Wolf in a Sheep's Clothing: When Do Complementors Face Competition With Platform Owners?" Forty-First International Conference on Information Systems,India,Proceedings. 5. https://aisel.aisnet.org/icis2020/sharing_economy/sharing_economy/5

Hamermesh, D. S., and Trejo, S. J. 2000. "The Demand for Hours of Labor: Direct Evidence From California," *The Review of Economics and Statistics* (82:1), pp. 38–47.

Hannah, D.P., and Eisenhardt, K.M., 2018. "How Firms Navigate Cooperation And Competition In Nascent Ecosystem," *Strategic Management Journal* (39), pp. 3163–3192.

Henfridsson, O., and Bygstad B. 2013. "The Generative Mechanisms of Digital Infrastructure Evolution," *MIS Quarterly* (37:3), pp. 907-931.

Henfridsson, O. Mathiassen L., and Svahn, F. 2014. "Managing Technological Change In The Digital Age: The Role Of Architectural Frames," *Journal of Information Technology* (29:1), pp. 27-43.

Henfridsson, O., Nandhakumar, J., Scarbrough H., and Panourgias N. 2018. "Recombination in the Open-Ended Value Landscape of Digital Innovation," *Information and Organization* (28:2), pp. 89-100.

Helson, H. 1964. "Adaptation-Level Theory" New York: Harper.

Huang, J., Henfridsson, O., Liu, M. J., and Newell, S. 2017. "Growing On Steriods: Rapidly Scaling The User Base of Digital Ventures Through Digital Innovation," *MIS Quarterly* (41:1), pp. 301–314.

Huber, T., Kude, T., Dibbern,J. 2017. "Governance Practices in Platform Ecosystems: Navigating Tensions Between cocreated Value and Governance Costs," *Information Systems Research* (28:3), pp. 63-584.

Hukal, P., Henfridsson, O., Shaikh, M., and Parker, G. 2020. "Platform Signaling for Generating Platform Content," *MIS Quarterly (44:3)*, pp. 1177-1205.

Iacus SM, King G, Porro G. 2011. "Multivariate Matching Methods That Are Monotonic Imbalance Bounding," *J. Amer. Statist. Assoc (*106:493),pp.345–361.

Jacobides, MG., Cennamo,C., Gawer,A. 2018. "Towards a Theory of Ecosystems," *Strategic Management* (39:8), pp. 2255-2276.

Jockbides MG., Sundararajan,A and Van Alstyne, M. 2019. "Platforms and Ecosystems: Enabling the Digital Economy," *World Economic Forum, Switzerland.*

Jones, S., Leiponen, A., & Vasudeva, G. 2022. The evolution of cooperation in the face of conflict: Evidence from the innovation ecosystem for mobile telecom standards development. *Strategic Management Journal* (43:3), pp. 425–446.

Jiang, B., Jerath, K., & Srinivasan, K. 2011. "Firm Strategies in the"Mmid Tail"of Platform-Based Retailing," *Marketing Science*(30:5), pp. 757–775.

Kahneman, D., and Tversky, A. 1979. "Prospect Theory: An analysis of Decision Under Risk," *Econometrica* (47:2), pp. 263-292.

Kapoor, R. 2018. "Ecosystem: Broadening the Locus of Value Creation," *Journal of Organization Design* (7:1), pp. 425-446.

Karhu, K., Gustafsson, R., Eaton, B., Henfridsson, O., & Sørensen, C. (2020). "Four Tactics for Implementing a Balanced Digital Platform Strategy." *MIS Quarterly Executive* (*19*:2), pp. 105-120.

Karhu, K., Gustafsson, R., and Lyytinen, K. 2018. "Exploiting and Defending Open Digital Platforms with Boundary Resources: Android's Five Platform Forks," *Information Systems Research* (29:2), pp. 479–497.

Katz, M. L., & Shapiro, C. 1985. "Network Externalities, Competition, and Compatibility," *American Economic Review* (75:3), pp. 424–440.

King, AA., and Tucci, CL. 2002. "Incumbent Entry into New Market Niches: The Role of Experience and Managerial Choice in the Creation of Dynamic Capabilities," *Management Science* (48:2), pp. 171-186.

Kock. 2009. "Information Systems Theorizing Based on Evolutionary Psychology: An Interdisciplinary Review and Theory Integration Framework," *MIS Quarterly* (33:2), pp. 395–418.

Kretschmer, T., Leionen, A., Schilling, M., and Vasudeva, G 2022. "Platform Ecosystems As Meta-Organizations: Implications For Platform Strategies," *Strategic Management Journal* (43:3), pp. 405-424.

Kuan, K. K. Y., Hui, K.-L., Prasarnphanich, P., and Lai, J. H. Y. 2011. "Online Voting and Review Helpfulness: An Empirical Investigation," working paper.

Kuratko, D. F., Fisher, G., Bloodgood, J. M., & Hornsby, J. S. 2017. "The Paradox of New Venture Legitimation within an Entrepreneurial Ecosystem," *Small Business Economics* (49:1), pp. 119–140.

Lan, S, Liu, K., Dong,YD. 2019. "Dancing with Wolves: How Value Creation and Value Capture Dynamics Affect Complementor Participation in Industry Platforms," *Industry and Innovation* (26:8), pp. 943-963.

Langer, E.J. 1975. "The Illusion of Control," *Journal of Personality & Social Psychology* (32:2), pp. 311–328.

Lechner, M. 2010. "The Estimation of Casual Effects by Difference-in-Difference Methods," *Foundations and Trends in Econometrics* (4:3), pp. 165-224.

Lee, GK., Liberman,MB., 2010. "Acquisition VS. Internal Development as Modes of Market Entry," *Strategic Management Journal* (31), pp. 140-158.

Lee, D., & Mendelson, H. 2008. "Divide and Conquer: Competing with Free Technology Under Network Effects," *Production and Operations Management* (17:1), pp. 12–28.

Levy, Y., Ellis, T. 2006. "A Systems Approach to Conduct an Effective Literature Review in Support of Information Systems Research" *Informing Science Journal* (9), pp. 181-212

Li, Z., and Agarwal, A. 2017. Platform Integration and Demand Spillovers in Complementary Markets: Evidence from Facebook's Integration of Instagram," *Management Science* (63:10), pp. 3438–3458.

Li, M., Goh, K. Y., and Cavusoglu, H. 2013. "Mobile App Portfolio Management and Developers' Performance: An Empirical Sutdy of The Apple iOS Platform," ICIS2013 Proceedings.

Liang, C., Shi, Z., and Raghu, T.S. 2021. "The Spillover of Spolight: Platform Recommendation in the Mobile App Market," *Information Systems Research* (30:4), pp1296-1318.

Liu, CW., Gao, G., and Agarwal, R. 2022. "Reciprocity Or Self-Interest? Leveraging Digital Social Connections For Healthy Behavior," *MIS Quarterly* (46:1), pp. 261-298.

Liu, Q., Steenburgh, TJ., Gupta,S. 2014. "The Cross Attributes Flexible Substitution Logit: Uncovering category expansion and share impacts of marketing instruments," *Marketing Science* (34:1), pp. 144-159.

Lusch R.F. and Nambisan, S. 2015. "Service Innovation: A Service-Dominant Logic Perspective," *MIS Quarterly* (39:1), pp 155-176.

Malinowski, B. 1932. Crime and custom in savage society. London: Paul, Trench, Trubner.

Mayer, M.C.J., Stadler, C., Hautz,J. 2015. "The Relationship Between Product and International Diversification: The Role of experience," *Strategic Management Journal* (36:10), pp. 1458-1468.

McDonald, R. M., and Eisenhardt, K. M. 2020. "Parallel Play: Startups, Nascent Markets, and Effective Business-Model Design," *Administrative Science Quarterly* (65:2), pp. 483-523.

McIntyre, D., Srinivasan, A., Afuah, A., Gawer, A., and Kretschmer, T. 2021. "Multisided Platforms as New Organizational Forms," *Academy of Management Perspectives* (35:4), pp. 566–583.

Meyer,M and Lehnerd, A. 1997. "The Power of Product Platforms: Building Value and Cost Leadership," New York: Free Press, 1997.

Michalopoulos, C., Bloom, H. S., and Hill, C. J. 2004. "Can Propensity-Score Methods Match the Findings from a Random Assignment Evaluation of Mandatory Welfare-to-Work Programs?," *Review of Economics and Statistics* (86:1), pp. 156–179.

Mitchell, W. 1989. "Whether and When? Probability and Timing of Incumbents' Entry Into Emerging Industrial Subfields," *Administrative Science Quarterly* (34:2), pp. 208-230.

Möhlmann, M. 2016. "Digital trust and peer-to-peer collaborative consumption platforms: A mediation analysis," Available at SSRN: http://dx.doi.org/10.2139/ssrn.2813367

Möhlmann, M., Zalmanson, L., Henfridsson, O., and Gregory, R. W. 2021. "Algorithmic Management of Work on Online Labor Platforms: When Matching Meets Control," *MIS Quarterly* (45:4), pp. 1999–2022.

Molm, L. D. 2000. "Theories of Social Exchange and Exchange Networks," In G. Ritzer & B. Smart (Eds.), Handbook of social theory: 260-272. Thousand Oaks, CA: Sage.

Navis, C., and Glynn, M.A. 2011, "Legitimate Distinctiveness in Entrepreneurial Identities: Effects on Investor Judgements of New Venture Plausibility," *Academy of Management Review* (36:3), pp. 479-499.

Nofer, M., Gomber,P., and Hinz, O. 2017. "Blockchain," *Business & Information Systems Engineering* (59:3), pp. 183–187.

O' Mahony, S., & Karp, R. 2022. "From Proprietary to Collective Governance: How Do Platform Participation Strategies Evolve?" *Strategic Management Journal* (43:3), pp. 530–562.

O'Reilly, Tim. 2010. Goverment as a Platform, chap. 2. Open Government, MIT Press, 11–40.

Park, K. F., Seamans, R., and Zhu, F. 2021. "Homing and Platform Responses to Entry: Historical Evidence from the U.S. Newspaper Industry," *Strategic Management Journal* (42:4), pp. 684–709.

Parker, G., and Van Alstyne, M. 2005. "Two-Sided Network Effects: A Theory of Information Product Design," *Management Science* (51:10), pp. 1494–1504.

Parker, G, Van Alstyne, M. 2013. "Innovation, Openness, and Platform Control" Available at SSRN 1079712 .

Parker, G., and Van Alstyne, M. 2014. "Platform Strategy Survey," Working Paper.

Parker, G., Van Alstyne, M., and Choudary S. 2016. "Platform Revolution: How Networked Markets Are Transforming the Economy – and How to Make Them Work for You," 1st edition. W.W. Norton & Company.

Parker, G and Van Alstyne, M., Jiang X. 2017. "Platform Ecosystems: How Developers Invert the Firm," *MIS Quarterly* (41:1), pp. 255-266.

Patton, M. 1990. "Qualitative Evaluation and Research Methods (2nd ed.)," Newbury Park, CA: Sage.

Porter, M. 1996. "What Is Strategy," Harvard Business Review, pp. 37-55.

Priem, RL. 2007. "A Consumer Perspective On Value Creation," *Academy of Management Review* (32:1), pp. 219-235.

Reinganum, J.F., 1983. "Uncertain Innovation and the Persistence of Monopoly," *The American Economic Review* (73:4), pp. 741–748.

Reuver, M.D., Sorensen, C., Basole, R.C. 2018. "The Digital Platform: a Research Agenda," *Journal of Information Technology* (33:2), pp. 124-135.

Rietveld, J., and Eggers, J.P. 2018. "Demand Heterogeneity in Platform Markets: Implications for Complementors," *Organization Science* (29:2), pp. 304-322.

Rietveld, J., and Schilling, M.A. 2020. "Platform Competition: A Systematic and Interdisciplinary Review of the Literature," *Journal of Management,* Forthcoming.

Rietveld, J., Schilling, M., Bellavitis, C. 2019. "Platform Strategy: Managing Ecosystem Value Through Selective Promotion of Complements," *Organization Science* (30:6), pp.1232-1251.

Rindova, V.P. and Fombrun, C.J. 2001. " Entrepreneurial Action in the Creation of Specialty coffee Niche" In C.B. Schoonhoven and E. Romanelli (eds.), The Entrepreneurship Dynamics: Origins of Entrepreneurship and the Evolution of Industries. Stanford, CA: Stanford University Press, pp. 236-261.

Rochet, J-C, and J Tirole. 2003. "Platform Competition in Two-Sided Markets," *Journal of the European Economic Association* (1:4), pp. 990-1029.

Rochet, J-C, and J Tirole. 2006. "Two-Sided Markets: A Progress Report.," *RAND Journal of Economics* (37:3), pp. 645–667.

Roger, G. and Vasconcelos, L. 2014. Platform Pricing Structure and Moral Hazard. *Journal of Economics and Management Strategy* (23:3), pp. 527-547.

Rogers, P. 1998. "The Cognitive Psychology of Lottery Gambling: A Theoretical Review," *Journal of Gambling Studies* (14:2), pp. 111-134.

Rohlfs, J, 1974. "Theory of Interdependent Demand for a Communications Service," *Bell Journal of Economics and Management Science* (5:1), pp. 16-37.

Rosenbaum, PR., Rubin, DB. 1983. "The central role of the propensity score in observational studies for causal effects," *Biometrica* (1083 70:1), pp. 41-55.

Rosenbaum, PR., Rubin, DB. 1985. "Constructing a Control Group Using Multivariate Matched Sampling Methods That Incorporate the Propensity Score," American Statistical Association.

Rubin DB.1976. "Multivariate Matching Methods That Are Equal Percent Bias Reducing, I: Some examples," *Biometrics* (32:1), pp. 109–120.

Rushe, D. 2019. "Uber Loses More Than $1Billion in First Quarterly Report Since IPO. The Guardian, https://www.theguardian.com/technology/2019/may/30/uber-first-quarterly-report-ipo-losses

Rysman, M. 2009. "The Economics of Two-Sided Markets," *Journal of Economic Perspectives* (23:3), pp. 125–143.

Santos, FM., Eisenhardt, KM. 2009. "Constructing Markets and Shaping Boundaries: Entrepreneurial Power in Nascent Fields," *Academy of Management Journal* (52:4), pp. 643-671.

Schilling, M. A. 2000. "Toward A General Modular System Theory And Its Application To Interfirm Product Modularity*," Academy of Management Review* (25:2), pp. 312-334.

Schirrmacher, N.B., Ondrus, J., and Kude, T. 2017. "Launch Strategies of Digital Platforms: Platforms with Switching and Non-Switching Users," In Proceedings of the 25th European Conference on Information Systems, pp. 658-673.

Schumpeter, J.A. 1934. " The Theory Of Economic Development," Harvard University Press, Cambridge, MA.

Sciuto, A., Saini, A., Forlizzi, J., Hong, J. 2018. "Hey Alexa, What's Up?: A Mixed-Methods Studies Of In-Home Conversational Agent Usage," *Proceedings of the 2018 Designing Interactive Systems Conference*, pp. 857-868.

Seamans, R., and Zhu, F. 2014. "Responses to Entry in Multi-Sided Markets: The Impact of Craigslist on Local Newspapers," *Management Science* (60:2), pp. 476–493.

Simon, H.A. 2002. "Near Decomposability And The Speed Of Evolution," *Industrial And Corporate Change* (11:3), pp. 587-599.

Simons, H. 2009. "Case Study Research in Practice," SAGE Publications, 2009.

Song, P., Xue, L., Rai, A., and Zhang, C. 2018. "The Ecosystem of Software Platform: A Study of Asymmetric Cross-Side Network Effects and Platform Governance," *MIS Quarterly* (42:1), pp. 121–142.

Stake, R. 1995. "The Art of Case Research," Thousand Oaks, CA: Sage, 1995.

Stake, R. 1978. "The Case Study Method in Social Inquiry," *Educational Researcher*, pp. 5–8.

Stake, R. 2006. "Qualitative Case Studies," in The Sage Handbook of Qualitative Research, Thousand Oaks, CA: Sage

Stark, L. 2018. "Algorithmic Psychometrics And The Scalable Subject," *Social Studied of Science* (48:2), pp. 204-231.

Stuart, E.A. and Rubin.DB 2007. "Matching with multiple control groups with adjustment for group differences." *Journal of Educational and Behavioral Statistics* . Forthcoming

Stummer, C., Kundisch, D., and Decker, R. 2018. "Platform Launch Strategies," *Business & Information Systems Engineering* (60:2), pp. 167–173.

Tan, B., Anderson, EG., Parker, GG. 2020. "Platform Pricing and Investment to Drive Third-Party Value Creation in Two-Sided Networks," *Information Systems Research* (31:1), pp. 217-239.

Teece, D.J. 1982. "Towards an Economic Theory of The Multiproduct Firm," *Journal of Economic Behavior & Organization* (3:1), pp. 39-63.

Teece,D.J.1986. "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy," *Research Policy* (15:6), pp. 285-305.

ter Huurne, M., Ronteltap, A., Corten, R., and Buskens, V. 2017. "Antecedents of Trust in the Sharing Economy: A Systematic Review," *Journal of Consumer Behaviour* (16:6), pp. 485–498.

Tiku, N. 2017. Facebook's ability to target 'insecure' teens could prompt backlash. Wired. Available at: https://www.wired.com/2017/05/welcome-next-phase-facebook-backlash/.

Teece, D.J. 1980."Economics of Scope and the Scope of the Enterprise," *Behavior and Organization*(1:3) pp. 223–247.

Tiwana, A. 2018. "Platform Synergy: Architectural Origins and Competitive Consequences," *Information Systems Research* (29:4), pp. 829-848.

Tiwana, A. 2015. "Evolutionary Competition in Platform Ecosystems," *Information Systems Research* (26:2), pp. 266-281.

Tiwana, A., Konsynshi,B., and Bush, A. 2010. "Research Commentary—Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics," *Information Systems Research* (21:4), pp. 675-687.

Trischler, M., Meier,P., Trabucchi,D. 2021. "Digital Platform Tactics: How to Implement Platform Strategy Over Time," *Journal of Business Models* (9:1), pp. 67-76.

Tushman, M.L. and Anderson, P. 1986. "Technological Discontinuities and Organizational Environments," *Administrative Science Quarterly* (31:3), pp. 439-465.

Urquhart, C. 2013. "Grounded Theory for Qualitative Research," SAGE Publications.

Van Alstyne, MW., Parker, GG., and Choudary SP. 2016. "6 Reasons Platforms Fail," *Harvard Business Review*, March 31 2016.

Van Pelt, R., Jansen,S., Baars,D and Overbeek,S. 2021. "Defining Blockchain Governance: A Framework for Analysis and Comparison," *Information Systems Management* (38:1), pp. 21–41.

von Krogh, G., Haefliger, S., Spaeth, S., and Wallin, M. W. 2012. "Carrots and Rainbows: Motivation and Social Practice in Open Source Software Development," *MIS Quarterly* (36:2), pp. 649–676.

Wan, J., Lu, Y., Wang, B., and Zhao, L. 2017. "How Attachment Influences Users' Willingness to Donate to Content Creators in Social Media: A Socio-Technical Systems Perspective," *Information & Management* (54:7), pp. 837–850.

Wareham, J., Fox, P., and Cano Giner, J.L., 2014. "Technology Ecosystem Governance," *Organization Science* (25:4), pp. 1195-1215.

Wen,W., Zhu, F. 2019. "Threat of Platform-Owner Entry and Complementor Responses: Evidence from The Mobile App Market," *Strategic Management Journal* (40:9) pp. 1336-1367.

Webster, J., and Watson, R.T. 2002. "Analysing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quarterly* (26:2), pp. 13-23.

Webley, P., Rogers, P., Coups, E. & Haddock, G. 1997. "It Could Be Us! Predictors and Correlated of National Lottery play in Britain,". Paper presented at the XXII

International Conference in Economic Psychology, Valencia, Spain, September 1997.

Wheelwright, S and Clark, K. 1992. "Creating Project Plans to Focus Product Development," *Harvard Business Review*(70:2), pp. 67–83

Wing, C., Simon, K., Bello-Gomez, R.A., 2018. "Designing Difference in Difference Studies: Best Practices for Public Health Policy Research," *Annual Review of Public Health* (39), pp. 453-469.

Wu, P. F. 2013. "In Search of Negativity Bias: An Empirical Study of Perceived Helpfulness of Online Reviews: Negativity Bias and Online Reviews," *Psychology & Marketing* (30:11), pp. 971–984.

Yin, D., Bond, S. D., and Zhang, H. 2014. "Anxious or Angry? Effects of Discrete Emotions on the Perceived Helpfulness of Online Reviews," *MIS Quarterly* (38:2), pp. 539–560.

Yin, R,K. 2003. "Case Study Research: Design and Methods," 3rd edition. Thousand Oaks, CA: Sage.

Yin, P. L., Davis, J. P., and Muzyrya, Y. 2014. "Entrepreneurial Innovation: Killer Apps in the IPhone Ecosystem," *American Economic Review* (104:5), pp. 255-259.

Yoo, Y., Henfridsson, O., and Lyytinen, K. 2010. "The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research," *Information Systems Research* (21:4), pp. 724–735.

Zheng, Z., Xie, S., Dai,H., Chen,X and Wang,H. 2017. "An Overview of Blockchain Technology: Architecture, Concensus, and Future Trends," Honolulu, USA, 2017.

Zhu, F., and Iansiti, M. 2012. "Entry into Platform-Based Markets," *Strategic Management Journal* (33:1), pp. 88–106.

Zhu, F., Li, X., Valavi, E., and Iansiti, M. 2021. "Network Interconnectivity and Entry into Platform Markets," *Information Systems Research*, Article in Advance, pp. 1-17.

Zhu, F., & Liu, Q. 2018. "Competing with complementors: An empirical look at Amazon.com," *Strategic Management Journal* (39:10), pp. 2618–2642.

Zhu, F 2019. "Friends or Foes? Examining Platform Owners' Entry into

Complementors' Spaces," *Journal of Economics and Management Strategy* (28:1), pp. 23-28.