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Closed or open platform? The nature of platform and a qualitative comparative analysis of the performance effect of platform openness

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ABSTRACT Internet platform enterprises have become one of the dominant organizational forms for internet-based businesses. Despite the strategically crucial role that openness decision plays for Internet platform enterprises, the results of existing research on the relationship between platform openness and platform performance are not conclusive. As to the nature of platform, its transaction attribute has been overemphasized while its innovation attribute is mostly neglected. Through decomposing platform openness into supply-side openness and demand-side openness, as well as introducing demand diversity and knowledge complexity as contextual variables, this study attempts to understand the impact of both types of attributes on performance by considering their configuration. Using fuzzy sets qualitative comparative analysis (fsQCA) method, we find that high demand diversity of platform users and high supply-side openness will lead to better platform performance. Moreover, the high knowledge complexity required for platform innovation together with high supply-side and demand-side openness will contribute to a high level of platform performance.

Keywords: Platform Openness; Transaction Attribute; Innovation Attribute; Demand Diversity; Knowledge Complexity
1. Introduction

Internet platform enterprises (IPEs), such as Alibaba, Airbnb, Haier Hope and Salesforce, play increasingly important roles in the development of modern economy (Parker et al., 2016). Many IPEs do not directly provide products or services to their end users; instead, they only provide building blocks to bring external suppliers and buyer users together through opening interface (Gawer, 2009; West, 2003). As such, platform openness is one of the important strategic decisions made by IPEs. Platform openness refers to the threshold condition of entry for supplier and buyer users, and a higher threshold means less openness (Boudreau, 2010). For example, Apple iOS is a relatively closed platform as its architecture is fully under the control of Apple. External suppliers need to meet the strict evaluation criteria for entry. In contrast, Android is much more open, and developers can help modify the Android platform. In this case, it is an essential issue in platform strategy research as of what kinds of openness options can lead to high platform performance (West, 2003; Boudreau, 2010; Cennamo, 2018). However, the results of existing research are not conclusive with the relationship between platform openness and platform performance (Boudreau, 2012; Casadesus and Halaburda, 2014). Among them, some argue that platform openness can increase the variety of products and service, enhance network effect, and then improve platform performance (Cenamor et al., 2013; Natalicchio et al., 2017). Others claim that the increase of the platform openness may lead to congested competition and coordination difficulties in innovation activities, which will be detrimental to ecological symbiosis and reduce platform performance (Casadesus and Halaburda, 2014).

The reason for inconsistent research conclusions can be attributed to the neglect of the ambidextrous attributes of platforms. Research on platform transaction attribute pays attention to the variety of products and services and argues that increasing openness can facilitate transaction matching on the platform (Chen and Yu, 2012). Research on platform innovation attribute is concerned with the dynamics of information and knowledge and argues that increasing openness can promote knowledge innovation on the platform to produce new production and service. In reality, platforms have the ambidextrous attributes of transaction and innovation (Alchian and Demsetz, 1972), in a sense that there are the transactions of products and services and new product and service innovations based on specific needs. Thus, the configuration of transaction and
innovation attitudes should be taken into consideration in the research on the relationship between platform openness and performance.

In light of the concerns mentioned above, this study intends to resolve the mixed findings by decomposing the underlying dimensions of platform openness and introducing two contextual variables. Considering the bilateral structure of platforms (Gawer and Cusumano, 2014), we decompose the platform openness into two dimensions, which are supply-side openness and demand-side openness. We argue that boundary conditions will affect the relationship between the two dimensions of platform openness and platform performance. From the transaction perspective, the performance effect of platform openness depends on platform users’ demand diversity, because it can help eliminate the competitive crowding effect among supply-side users (Hagiu, 2009). From the innovation perspective, the performance effect of platform openness depends on knowledge complexity required for platform innovation. Since diversified user base is required to provide heterogeneous information and resources relevant to the production and service innovation on the platform (Baldwin and Von Hippel, 2011). Extant studies on platform openness are more concerned with supply-side openness rather than demand-side openness (Parker and Van Alstyne, 2018).

This study contributes to the platform openness decision research by purposively integrating transaction and innovation attributes of platforms. There are inconsistent findings on whether more open platform is associated with better performance (Casadesus and Halaburda, 2014). This study reconciles the mixed findings in the literature by providing a conceptual approach of decomposing the platform openness into supply-side openness and demand-side openness. In addition, this study emphasizes the importance of taking platform characteristics into consideration. In fact, platform performance is a mix result of the interdependence of platform openness and these characteristic (Misangyi et al., 2017). To address the causal complexity issue, this study examines the configuration effects of openness dimensions, demand diversity and knowledge complexity on platform performance using fuzzy sets qualitative comparative analysis method (QCA), a widely used method in configuration analysis (Jenson et al, 2016). We test our hypotheses using a data set collected from IPEs in China. China is an ideal setting for our analysis since many IPEs in China have achieved business success. Chinese Internet giants, such as Alibaba and Tencent, have become the leading IPEs in the world. As such, Chinese IPEs provide a
rich context to investigate the impact of platform openness strategy on their performance.

In the field of e-commerce research, both e-commerce platforms and social media platforms have been investigated (Chen and Yu, 2012; Zhang et al., 2018). However, the prior studies have not paid enough attention to the influence of platform heterogeneity. It is worth noting that transaction and innovation attributes for these two kinds of platforms are quite different and thus should be managed by different strategies. Our study emphasizes the necessity of taking platform attributes into consideration in building theoretical model.

This study is organized as follows. Theoretical background and research hypotheses are introduced in the next section. Details as regard to the research method and the QCA are explained in the third section. Then we report the results. Discussion, summary and theoretical implications are presented in the last two sections.

2. Theoretical background and research hypotheses

2.1. Theoretical background

The relationship between platform openness and platform performance is essentially an issue of firm governance. It is about how platforms handle their relationships with platform participants (Tiwana, 2014). Because the enterprise is an entity of both transaction and innovation attributes (Alchian and Demsetz, 1972; Simon, 1997; Williamson, 1985), platform openness decisions need to integrate both the transaction governance logic and the innovation governance logic (Felin and Zenger, 2014). However, most of the existing studies stand on either position and follow only one governance logic. A handful of available studies on the nature of platforms mainly discuss the trade-off between product variety and competitive crowding effects (Boudreau, 2010; Huber, Kude and Dibbern, 2017) with an exclusive focus on the transaction attribute of platforms.

Existing research neglects the ambidextrous attributes of platforms, which may lead to inconsistent conclusions. To solve this problem, this study introduces two contextual variables, i.e., demand diversity and knowledge complexity, to capture the ambidextrous attributes of platforms. On the one hand, the platform openness governance based on the transaction attribute is related to managing product variety and improving matching efficiency (Cennamo, 2018). The contextual condition affecting such governance logic is the platform users’ demand diversity (Ghazawneh and Henfridsson, 2013). On the other hand, the platform openness governance based
on the innovation attribute is associated with managing knowledge complexity and improving collaborative efficiency. In this case, the contextual condition becomes the knowledge complexity for product and service innovations on the platform (Alexy et al., 2018; West, 2003).

2.2. Research hypotheses

Supply-side users mainly provide products or services required for the transaction in the platform architecture. When platform openness is high, the number of suppliers who can access the platform will increase. This increase in supplier size may lead to two opposite results as follows. For one thing, it may bring about an increase in the number and the variety of complementary products, attract more users to the platform and promote platform performance under indirect network effects (Lin and Daim, 2009). For example, Boudreau (2012) explain that the users’ demand diversity is the reason why supply-side openness on the computer system platform, such as Palm, Microsoft Windows CE, Symbian, and Linux platforms, keeps improving to introduce external developers. For another, as suppliers’ size increases, the homogenization of products or services resulting from competitive imitation among suppliers may lead to the effect of competition and crowding out (Casadesus and Halaburda, 2014). Excessive competition may also lead to adverse selection problems and the decline of the platform quality. Eventually, demand-side users will flee away and the platform would fail in the end (Boudreau, 2012).

The relative explanatory power of the two above-mentioned mechanisms will be strongly influenced by the demand diversity of the users (Hagiu, 2009). Different platforms have different types of users with various preferences. When the level of diversification of users' needs is high, a high degree of supply-side platform openness will lead to an increase in suppliers and then enhanced quantity, quality and variety of products or services. Under this circumstance, the platform can better match the needs of users and attract more users to join in. Moreover, higher demand diversity means that there are many niches for suppliers to cater to (Freeman and Hannan, 1983) and it is less possible to become a “winner takes all” market. Thus, there are opportunities for many suppliers to flourish without competing directly. When a balance of supply and demand is reached, the platform performance will increase. In latest literature, researchers also paid attention on the influence of user preferences on platform strategies (Panico and Cennamo, 2020). Therefore, we propose the following hypothesis 1.

Hypothesis 1: The configuration between high demand diversity of platform users and high
supply-side openness will lead to high platform performance.

From the innovation attribute perspective of the platform, products and services innovations within the platform architecture are derived from the value co-creation activities among the platform, supply-side users and demand-side users (Ceccagnoli et al., 2012). Higher platform openness can increase the total number of suppliers and users, resulting in an increased amount of resources and knowledge assets (Inkpen and Tsang, 2005). Especially, non-redundant information and resources will help improve platform innovation performance (Barney and Clark, 2007). At the same time, an increase in the number of platform users may lead to coordination problems in knowledge sharing, delivery and integration (Hansen, 1999; Von Hippel, 1994).

The relative explanatory power of the above two mechanisms will greatly depend on the knowledge complexity required for platform innovation. When the level of knowledge complexity required for platform innovation is high, knowledge diversity brought by the increase of users will be fully exploited (Cassiman and Valentini, 2016) and more opened platforms will obtain more returns on platform performance. In addition, platform product and service innovations require knowledge supply from both supply-side users and demand-side users. With the help of indirect network effect, a wider range of interactions between supply-side users and demand-side users at high levels of platform openness can build reputation and trust among users. The above interaction is essential to solve the coordination problem of complex knowledge innovation and facilitate tacit knowledge transfer for platform innovation (Baldwin et al., 2011). Similarly, the study of Randhawa et al. (2017) on online community platform “Nexus” also emphasizes the significance of platform openness and participation of multilateral users. Therefore, we propose the following hypothesis 2.

**Hypothesis 2:** The configuration of high knowledge complexity of platform innovation with high levels of supply-side and demand-side openness will lead to high platform performance.

In summary, Figure 1 presents the theoretical model.

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3. Method

3.1. Qualitative comparative analysis

The QCA method can be further divided into crisp sets qualitative comparative analysis (csQCA) and fuzzy sets qualitative comparative analysis (fsQCA). The csQCA shows that there are only two values of "0 or 1" for research variables, and "1" indicates the complete membership of the collection while "0" indicates the complete non-affiliation of the collection. The fsQCA is an extension of csQCA and the assignment of variables is in the "0-1" range, allowing the existence of "partial affiliation". For the purposes of this article, there is a partial affiliation in variable assignment. Therefore, the method used in this study is fsQCA.

Qualitative comparative analysis (QCA) has been widely used in management research in recent years (Fang et al., 2016; Misangyi et al., 2017). For one thing, the QCA method embraces the causal complexity and turns to a configuration effect analysis of various factors on the results instead of analyzing single factor isolated effect. For another, qualitative comparative analysis can deal with large sample survey data and small sample case coding data (Ragin, 2008; Xie et al., 2016).

Qualitative comparative analysis is suitable for this study for two reasons. First, the qualitative research method focuses on the complex mechanism of cause and effect (Ragin, 2008), which fits well with the idea of focusing on the ambidexterity attributes of the platform. It integrates and analyzes the influence of platform openness and contextual variables on platform performance. Secondly, as a new research field, sample collection for platform research is quite limited and there is still a lack of research database. Therefore, the QCA method suitable for small samples is very useful in this study (Xie et al., 2016).

3.2. Measures

The QCA method is based on an overall reflection of quantitative and qualitative data (Schneider and Wagemann, 2012). For the measurements of variables involved in this article which are mainly collected from existing literature, we try to find the corresponding supporting materials in the platform context. Specifically, using fsQCA requires assigning values to all variables through coding based on sample information. For the assignment method in coding, there are multiple choices such as the three-valued assignment "0, 0.5, 1" and the four-valued
assignment "0.00, 0.33, 0.67, 1.00". For the four-valued assignment, "0.00" represents no membership at all, "0.33" represents that the degree of non-subordination is greater than subordination, "0.67" represents that subordination degree is greater than non-subordination, and "1.00" represents full subordination. Choice of different assignment method depends on the specific research situation (Ragin, 2008). Through classification and sorting of sample data, the four-valued assignment can reflect the differences between sample data more finely in this study. The specific settings for assigning the corresponding variables are as follows.

**Platform Openness.** Openness is the open threshold strategy adopted by the IPEs which play leading roles in the platform-based ecosystem. The openness measure mainly refers to the depth and breadth of openness (cf. Laursen and Salter, 2006). Based on the research of Boudreau (2010), this study defines platform openness as the open access and the open architecture. Access openness is the entry threshold for users to platforms. Open architecture is the degree of user participation in the innovation of the architecture after user entering the platform. Specifically, supply-side openness refers to the openness of IPEs to products or service suppliers, while demand-side openness is the openness of IPEs to users. The higher the platform openness is, the higher the participation of users is.

**Demand Diversity.** Demand diversity of users is an important factor to be considered in the development strategy of platforms. The demand diversity of platform users depends on the functional positioning of the platform (Hagiu, 2009). A segmentation platform is limited to a certain business area and has a low degree of diversity, such as the home appliance development platform in Haier Company (which is China's largest home appliance manufacturer). On the contrary, an integrated platform has a broader business scope with higher user demand diversity, such as Amazon and Taobao. Thus, this study uses the business scope positioning of platform as the alternative measure of demand diversity. This study also includes the differences in the demographics of the platform user (e.g., gender, age and educational level) in data coding.

**Knowledge Complexity.** Knowledge complexity is an important variable in the field of knowledge innovation and governance (Nonaka, 1994), which refers the density of interdependencies between functional components of knowledge activities and the degree of knowledge codification (Kauffman, 1993; Hansen, 1999). We measure knowledge complexity in the following two ways: the degree of knowledge diversity is measured by finding whether
platforms require knowledge from just one party or all of supply-side users, demand-side users and the platform; and the degree of knowledge expression is measured by distinguishing whether the platform is biased towards simple product transactions or complex knowledge innovations (Cenamor et al., 2013).

**Platform Performance.** IPEs are building blocks connecting supply-side and demand-side users to facilitate transaction and innovation activities (Gawer, 2009). Therefore, the measure of platform performance should be based on both the value creation activities and its outcome to supply-side and demand-side users. Following Cennamo (2018), this study measures platform performance through their installed base the transaction volume and the ranking of IPEs.

Table 1 presents the measures of variables.

Insert Table 1 about here.

### 3.3. Sample

As a qualitatively oriented research method, the QCA method requires theoretical sampling rather than random sampling (Ragin, 2008). We take the following three criteria in selecting research sample of IPEs. First, IPEs should exhibit the features of the platform business model and be established for more than one year. We use two key features, i.e., two-sided architecture and network effect, to judge the platform business model (Gawer, 2009). Sample bias can be controlled by requiring the platforms to have continuous operations for more than 1 year (Gawer, 2009). Second, we consider the sample variations in platform ambidexterity to cover both transaction attribute and innovation attribute. According to the definition of Jacobides (2018), transaction platforms refer to the information display platform or two-sided markets, such as Amazon and Taobao. Innovation platforms are established for developing new products and services by collaboration between suppliers and users, such as iOS platform and Haier open innovation platform. Third, in order to gather sufficient data, we select those platforms which can provide first-hand information through interviews (Eisenhardt, 1989). Most of the samples are from Yangtze River Delta Area in China where the authors live. Although these platforms are concentrated in this area, regional factors will not have a big impact on sample selection because the operation of IPEs is online virtual and not conatined by such limitations as time and space.
Then we obtain a sample of 21 IPEs as shown in Table 2. The sample covers a number of industry sectors such as e-commerce, smart manufacturing, logistics and internet education. This sample size is similar to the general practice of recently published articles using the QCA method in the field of management and business (Greckhamer, 2016). As suggested by Ragin (2008), the sample size is at least $2^n$, and $n$ is the number of the antecedent. In this research, $n$ equals 4, and the number of sample size is at least 16.

3.4. Data Collection

Data of the same case should be collected from different channels so as to do triangle validation to insure reliability and validity (Eisenhardt, 1989). The data is collected from two channels. The first channel is online and offline interviews with managers of IPEs as much as possible, and the data collection based on interviews covers the platforms. We also did fieldwork to access the appropriate data by consulting project research, industry conferences and relationships network. The second channel is to collect secondary data, including case materials from official websites of IPEs, annual reports, internal documents and industry research reports. During the data collection process, we did not directly encode the entire sample, instead, we first conducted an exploratory analysis of four cases for two purposes. On the one hand, such a practice helps us to corroborate the rationality of the theoretical model. On the other hand, it can help us to modify and refine the coding measures of the variables. Moreover, the contextual variables of the theoretical model are actually progressively explicit in the process of case study. The effect of demand diversity and knowledge complexity on the relationship between the openness and performance is corroborated by the interview material, as shown in Table 2.

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Then three researchers encoded the samples one by one and obtained the coding results as presented in Table 3. Data encoding process requires strict cross-validation to ensure research reliability and validity, and data encoding by more researchers can improve research reliability (Yin, 2009). The researchers involved in the coding process have a good theoretical foundation in the fields of TCE, RBV and innovation research, which can effectively guarantee the validity of coding. Also, back-to-back coding was performed by the three-person coding group to discuss and
analyze the inconsistent results. Combining the theory with reality, a suitable code value is finally determined, and reliability of coding is guaranteed by cross-validation. The final coding results show that there is a certain degree of difference in the evaluation level of each variable. And the coding results also provide the materials for fsQCA.

3.5. Calibration

Calibrating the measures is the first step for the qualitative comparative analysis. The transformation of Measures into sets is relatively unproblematic and employs the direct method described by Ragin (2008). The method is using a crossover point as an anchor to calculate the deviation scores and taking the values of pertinence as the upper or lower boundaries. To calibrate these observations, the interval is divided into two different measures, whose values are between 0 and 1. These values do not represent probabilities but rather transformations of the quantitative scale in degrees of integration within the category. The fuzzy set's values for full membership, crossover point, and full non-membership are minimum value, mean value, and maximum value, respectively. For platform performance in this study, a value of 1 indicates full membership, whereas a value of 0 indicates full non-membership, and a value of 0.62 indicates the crossover point. 0.62 is the reference to Ragin's book with the average as the crossover point. All analyses use the fsQCA 3.0 software package.

4. Results

After calibrating the measures, the necessity test has been conducted. If the condition is necessary, it is not suitable for fsQCA (Ragin, 2008). The study uses the consistency in the fsQCA to judge the necessary conditions. If the consistency is more than 0.90, the condition is necessary. The results of necessity test show in Table 4. All the consistency values of the conditions are less than 1, indicating that these condition variables cannot fully explain the result variable, that is, they are not necessary conditions of the result variable. The analysis of single variable is insufficient, and further conditional configuration combination analysis is required (Ragin, 2008). To sum up, the necessity test of sample has been passed.
The next step is to verify the conditions of sufficiency after establishing the necessary conditions. The number of samples covered by the configuration combination is set to 1. The consistency threshold is set at 0.8, which is recommended by Ragin (2008). The results in Table 4 report the causal paths: the combinations of these causal conditions. Two of these causal paths are empirically important. Empirical importance stems from the degree to which the causal condition or combination of conditions explains the result. Two indicators assess empirical importance: consistency and coverage (Ragin, 2008). In this case, the overall solution consistency is 0.92, and the overall solution coverage is 0.85. The results indicate that the two paths cover most of the outcome. The raw coverage for single causal paths is 0.10 and 0.36. On the whole, this research produces two configurations and both of them comply with the consistency threshold.

The first configuration in Table 5 shows that (a) high supply-side openness, (b) high demand diversity lead to better platform performance. The consistency is very high with satisfactory coverage. Thus hypothesis 1 is supported. Specifically, the results suggest that the higher the demand diversity of platform users is and the more supply-side openness is, the better the platform performance can be. Increasing the platform openness can increase supply of products and services and more effectively match demand, thereby promoting platform performance (Ceccagnoli et al., 2012). At the same time, competition among users has been strengthened along with the increase in platform openness (Casadesus and Halaburda, 2014). However, our research results show that the demand diversity of users can alleviate the competition effect of supply-side users, thereby improving platform performance.

As the interviewee of IPEs said, “we are different from the platform with vertical segmentation, such as the platform for snacks and shoes. They may need to reduce the openness and focus on quality control to attract consumers. Our position is to build an integrated platform to satisfy diverse demands from different consumers. Therefore, we need to increase the supply-side openness and bring in a variety of suppliers, which has become our competitive advantage.”

Insert Table 4 about here.

Insert Table 5 about here.
The second configuration in Table 5 shows that (a) high supply-side openness, (b) high demand-side openness, and (c) high knowledge complexity result in better platform performance. Both consistency and coverage is high for this solution. Thus hypothesis 2 is supported. With the increase of platform openness, more information and knowledge assets are carried by the users, and the heterogeneity level is increasing, which can promote knowledge innovation activities, thereby promoting platform performance (Kogut and Zander, 1992). At the same time, the increase in openness can lead to the knowledge redundancy and management coordination problems among users. However, our results also show that knowledge complexity in platform operations can reduce the difficulty of managing coordination, thereby improving platform performance.

As the interviewee of IPEs said, “we are different from product release platform which is simple promotion of mature product. We analyze the demand of users, communicate with developers for preconcert development and link complete value chain operations for the platform of manufacture resources. Knowledge innovation is highly complicated. It needs high involvement of users and the supply of diversified knowledge, as well as the abilities of different development agents, to co-create value.

5. Discussion

This study elaborates that there is a difference between the performance effect of demand-side openness and that of supply-side openness of IPEs. Though there is a consensus in the literature that a platform can be divided into the demand side and the supply side (Gawer and Cusumano, 2014), the necessity of decomposing the platform openness has not been taken into consideration yet. That is why there is a long existing disagreement on the performance effect of platform openness (Boudreau, 2010; Cennamo, 2018). As such, it is worth noting that the contents of the two underlying kinds of openness are different. The supply-side openness is the threshold of the platform for product and knowledge suppliers, while the demand-side openness is the threshold of the platform for product and knowledge consumers. High supply-side openness is related to market competition (Casadesus and Halaburda, 2014), while high demand-side openness is associated with user engagement innovation and multilateral value co-creation (Von Hippel, 1986; Sheth, 2019).
The study confirms that the configuration of high supply-side openness and high demand-side openness can increase platform performance. Consistent with prior studies, the enhancement of openness can bring rapid growth of the platform (Boudreau, 2010). Meanwhile, this study calls for the analysis of the contextual conditions on the relationship between openness and performance of the platform. The results suggest that for the transaction attribute of platforms, the impact of platform openness on platform performance lies in the trade-off between transaction matching and competition (Felin et al., 2014). High demand diversity can reduce the crowding-out influence of supply-side competition which is caused by high openness (Boudreau, 2012). The study also reveals that the configuration of high supply-side openness and demand-side openness as well as high knowledge complexity can enhance platform performance. Existing research pays more attention to the matching of supply-side and demand-side maturity requirements (Hagiu, 2009; Fang et al., 2016), but neglects the essential role of multilateral knowledge innovation. The results in our research reveal that as regarding to the innovation attribute of platforms, the relationship between platform openness and performance lies in the trade-off between knowledge innovation and management coordination. Considering that platform can promote knowledge transfer and creation between supply-side and demand-side users, high knowledge complexity can alleviate the negative effect of information redundancy which is relevant to the multilateral value co-creation in online open community (Sheth, 2019). Especially, this study is different from the prior research on two-sided market which only focuses on the transaction attribute of platforms (Hagiu, 2006). In contrast, this study integrates the innovation attribute of platforms into the conceptual framework and highlights the importance of knowledge complexity in shaping the relationship between platform openness and platform performance. Finally, it is worth noting that platform operations are inevitably influenced by external environment such as the control and support from government (Wang et al., 2019), because IPEs with high supply-side and demand-side openness becomes a platform-based ecosystem (Jacobides et al., 2018). Government agents will intervene when there are fakes in a platform due to lower threshold and less control to the quality of product and service, such as the control practices by the Chinese government on the fakes of Taobao in the past. On the other hand, government agents will also intervene when there are discriminatory rules on higher threshold in order to ensure fair competition within the platform-based ecosystem (Gorwa, 2019). Although the external environment variables such as
government control have not been included explicitly in the model, there is evidence to support such an influence from the interviews and the exploratory case study. Future research needs to pay more attention to the impacts of institutional environment factors on platform openness decision (Tiwana et al., 2010).

6. Summary and Theoretical Implications

6.1 Conclusions

This study focuses on the relationship between platform openness and platform performance, and decomposes platform openness to supply-side openness and demand-side openness. In addition, the research introduces demand diversity and knowledge complexity as the contextual factors for the performance effect of platform openness. Using fsQCA, this study examines the effect of platform openness on the level of platform performance. The findings reveal that various combinations of factors including the platform openness, demand diversity and knowledge complexity determine the level of platform performance. Specially, this study finds that high demand diversity of platform users and high supply-side openness will lead to better platform performance. In addition, high knowledge complexity required for platform innovation together with high supply-side and demand-side openness will contribute to a high level of platform performance.

6.2 Theoretical contributions

This study makes several contributions to platform openness decision research, as shown in the Table 6. Firstly, this study argues that mixed findings in the literature on performance effect of platform openness partly come from the misunderstanding of the nature of platforms. More specifically, most of the existing studies neglect the ambidexterity attributes of platforms, and only take IPEs as either a transaction platform based on two-sided market (Hagiu, 2009) or an innovation platform with multiple collaborations (Cenamor et al., 2013). However, IPEs are always the embodiment of the ambidextrous attributes of transaction and innovation, and such ambidextrous attributes are not mutually exclusive. This theoretical len is consistent with the recent research of Cusumano et al. (2019), based on the study of IPEs in the America and Europe, such as Software, Google, Amazon and SAP. They also point out that future studies should focus on the ambidextrous attributes of platforms.
Secondly, this study explores the boundary conditions of the performance effect of platform openness. The empirical results reveal that the interaction between demand diversity and supply-side openness can significantly enhance platform performance. Higher demand diversity means that there are many niches for suppliers to cater to and it is less of a “winner takes all market” (Freeman and Hannan, 1983). Thus, there is an opportunity for many suppliers to flourish by catering to these varied needs and these suppliers are not competing directly. As such, this study is an echo to the call for examining the impact of user heterogeneity in the field of platform research (Rietveld and Eggers, 2018). Through investigating the configuration of knowledge complexity together with supply-side and demand-side openness on platform performance, this research also echoes the latest idea in open innovation, that the depth and width of open innovation should be matched with the knowledge content of innovation cooperation (Bengtsson et al., 2015). Last but not the least, this study elaborates platform openness into supply-side openness and demand-side openness because the platform is an architecture connecting suppliers and users (Gawer, 2009). Existing literature mainly focus on the effect of supply-side production and diverse service on platform performance based on transaction attribute of platforms (Casadesus and Halaburda, 2014). The co-creation value of demand-side users is necessary for innovation attribute of platforms (West, 2003; Sheth, J. N. 2019). Therefore, this study takes both supply-side openness and demand-side openness into consideration.

6.3 Managerial implications

The particularity of IPEs lies in the open interface. Different from traditional enterprises which only choose their own business boundaries, IPEs need to control their ecological boundaries through selecting the levels of platform openness. On the one hand, platform managers need to know that the relationship between openness governance and platform performance is nonlinear. Moreover, platform managers need to think about the openness decision as a simultaneous consideration of supply-side openness and demand-side openness. The fundamental guideline for selection is that supply-side openness should pay more attention to the diversity of the transaction of products and services, while demand-side openness should emphasize more on the innovation
participation of platform users. On the other hand, the selection of platform openness should involve the consideration of the evolution of platform attributes and should be carried out in a style of rapid iteration. For a platform with more focus on transaction attribute, it is more critical to match high demand diversity with high supply-side openness. For a platform with more focus on the innovation attribute, high knowledge complexity requires both high supply-side openness and high demand-side openness.

In addition, the importance of IPEs becomes more obvious with the global spread of COVID-19. Without the support of IPEs, a large number of transaction and innovation activities cannot even take place. For example, recently our shopping and consumption needs are greatly supported by Alibaba and Amazon. In addition, “fake news” becomes easier to occur during the epidemic, and consequently Tencent and Facebook have to think about strengthening platform governance. As such, enterprises probably need to invest in the construction of internet platforms and conduct differentiated governance according to their platform attributes even after the epidemic. On the other hand, government departments can initiate policy supports for platform infrastructure construction, aiming to help enterprises to use new technologies such as 5G, Cloud Service and Block Chain at a low cost to accelerate their digital transformation.

6.4 Limitations and future research

This study has several limitations. The future research can be developed from three directions as follows. Firstly, external environment variable has not been taken into consideration in the model, such as the impact of government policy and the competition among participating firms. The investigation on the antecedents of platform performance can be extended by including the competitive strategy of IPEs and the impact of external institutional environment. For example, JD.com improves the quality of products by taking low openness, while Taobao.com satisfies diversified demand of users by taking high openness. In addition, government policy has an important impact on the platform openness decision. Platforms have strong market power because of the monopolistic competition market resulted from network effect. In this case, government will set control over the openness strategy taken by the platform once they engage in discriminatory behavior. Secondly, large sample analysis with objective data should be taken into consideration in future research. Also, the data analyzed in this study comes from encoding method rather than objective data. Future studies can consider using objective data to validate the
robustness of the research. Multiple methods can be used to carry out repeated studies and to test the external validity of research conclusions by increasing the sample size and diversity. The applicability of these research conclusions to other countries and regions can be further validated.

Lastly, the dynamic evolution of platform openness strategy and platform attributes has not yet been considered. In reality, the development of platforms is a process of dynamic evolution. Platform attributes keep changing in different stages. For example, Taobao is no longer a simple online trading platform and has gradually evolved into an innovation ecosystem (Zeng, 2018). Therefore, a process model is needed in the future studies to capture the dynamic nature of platform openness strategy.
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**Platform Openness**

- **Supply-side Openness**
- **Demand-side Openness**

**Contextual Variables**

- **Demand Diversity**
- **Knowledge Complexity**

**Figure 1 Research model**

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**TABLE 1**

**Measurement of Variables**

| Value | Basis |
|-------|-------|
| 1.00  | The platform provides almost no barriers for users to enter and at the same time builds a community of users and encourages supply-side users to participate in the platform architecture innovation and custom development of transaction business. |
| 0.67  | Platform for the supply of users to set the threshold low, for the user can participate in the platform architecture innovation and trading business custom development. |
| 0.33  | Platform for supplier users to set a high threshold, a small amount of supply users occasionally involved in platform architecture innovation and trading business custom development. |
| 0.00  | The platform for the supplier user to enter the invitation system, the supplier user does not participate in platform architecture innovation and trading business custom development. |
| 1.00  | Platform on the demand side of the user access to almost no threshold, the establishment of user communities to encourage demand-side users to participate in the platform architecture and trading business custom development. |

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[Laursen, Salter, 2006; Boudreau, 2010]
| Score | Description |
|-------|-------------|
| 0.67  | Platform on the demand side to enter the user set the threshold is low, the demand side users can participate in platform architecture and transaction business custom development. |
| 0.33  | Platform on the demand side to enter the user to set a high threshold, a small amount of demand-side users occasionally involved in platform architecture and transaction business custom development. |
| 0.00  | The platform for the demand side users to enter the invitation system, the demand side users do not participate in the platform architecture and transaction business custom development. |
| 1.00  | The platform is a cross-cutting leader with a very diverse range of products and services, with existing users covering all genres (clustering by gender, age and education). |
| 0.67  | Platforms are large, cross-domain platforms that offer a wide range of products and services that vary widely from user to user (at least in terms of gender, age, or education). |
| 0.33  | Platform is the leading platform in the field of segmentation, products and services are more concentrated, and more users have been more homogeneous. |
| 0.00  | Platform is a professional platform for the field of subdivision, products and services are more single, users have high homogeneity. |
| 1.00  | Platform requires participatory innovation among multiple subjects; the knowledge exchanged between subjects cannot be documented; the communication is less accomplished through written documents; and the types of knowledge are almost all skillful and difficult to disassemble. |
| 0.67  | The platform encourages participatory innovation among multiple subjects; the knowledge exchanged between subjects is hard to document; part of communication is difficult to accomplish through written documents; and the type of knowledge is more skillful and difficult to decompose. |
| 0.33  | Platform is mainly a multi-factor transaction between elements; the exchange of knowledge between the main body can be documented, communication can be completed through written documents, the type of knowledge is more explicit knowledge, you can modular decomposition. |
| 0.00  | Almost all of the platform is a multi-factor transaction between elements; the exchange of documents between the main body of knowledge; communication through written documents to complete; almost all types of knowledge is explicit knowledge, can be modular decomposition. |
| 1.00  | Platform business users a large base (tens of millions), or platform brands in the field in a leading position (top two). |
| 0.67  | Platform business users a larger base (million), or platform brands in the field in a leading position (top five). |
| 0.33  | Platform business user base is small (one hundred thousand), or platform brand in the field in the middle level (can enter the relevant leaderboards). |
| 0.00  | Platform business users base small (10,000 and below), or platform brands in the field at a lower level. |
## TABLE 2

### Exploratory Case Study

| Firm       | Representative Quotes                                                                                                                                                                                                 | Comparative analysis                                                                                     |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Ulibuy     | The Minister of Strategic Investment said, “Our customers are diverse, with a wide range of ages and income levels, and their needs are even more varied. However, our product channels are limited, and our control thresholds are high, resulting in supply-side products and services cannot meet our customers well.” | High supply-side platform openness matching with demand diversity leads to high performance               |
| Ctrip      | The business manager said, “Our customers’ travel needs are diverse, including hotels, airline tickets, tickets, etc. Thus, we take a highly open strategy to bring in a large number of external suppliers, so that our platform can achieve better matching and serve users well.” |                                                                                                           |
| Moocollage | “We are an online education community, and knowledge sharing, and creation requires the participation of both supply-side and demand-side users,” said the COO. We thought that the previous strategy may not be appropriate and that we were not open enough to course providers, resulting in the interactions that didn't form well.” | High supply-side and demand-side openness matching with knowledge complexity leads to high performance    |
| MIUI       | The business manager said, "we built an online developer community, introduced a large number of audiophile users, docked with product developers, promoted user participation in the innovation, and accelerated product iteration with product development companies. This business mode helped us to succeed. |                                                                                                           |
### TABLE 3

Descriptive Statistics of Sample

| Firm          | Domain                      | SSO  | DSO  | KC    | DV   | PP  |
|---------------|-----------------------------|------|------|-------|------|-----|
| Taobao       | E-commerce                  | 1    | 0.67 | 0.33  | 1    | 0.67|
| Toocle       | E-commerce                  | 0.33 | 0.67 | 0.67  | 0.67 | 0.67|
| Ulibuy       | E-commerce                  | 0.33 | 0.33 | 0.33  | 0.67 | 0 |
| Ctrip        | Tourism e-commerce          | 0.67 | 0.67 | 0.67  | 1    | 0.67|
| Wanzi        | Tourism e-commerce          | 0.33 | 0.67 | 0.67  | 0.67 | 0.33|
| City.zbj     | E-commerce                  | 0.67 | 0.33 | 0.33  | 0.67 | 0.67|
| Zhizao.zbj   | Intelligent Manufacturing    | 0.67 | 0.67 | 0.33  | 0.67 | 0.67|
| Ehaier       | E-commerce                  | 0.67 | 0.67 | 0.33  | 0.67 | 0.33|
| Hope         | Technical service           | 0.67 | 0.67 | 0.67  | 0.67 | 0.67|
| Mi.com       | E-commerce                  | 0.33 | 0.67 | 0.33  | 0.67 | 0.67|
| MIUI         | Software development        | 0.67 | 1    | 0.67  | 0.33 | 0.67|
| Apple Store  | Software development        | 0.33 | 0.33 | 0.67  | 0.33 | 0.67|
| Google Play  | Software development        | 1    | 0.67 | 0.33  | 0.67 | 0.67|
| Ali-innovation| Entrepreneur Services      | 0.67 | 0.67 | 0.67  | 0.67 | 0.67|
| Bio4P        | Entrepreneur Services       | 0.67 | 0.67 | 0.67  | 0.33 | 0.67|
| Transfar     | Logistics service           | 0.67 | 0.67 | 0.67  | 0.67 | 0.67|
| Daojia.jd    | Logistics service           | 0.67 | 0.33 | 0.33  | 0.67 | 0.67|
| Izhongchou   | Crowdfunding services       | 0.67 | 0.67 | 0.33  | 0.67 | 0.67|
| Demohour     | Crowdfunding services       | 0.67 | 0.67 | 0.67  | 0.33 | 0.67|
| Moocollege   | Internet education          | 0.33 | 0.33 | 0.67  | 0   | 0   |
| Genshuixue   | Internet education          | 0.67 | 0.33 | 0.33  | 0.67 | 0.67|

### TABLE 4

Necessity Test of the Influence Condition of Platform Performance

#### Analysis of Necessary Conditions
Outcome variable: PP

| Conditions tested: | Consistency | Coverage |
|--------------------|-------------|----------|
| sso                | 0.897160    | 0.921198 |
| ~sso               | 0.482732    | 0.921198 |
| dso                | 0.794321    | 0.837379 |
| ~dso               | 0.560246    | 0.844907 |
| kc                 | 0.742134    | 0.878292 |
| ~kc                | 0.637759    | 0.831832 |
| dv                 | 0.818112    | 0.863857 |
| ~dv                | 0.561780    | 0.845266 |
### TABLE 5
The Results of fsQCA

| Variable                        | Platform Performance (PP) |
|---------------------------------|----------------------------|
|                                 | Path 1                    | Path 2 |
| Supply-side Openness (SSO)      | ●                         | ●     |
| Demand-side Openness (DSO)      | ●                         | ☒     |
| Demand Diversity (DD)           | ●                         |       |
| Knowledge Complexity (KC)       |                           | ●     |
| consistency                     | 0.905444                  | 0.906279 |
| raw coverage                    | 0.485034                  | 0.742133 |
| unique coverage                 | 0.104375                  | 0.361474 |
| overall solution coverage       | 0.846508                  |        |
| overall solution consistency    | 0.916874                  |        |

● Core condition present ☒ Core condition absent ● Peripheral conditions present ☐ Peripheral conditions absent

### Table 6
Comparison of prior studies on platform attributes

| Platform attributes | Transaction attribute of platform | Innovation attribute of platform | transaction and innovation attributes of platform |
|---------------------|----------------------------------|---------------------------------|--------------------------------------------------|
| Representative literatures | Boudreau (2012) Casadesus and Halaburda (2014) | Cenamor et al. (2013) Natalicchio et al. (2017) | This study |
| Openness focus | Supply-side openness | Demand-side openness | Supply-side and demand-side openness |
| Performance | Mixed findings | Mixed findings | Depend on the context |
| Contextual variables | None | None | Knowledge complexity Demand diversity |
| Strategy implication | Warnings of competitive crowding lead by increased supply-side openness | Warnings of declining user identity due to increased demand-side openness | Differentiate the dimension of platform openness; Select the openness according to the platform characteristics |

Closed or open platform? The nature of platform and a qualitative comparative analysis of the performance effect of platform openness
**Highlights**

1. Internet Platform enterprises have the ambidextrous attributes of transaction and innovation.

2. This study elaborates the concept of platform openness into supply-side openness and demand-side openness with a thinking that platform is an architecture connecting suppliers and users.

3. Demand diversity and knowledge complexity as the contextual variables influence the relationship between platform openness and performance.