Generic or Specialized? Dependence Asymmetry and PFI -- A Case Study of iPhone Innovation Ecosystem

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Abstract. This paper integrates the of Resource Dependence Theory and Profit from Innovation to explicate the determinants of how innovation profit distributed between focal firm and the complementary firms. The types of the complementary firms are divided into four new type--positive dependence, negative dependence, interdependence, limited dependence, according to the symmetry and strength between focal firms and complementary firms. The case study of iPhone ecosystem helps us figure out and reorganize the relationship between the dominant design, the appropriability mechanism and the complementary assets. As a result, in the industries which is in the post dominant paradigm era, the generic complementary enterprises with strong appropriability will evolve as a bottleneck of the ecosystem, therefor the generic firm will appropriate additional profit from other actors in the ecosystem.

Keywords: Innovation ecosystem; appropriability mechanism; dependence.

1. Introduction

In recent years, with the rapid development and wide application of Big Data, mobile web, etc., the boundaries between industries have become increasingly blurred, and innovation activities are no longer limited within enterprises or industries. Many innovative entities have continuously gathered innovative resources through the connection of open platforms. The innovative network with complementary assets makes the core enterprises or platforms more valuable[1]. At the same time,it also promotes platform providers to accelerate the transformation to an innovation ecosystem[2]. Innovation ecosystem makes resource integration a core practice activity for all the paticipated actors. In the process of enterprise practice, some innovative companies can achieve huge profits by connecting with core enterprises, while some innovative enterprises have not. So what kind of enterprises can obtain innovation profits? In the context of innovation ecosystem, the source of competitive advantage is no longer limited within the enterprise, but also depends on the vitality of the ecosystem in which it operates, as well as the ability to obtain complementary resources from the system. On the one hand, it is difficult for any sigle company to grasp all the elements and resources of the whole industry and full value chain, and all the enterprises need partners to provide complementary resources for them, so as to complete innovation activities [3]. On the other hand, the technology complexity and the market turbulence have also made the interaction between actors of the innovation ecosystem more frequent and deeper, therefore the interdependence has also become enhanced[4]. Although research on innovation ecosystem has attracted both academic and practical attention, existing research has focused only on the role of complementary resources in the process of value creation, while ignoring how the values created by system members should be distributed. This paper will reveal the mechanism of the dependence of participants on the profit distribution mechanism in the context of ecosystem.

2. Literature Review

2.1 Profiting from Innovation

Teece[5] puts forward Profiting from innovation theory to explain the distribution of innovation profits among innovators, imitators and complementary enterprises. Teece builds a theoretical framework centered on regimes of appropriability, complementary assets and dominant design, to

explain the strategies that focal firms should adopt to prevent innovation profits from being acquired by imitators and complementary companies.

2.1.1 Complementary Assets

Teece defines complementary assets as the resources or capabilities that an enterprise must possess in order to obtain the economic benefits of innovation[5]. On the basis of this research, some scholars have further extended the definition of complementary assets. For example, Rothaermel[6] has studied the technological innovation in biopharmaceutical industry, and the results show that product experimentation, marketing and distribution are of complementary among technological innovations process. Hughes and Morton[7] have found that complementary assets should also include intangible assets such as human resources and organizational processes through case studies of innovative applications of their products and services. Taking Schreiner[8]'s definition of complementarity, this paper defines complementary assets as resource which has no overlap with the market offerings of other enterprises, and the lack of either party the innovation will not be achieved. Based on the relationship between complementary assets and innovation, Teece divides complementary assets into generic assets, specialized assets, and co-specialized assets. Among them, the generic assets are used for generics, and do not need to be tailored for innovative activities. specialized assets are essential for completing innovative activities and are unilaterally dependent assets.

2.1.2 Regimes of Appropriability

In 1986, Teece proposed that regimes of appropriability, dominant design and complementary assets are the three main factors that determine the distribution of innovation value among innovators, imitators, and complementary firms. The regimes of appropriability mechanism mainly refers to whether the environment in which the enterprise is located can provide enough support and protection for innovation, such as the intellectual property system. When the regimes of appropriability is weak, enterprises cannot effectively protect the innovation. At this time, in order to obtain the benefits of innovation, it is necessary to control and utilize complementary assets. The application of generic complementary assets in the same industry has a higher homogenization, and it can be used for other companies as well. Therefore, the dependence between each other is also weak. While the specialized assets are of high complementarity to the focal firm's innovation, also the dependence between them is also higher than the generic firm, the enterprise should internalize the it through acquisition or self-building. As the degree of specialization of enterprises deepens, the importance of specialized complementary assets is increasing. Both focal firm and complementary firms will invest in specialized assets for further considerations, which not only means a commitment to long-term cooperation, but also causes locking effect[9], which also enhances the risk of specialized complementary companies and deepens its dependence on core companies.

2.1.3 The Dominant Design Paradigm

The concept of "dominant design" was first mentioned by Abernathy and Utterback[10]. The emergenceof a dominant paradigm signals scientific maturity and the acceptance of agreed upon "standards" by which what has been referred to as "normal"scientific research can proceed. These "standards"remain in force unless or until the paradigm is overturned. Abernathy and Utterback[10] also pointed out that before the emergence of the dominant design, the competition among enterprises mainly focused on improving product performance. Once the design stage was entered, the competition gradually turned product innovation to process innovation , and focused more on cost control. Teece also mentioned that once a dominant design is formed, competition between firms will shift from product to price. Incumbents may reduce costs through economies of scale and learning, and reduce the uncertainty of product innovation by investing in specialized assets[11]. It can be seen that the formation of the dominant design determines the paradigm of innovation and the sensitivity to cost, which in turn affects the relationship betwee complementary enterprises and focal firms, especially the profit distribution mechanism.

2.2 Resource Dependence Theory

The resource dependence theory mainly describes the dependence of the organization on its environment, and it is believed that organization can adjust itself to adapt to the environment. Organizations could choose to change the environment through various strategic actions to enhance the control of external resources while reducing the dependence on the external environment[12]. The degree to which a company relies on a certain resource depends mainly on two factors: first, the importance of the resource to the organization; second, the degree of substitutability of the resource. Pfeffer[12] pointed out that when an actor cannot fully control all the conditions of an action or possess necessary to obtain an expected result from the action, dependence emerges. Individuals or organizations that control critical resources would obtain power. This leads to the asymmetry of dependence, that is, the interdependence of actors in the binary exchange relationship[13]. The degree of dominance of the actor's power reflects the degree of actor's dependence on another actor. Asymmetric dependence will lead to an imbalance of power and may have a bad effecct on the weaker party[14].

3. Methods

3.1 Theoretical Framework

Teece proposed PFI to explain the distribution of innovation profit between innovators and complementary firms, but the PFI framework ignored the other facet of complementarity—dependence. So, this paper integrates the resource dependence theory and PFI, and the nature of complementary assets are explained in a new way (see Figure 1) “positive dependence, negative dependence, mutual dependence, limited dependence". Among them, the forward-dependent enterprises mean that the complementary enterprises are more dependent on the core enterprises than the core enterprises. The negative-dependent complementary enterprises mean that the complementary enterprises are less dependent on the core enterprises than the core enterprises, and depend on each other. The degree of dependence between the independent enterprises and the core enterprises is similar. The interdependent enterprises refer to the high degree of mutual dependence, and the independent enterprises refer to the low degree of mutual dependence.

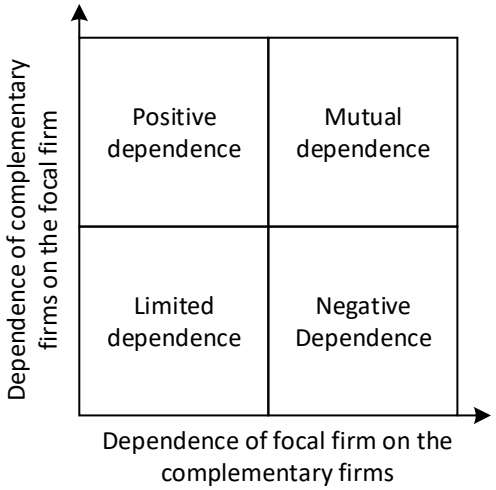

Fig. 1 Types of complementary firms

3.2 Methods

Existing research has not explored how the dependency relationship affects the distribution among partners in innovation ecosystem. This research is mainly based on exploration and explanation, so case study is a more appropriate method[15]. As this paper intends to explore the impact of dependence on the profit distribution. It is a long-term and dynamic process, and should be explored in a vertical perspective as well as focused on a suitable case. Therefore, this paper adopts a single

case. In the knowledge-intensive innovation ecosystem, the specialized division of labor is obvious, and the rate of technological change is relatively fast. As a result, the frequency of interaction between enterprises is higher than that of traditional industries, and the dependence between organizations is more significant. It is suitable to explore the interaction and evolution of innovation ecosystem. This paper takes iPhone ecosystem as the background, and focuses on the two types of complementary enterprises that have asymmetric dependence on Apple. And to figure out how will asymmetric dependence affect the distribution of benefits among system members.

To ensure the reliability and validity, the data was obtained through multiple ways. The main sources of data are first-hand data (telephone interviews) and second-hand data (internal documents, publicly available documents). By classifying and sorting out a large amount of publicly available materials, identifying complementary products provided by each cooperative enterprise, and classifying complementary enterprises into positive dependence, negative dependence, mutual dependence, limited dependence according to the degree of interdependence between focal firm and complementary enterprises.

4. Value Appropriation in iPhone Ecosystem

This article limits the scope of research to an innovation ecosystem with the iPhone as its core product. Since iPhone 4, Apple's mobile phone has not only become the target of global consumers' recognition and pursuit, but also has become the benchmark for the industry to gradually imitate. The smart phone production industry has basically established the dominant design paradigm. Industry innovation activities have gradually evolved from product innovation to process innovation, and Apple has paid more attention to cost control. According to the definitions mentioned above, the complementary enterprises in the system are classified into four types: interdependence, mutual dependence, positive dependence and negative dependence, and select complementary enterprises with typical and representative research.

4.1 Generic Complementary Firms

4.1.1 Negative Dependence

According to the research above, the negative dependence means that the focal firms dependents more on the complementary firms. Qualcomm is Apple's generic complementary company which provides baseband chips for iPhone. As a generic complementary enterprise, the complementary assets provided by Qualcomm have little relation to Apple's innovation, and only provide basic functions for iPhone. So, the innovative profits should flow to Apple. However, Qualcomm has a large number of basic patents in tele-communication industry which other companies cannot avoid if they want to have any innovation in baseband, and Qualcomm adopts a closed patent strategy. It does not license patents to other companies, but collects patent fees instead as its main business model. The monopoly brought high profits to Qualcomm, and it also made it impossible for Apple to develop its own products or find substitutes in a short period of time, which increased Apple's dependence on it. And it also weakened Apple’s bargaining power in cooperation. And innovation profits are flowing to the negative dependence complementary enterprises.

4.1.2 Limited Dependence

As we defined above, companies that depend on each other as enterprises with similar and low level. Among Apple's complementary companies, Corning, as a complementary company of its mobile phone screens, provides complementary assets that are not closely related to innovation, while providing the same type of complementary assets to other companies in the smart phone industry. In addition, Corning's business involved mobile emissions control, telecommunications and life sciences, and is relatively low-reliance on Apple. Apple first tried using glass as a screen material on the iPhone 4 and chosen Corning as its partner. Corning quickly developed Gorilla Glass that meets Apple's requirements, and with this product, it has brought high and stable income to Corning. Previously, Apple once wanted to abandon the glass screen and use the sapphire screen. This news caused

Corning's stock price to fall, and generic companies also depended on the existence of dependencies, but even if they lost Apple's orders, Corning could still provide glass screens for companies including Samsung, Huawei, and Lenovo to make profits.

4.2 Specialized Complementary Firms

4.2.1 Positive Dependence

The positive dependence enterprises mentioned in this paper refer to enterprises that are more dependent on the core enterprises than the core enterprises. Among Apple's complementary companies, GTAT is responsible for supplying sapphire screen to Apple. The sapphire screen is better than glass screen, and is not owned by other competitors in the same industry. It is closely related to Apple's innovation. It is defined here as a dedicated complementary enterprise. Before working with Apple, GTAT did not have the experience of large-scale production of sapphire screen, and the stringent quality requirements imposed by Apple led to a 50% yield rate of sapphire screens produced by GTAT, which made it difficult for GTAT to meet Apple's requirements. In the end, Apple did not use GTAT's sapphire glass, which caused GTAT to be hit hard and filed for bankruptcy. Apple's exclusive treaty provisions have also increased GTAT's dependence on Apple, making GTAT must bear greater operational risks. In the end, the cooperation between the two companies was not reached, which led to the bankruptcy of GTAT and suffered huge losses.

4.2.2 Mutual Dependence

The mutual dependence enterprises defined in this paper refer to both the complementary enterprises and the core enterprises have a high degree of dependence on each other. In Apple's complementary company, Imagination Technologies company is a complementary company that provides graphics processing chips to Apple. The long-term, stable partnerships with Apple that have brought lasting and stable profits to Imagination Technologies. However, there are alternatives to GPU architecture design. In addition, with the development of AI technology and the wide application of VR and AR, the performance of GPU has gradually become one of the important ways for smartphone products to enhance user experience and gain competitive advantage. Apple has also accelerated the GPU self-research process and announced its this news in 2017. As soon as the news came out, Imagination Technologies' share price followed in half. In this case, Apple has improved the substitutability of complementary assets by learning the Imagination Technologies GPU chip technology and its strong R&D capabilities, thereby reducing the dependence of core enterprises, which also making innovation profits flow to core enterprises.

4.3 Summary

Compared with the generic complementary enterprises, the complementary assets provided by the specialized complementary enterprises are vital to the core enterprise's product innovation, and the application scope is inevitably relatively narrow, which leads to high dependence of the specialized complementary enterprises on the focal firms. Its ability to acquire innovative profits would also be weak. Therefore, specialized complementary enterprises should improve their innovation ability, reduce the substitutability, and increase the exclusiveness of resources through intellectual property and other means, thereby reducing the unilateral dependence of the core enterprise.

5. Conclusion

This study focuses on the factors which affect the distribution of interests among members in innovation ecosystem. It integrates resource dependence theory with PFI. And based on the strength and symmetry of the dependence between complementary enterprise and core enterprise, we put forward a new type to divide the complementary firms into four types, positive-dependent, negative-dependent, mutual dependent and limited dependent. Furthermore, the mechanism of the appropriability mechanism, the dominant design, and the complementary assets to the dependencies is clarified. In the industries where the dominant design has been formed, the innovation activities

are mainly process innovation, the enterprises pay more attention to the control of costs, and the core enterprises will also consciously adjust the profit distribution mechanism in the system. The substitutability of complementary assets determines the strength and symmetry of interdependence between enterprises, which in turn affects the bargaining power between firms. And the appropriability mechanism reduces the substitutability of complementary assets and enhances the power. At the same time, generic complementary enterprises have a wide range of technology applications, and the ability to innovate is also in a dominant position, further magnifying the power advantage, making the core enterprises more dependent on them, and thus gaining most of the systems. innovative profit. For specialized complementary enterprises, limited by their technical application scope, the enterprise is usually small and has strong dependence on core enterprises. When the appropriability mechanism is weak, the power of specialized assets will be weakened, thereby enhancing the degree of dependence on core enterprises, which makes specialized complementary enterprises in a disadvantageous position. Through the above research, it is found that both the specialized complementary enterprise and the generic complementary enterprise may become the bottleneck. Once the generic complementary enterprise becomes the bottleneck of system innovation, it will have a huge impact on the system members' innovation profits.

As a case study, the limitation of this paper is to explore mechanism of profit distribution only through the case of Apple. Due to the limitations of the case materials, whether this paper is suitable for other types of innovation ecosystems still needs further research. Secondly, this paper only qualitatively analyzes the relationship between dependence and benefit distribution. Subsequent research can verify the viewpoint of this paper through quantitative analysis. In addition, future research can also reveal the impact of substitutability on dependencies through quantitative analysis.

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