A Comparison Study on the Vertical Integration and Horizontal Specialization of Chinese ICT Companies

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Abstract

The debate between vertical integration vs. horizontal specialization appears to be reinvigorated. The decision of vertical integration or horizontal specialization affects a firm's profit and competitive advantage, especially in the ICT industry which is difficult to create added value due to the commoditization of digital products. The ongoing commoditization of smartphone brings the rising of Chinese ICT companies but these companies adopt different strategies/operation systems to create their own competitive advantages. In this paper, we focus on top-shared Chinese ICT companies in global smartphone industry, Huawei and Xiaomi, to examine how they design their operation systems in R&D and gain competitive advantages, also to compare their systems with each other. The patent information of these two companies is used to visualize their technical orientations and operation systems in R&D by text mining.

Keywords: patent analysis, social network analysis, Chinese ICT companies, the boundary of the firm, vertical integration, h orizontal specialization

1. Introduction

No doubt smartphone has replaced feature phone to become the core device in electronics industry now. Since iPhone was launched at 2007, the global smartphone market has been changed rapidly. Recently, Chinese ICT companies are on the rise in the global smartphone market and they almost occupy the global top ten besides Samsung and Apple.

Although the open source of Android caused the rising of Chinese ICT companies, they do not simply adopt the cost leadership strategy. For example, Xiaomi is an internet startup with short company history, and its rapid growth tells a story that it may grow up by outsourcing. On the other hand, Huawei has been the giant smartphone firm with long history, and it is also one of the innovative Chinese firms that have top class filings of patents.

However, how Chinese ICT companies adopt different strategies, even the operation systems? It seems that Chinese ICT companies, like Xiaomi and Huawei, develop their operation systems by either make or buy. Actually, the decision of make or buy, in other words, vertical integration or horizontal specialization affects a firm's profit and competitive advantage. The debate between vertical integration vs. horizontal specialization appears to be reinvigorated especially in the ICT industry which is difficult to create added value due to the commoditization of digital products.

In this paper, we focus on top-shared Chinese ICT companies in global smartphone industry, Xiaomi and Huawei, to examine how they design their operation systems in R&D and gain competitive advantages, also to compare their systems with each other. The patent information of these two companies is used to visualize their technical orientations, R&D networks and operation systems in R&D by text mining.

2. Research Background

2.1 *Open innovation and patent analysis*

Companies comprise various activities. In order to carry out their activities, companies inevitably cooperate with other companies to use external resources. At the same time, companies face the issue of what to outsource from other companies and how to manage their own systems while cooperating with other companies. The decision making of what and how to outsource from others refers to the issue of boundary of the firm. The issue of make or buy in the vertical flow of production is the typical issue in the boundary of the firm.

In fact, the boundary of the firm is an important issue in not only production, but also in R&D. Theoretically, much attention has been drawing to using external resource to drive innovation, which is defined as open innovation. Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. This paradigm assumes that companies can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology [1]. Horizontal specialization oriented companies tend to outsource and cooperate with other companies, hence benefit from open innovation in R&D.

And the boundary of the firm in R&D also concerns the national innovation system. The national innovation system is the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies [2].

Patent documents are an ample source of technical and commercial knowledge. The patent is one of the indicators of capacity for technological development. There are some researches aimed at visualizing and analyzing patents, or proposing efficient text-mining approaches for creating patent maps. However, there are few researches focusing on R&D management strategies based on text-mining analysis of patents. Therefore, this paper describes the features of Chinese ICT companies' R&D management based on the patent analysis.

2.2 *The overview of Chinese ICT companies*

The global market share of smartphone out of analyst firm IDC shows a major shakeup in the Chinese smartphone market from 2013 Q1 to 2015 Q4. According to Figure 1, 3 Chinese ICT companies of Huawei, Xiaomi and Lenovo occupied the top 3rd-5th share in the global market. Huawei has made a breakthrough in global market share, following Samsung and Apple, but Xiaomi is stalling from the end of 2014.

Xiaomi (Xiaomi Technology Co., Ltd) founded in 2010 by a well-known angel investor Lei Jun, and achieved impressive growth soon after its existence. Xiaomi is a mobile internet company and focuses its businesses on smartphones (Xiaomi Phones), including the OS of MIUI, MiTalk, the e-commerce platform of XIaomi.com, MiBox etc. On the other hand, Huawei (Huawei Technologies Co. Ltd.) was founded in 1987, and started its business by producing private branch exchange switches. Now the company has become one of the top telecommunications equipment suppliers and has active R&D activities since its start. Its businesses comprise mobile and fixed broadband networks, smartphones, tablet computers etc.

Figure 2 shows that while Huawei stably maintains high ROE, Xiaomi explosively expanded ROE in 2013 and 2014, but has declined since then.

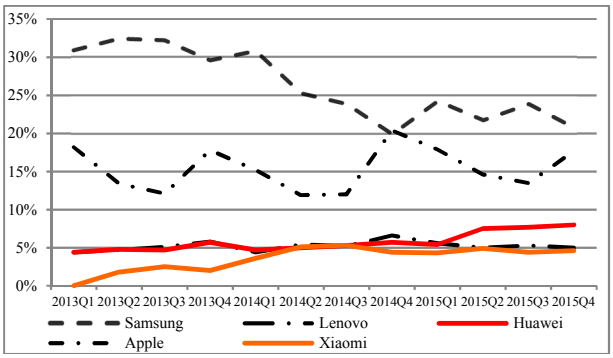

Figure 1 Global market share by vendors

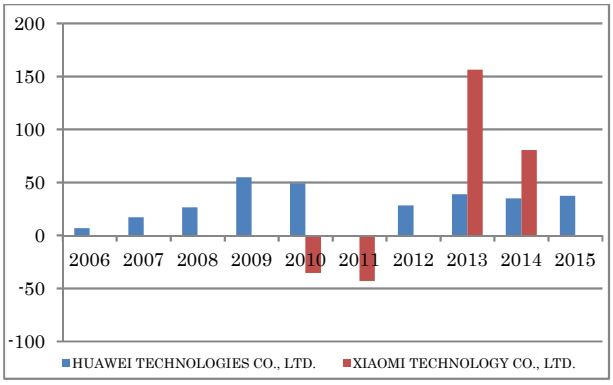

Figure 2 ROE of Huawei and Xiaomi

3. Methodology and data

In the following sections, the R&D strategies/operation systems of Chinese ITC companies are analyzed. In order to examine target companies' R&D strategies and the change of core researchers in their R&D projects, we visualize their patent information in 3 steps: the number calculation of patent publications, text mining, and social network analysis.

We use the IPC (International Patent Classification) code for analyzing the smartphone industry. IPC, established by the Strasbourg Agreement 1971, provides for a hierarchical system of language independent symbols for the classification of patents and utility models according to the different areas of technology to which they pertain.

Table 1 is most frequently used IPC in smartphone industry. Based on these IPC related to smartphone, patents related to smartphone published by each company are extracted and collected from the patent information.

Table1 IPC classes of smartphone

IPC	Description
H01, H02	Electricity: Battery or Capacitor Charging or Discharging
H03, H04	Coded Data Generation or Conversion
G02	Liquid Crystal Cells, Elements and Systems
H02, F21	Electricity: Electrical Systems and Devices
H04,G01, G06, G08	Multiplex Communications
H03, H04	Pulse or Digital Communications
H04	Telephonic Communications
G02, H04	Optical Communications
H04	Telecommunications
G06, G10	Data Processing: Speech Signal Processing, Linguistics, Language Translation, and Audio Compression/Decompression
G06	Data Processing: Artificial Intelligence
G06	Data Processing: Database and File Management or Data Structures
G06	Data Processing: Presentation Processing of Document, Operator Interface Processing, and Screen Saver Display Processing
G06	Interprogram Communication or Interprocess Communication (IPC) (Electrical Computers and Digital Processing Systems)

4. Analysis

4.1 *An approach based on the number of patent publications*

As our first approach, the numbers of patent publications associated with ICT in each of the companies are shown in Figure 3. Every company obtains related patents to a certain extent and the number of patents of all of them kept on increasing during the years except for 2016.

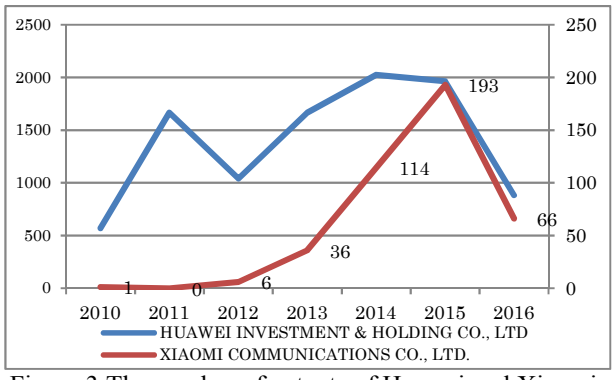

Figure 3 The number of patents of Huawei and Xiaomi

4.2 *An approach by correspondence analysis*

We use the correspondence analysis based on text mining to disclose the technical trends and features by IPC codes associated with smartphone. The reference data in the analysis is the numbers of each their patent document in each year. These figures are based on dates of patent publication, and patents are applied to products in the companies. Figure 4 shows that Xiaomi probably develops different technologies in each year,

and Huawei tends to constantly develop technologies that highly related.

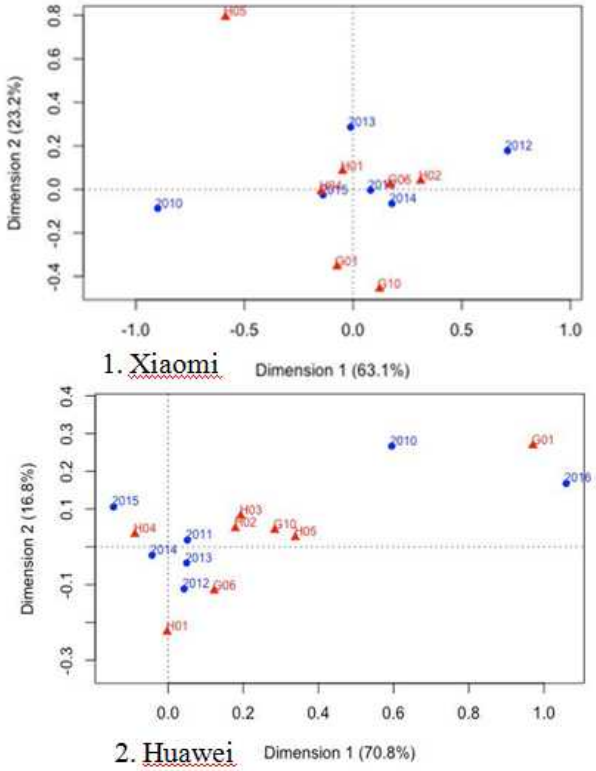

Figure 4 Results of correspondence analysis

4.3 *An approach by the social network analysis*

4.3.1. R&D network Figure 5 is the R&D networks of Xiaomi and Huawei. The results show that Xiaomi and Huawei have different R&D patterns. In Xiaomi's case, several islands that connected only to related patents are observed. It seems there is little relationship between technologies. On the other hand, the technology network of Huawei concentrated on several core patents and technologies are expanded based on these core patents.

Figure 5 R&D Networks of Xiaomi and Huawei

4.3.2. *The evaluation of core rigidity in R&D*

We define that patent applicants are key persons attaining high scores calculated by centrality of social network analysis. Centrality is a well-known index in this field. Freeman proposed three distinct conceptions of centrality: degree, betweenness and closeness [3]. And, it indicates that conditional probability appears where whether or not upper rank *j*% of person at *i* year appears upper rank *j*% of person at *i*+1 year. When such probability scores are high, they have core rigidity [4].

$$\text{Core Rigidity} = \text{Conditional Probability}\left(\frac{\text{upper rank j\% of person at i + 1 year}}{\text{upper rank j\% of person at i year}}\right)$$

We visualize the human resource reallocation of personnel engaged in R&D project by heat-map. Where the color is dark red in heat-map, it indicates an un-executed reallocation of a core engineer; otherwise, the color is light red, it means a radical change of core member in that year. As one of the example, the core rigidity of human resource and the change of R&D area the personnel involved in Xiaomi and Huawei are shown in Figure 6. There is more change in Xiaomi's core rigidity degree than change in Huawei. This is because Xiaomi must obtain to new patent for entering new market such as U.S. and Huawei has been exploiting research and develop for long time.

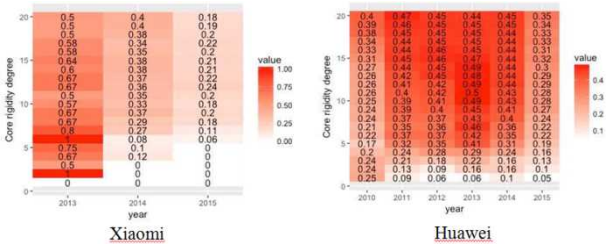

Figure 6 The core rigidity of Xiaomi and Huawei

5. Conclusions

This paper focused on Xiaomi and Huawei, the two major Chinese ICT companies to examine how they design their strategy/operation systems in R&D. Patent data were used to investigate Xiaomi's and Huawei's technology strategies and technical networks. Analysis includes: (1) the number of patent publications, (2) technological orientations, (3) R&D networks, (4) degree of core rigidity of R&D.

From the analysis of R&D network of Xiaomi, we supposed that it probably acquires external related patents rather than develops its own technologies inside the firm. Actually, Xiaomi did buy patents from other companies, for instance, Microsoft. In addition, in the degree of core rigidity of R&D, Xiaomi has rough R&D organization structures and hence has low level of integration. In fact, Xiaomi has few manufacturing facilities of its own, instead it outsource all production to contract manufactures such as Taiwan's Foxconn. And they also have not much invested R&D. Xiaomi's problem for new market entry is a lack of patent holdings and faces intellectual property-related lawsuits. And Xiaomi have tried to apply new patent recently. But Xiaomi's patent portfolio is still thin.

On the other hand, Huawei has high weight on internal R&D, and explores technologies related to core technologies. The heat map of core rigidity of Huawei shows that its R&D structure is more highly integrated than Xiaomi. Huawei is increasing its emphasis on R&D to become more innovative as a foundation for surviving in a highly competitive and rapidly consolidating industry. Being able to continuously and successfully innovate through vertical integration, Huawei is trying to do what can create a competitive advantage.

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