Research on the Relationship of Tie Modality of Interfirm Network and Technological Innovation

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Abstract: The paper employs a case to explore and explain the relative propositions of tie modality of interfirm network and different technological innovation. The impact of different network tie strengths on exploratory and exploitative innovation success is analyzed in detail. A key point is that strong ties are valuable in environments that require exploitation, while weak ties would be more appropriate for exploration. Therefore, the benefits of each type of firm tie not only vary across each other but will be moderated by market uncertainty such that certain types of ties will matter more or less under certain conditions. The paper claims that exploration and exploitation are two essential innovative models, under which firms need make a reasonable choice between them according the development stage, market environment and innovative targets.

Key-Words: Tie strengths, interfirm networks, exploratory innovation, exploitative innovation

1 Introduction

There is a rapidly expanding body of theoretical and empirical literature showing that interfirm network ties constitute a valuable means for integrating complementary resources into a firm's innovation processes, thereby significantly increasing a firm's innovation success. However, research has produced contradictory and confusing implications regarding how firms should be tied to one another in networks [1]. Depending on a firm's innovation targets, internal resources and its external context, different external resources are needed. We assume that different types of ties are particularly appropriate to contributing specific kinds of resources and know-how [2].

In this paper, we propose that network ties are not uniform in their effects on firm innovation, but rather vary across different types of network ties a firm has developed as well as the environment uncertainty. Together, these two dimensions, network tie strengths and market uncertainty, form the basis of our exploration into the contingent value of interfirm relationships for firm innovation. We focus on two types of tie strengths: strong ties and weak ties, and two types of innovation: exploration and exploitation. And we focus on market uncertainty as a moderator of network effects.

2 Theory Review

2.1 Exploitative Vs. Explorative Innovation

Technological innovation could be divided into exploratory innovation and exploitative innovative based on enterprise existing knowledge and different technology trajectory [3] [4]. Exploration and exploitation have been characterized as fundamentally different search modes [5]. While exploitation involves local search that builds on a firm's existing technological capabilities, exploration involves more distant search for new capabilities. Exploitative innovations involve improvements in existing components and architectures and build on the existing technological trajectory, whereas exploratory innovation involves a shift to a different technological trajectory. Empirical literature reflects this dichotomy, often distinguishing between innovations that leverage a firm's existing knowledge and innovations that rely on no previous firm knowledge.

An assumption is that truly exploratory, variance-increasing activities require distant search and a departure from a focal firm's store of current skills and capabilities. The idea of exploration as distant search can be extended by characterizing an organization's innovative activity along a continuum, measured by the extent to which it is anchored in knowledge used in a firm's previous innovations. Innovation is increasingly exploratory the more it departs from knowledge used in prior innovation
efforts and, conversely, increasingly exploitative the more deeply anchored it is in existing firm knowledge.

2.2 Strong Ties Versus Weak Ties
Much of the early research on tie strengths draws on Granovetter’s (1973) [6] conceptualization of ties with a focus on information flows among individuals. The crux of his theory is that strong ties among individuals facilitate information flows but such individuals are likely to possess highly redundant information. In contrast, individuals with weak ties will likely possess more diverse information (increasing the likelihood of finding novel ideas), but the weakness of their ties increases the difficulty of information flow among them. Thus weak ties have a greater potential for generating novel solutions but lack the characteristics to realize that potential.

Rangan (2000) [7] conceptualized a tie between organizations as an information bridge between them. Information is transferred over this bridge between the parties. Both strong and weak ties have different roles with information transfers. Both of them benefit innovation differently. The strong tie benefits innovation with the transfers of complex information. This kind of information is often uncertainty, unclear and difficult to understand without processing. However, it carries great insights that are particularly useful to innovation. To transfer complex information, much effort is required in the transfer processes. The strong tie eases transfer processes by encouraging parties to spend time and have close communications. However, the strong tie carries undesirable effects. Partners may end-up locked-in among themselves and lock-out new partners who potentially bring in novelties. The results bring a lack of new information and potentially hindering innovation. Here is where the weak tie helps innovation. The weak tie benefits innovation with the transfers of simple information. This kind of information captures a limited content.

However, it does not take much effort to transfer simple information. The information is largely context independent and highly portable [8]. Unlike the complex information in the strong tie, a breadth of information is carried by the weak tie. Salman and Saives (2005) [9] argued an organization requires a number of weak ties to fully benefit innovation because innovation benefits from a variety of information.

2.3 Market Uncertainty
We argue that the environmental uncertainty is useful for understanding the conditions under which strong and weak ties are advantageous. Uncertainty also challenges managers by making it difficult for them to predict the future. We focus on market uncertainty, the extent to which the industry environment is volatile and fast changing, because it creates greater uncertainty about the actions of other economic actors, such as customers, competitors, suppliers, and regulators [10].

When the market uncertainty is high, firms are required development new product to sustain their competitive advantages, so exploring new knowledge is more important than exploiting existing knowledge. Rather, when the market uncertainty is low, firms can enhance their product quality or reduce the cost to win the competition, in the situation, exploiting existing knowledge is more important.

Moreover, one of the implications of Afuah’s (2000) [11] study of alliances among computer workstation manufacturers is that a firm operation in a turbulent environment (rapid technological change and obsolescence) should not invest all of is alliance resources in strong ties to a small set of suppliers and horizontal partners. A technological shock could dramatically impede its competitive advantage, because it is overcommitted to the strategic position established through its close partners. Thus, firms need to allocate resources to maintaining at least weak relationships with alternative partners, who represent options for dealing with environmental shocks. Overall, the relationship between tie strengths and firm performance depends on whether the environment demands a relatively high degree of exploitation or exploration.

3 Methods
It is beneficial to use the case study to generate theory that is both relevant and practically useful (Yin, 1981) [12]. Haitian Plastic Injection Molding Machinery (hereinafter be abbreviated PIMM) Group Ltd., a Chinese enterprise, was established in 1966. After 42 years’ development, Haitian has become a national-large scaled enterprise. With a covered area of more than 566 thousand sq meters and more than 3,000 staff, Haitian Group is nowadays the largest production base of plastic machinery in the world. The case-study methodology is appropriate because it allows us to study the rationale and process of network configuration by which Haitian may evolve from being a small collective firm to a fully
integrated producer of advanced technology products.

Data on Haitian were gathered from both archival sources and interviews. Interviews were conducted over a 2-months period with managers and engineers in Haitian, practitioners and experts in China’s PIMM industry. Anchored in archival data on the firm’s development since its founding, semi-structured interviews focused on characteristics of the market and competitive environment facing Haitian, product development, R&D activities, tie strengths and strategic response to changes in its environment.

4 A Case Study
The following is the empirical research on the dynamic changing between network tie strengths and innovative patterns of Haitian Group.

4.1 The first stage (1966-1989): High market uncertainty, weak ties, and exploratory innovation.

1) Market uncertainty: China is on the initial stage of market reform during the 1980s, so the PIMM sales in were small and seldom leading multinational PIMM manufacturers entered into the market. Therefore, the market uncertainty is relatively high. However, Haitian is located in Ningbo city, a coastal port and developed region in East of China, the plastic products are in strong demand which give Haitian a chance to produce low-end products, such as small injection molding machinery.

2) Tie strengths: At that time, there were only a few state-owned enterprises producing PIMM, and only Beijing University of Chemical Technology and Shanghai Light Group research institutes were working on this technology. Considering the lack of necessary talents, from 1976, on one hand, Haitian cooperated with the technical personnel from state-owned enterprises as well as the experts from research institutes at personal level. On the other hand, Selected staff of Haitian were sent to study in state-owned enterprises, learning the advanced technology and management knowledge, and Haitian got most blueprints and related materials from them. Rely on the support of them, Haitian has acquired the basic technology of PIMM and trained its own technical personnel under their help. Due to these weak ties, Haitian technology capability stepped into a new level and the factory formed a good trend of rapid development and steady progress.

3) Innovation mode: Exploratory innovation is the dominated innovative pattern during this period. Through the corporation with the state-owned enterprises and the research institutions, Haitian not only accumulated the necessary capital, but also learned how to manufacture and how to build the marketing channel. Through these activities, Haitian also began to build up its understanding of its Chinese customers and their PIMM purchasing habits.

By the end of this initial period, Haitian had made significant progress in creating its national manufacturing network that was a scarce and competitively valuable resource, especially at this early stage of China’s market transition. The successful development of the 750 gram PIMM in the stage indicated that Haitian has entered into the large PIMM industry.

4.2 The second stage (1990-2000): Low market uncertainty, strong ties, and exploitative innovation

1) Market uncertainty: With the rise of the household appliance industry in China, the market requires higher performance of PIMM. Along with the development of China's economy and the expansive demand of plastics processing equipment, more and more international PIMM Giants came to invest in China and formed the plastics machinery industry cluster in Guangdong and Zhejiang. The manufacturing in Ningbo city and "the Yangtze River Delta" area is well developed, especially the manufacture of mechanical and electrical equipment, household appliances, automobile parts, packaging materials, sporting goods, household plastics goods and emerging telecommunications and IT industries. This region has become the largest consumer market of plastics machinery, accounting for 30%-35%, and the PIMM industry in Ningbo has provided a powerful support for this large consumption. The absorptive advantages of the downstream plastic consumer market has promoted the rapid development of PIMM industry, and thereby formed a complete industrial chain with the injection Plastics Machinery industry. So, PIMM market uncertainty is relative low.

2) Tie strengths: During this period, technology in many domestic PIMM manufacturers still can not satisfy the needs of home appliances enterprises. As a result, many domestic PIMM manufacturers desiderated to attain the necessary technology from the multinational companies through some ties.
For Haitian, to settle the problem of capital, it imported the investment from Hong Kong Ningxing Corporation to establish a joint venture in 1991, which is the birth of Haitian Group Ltd. In order to enhance the technology capability and acquire more advanced technology, Haitian established a joint venture Congtian Corporation with Taiwan Congwei Corporation in 1992. The establishment of the joint-venture has provided a good technology learning platform for Haitian. In 1992, Haitian successfully developed HTF2500 and began the production of large PIMM. Inspired by these successful cases, Haitian cooperated with DEMAG (a corporation in Germany) to establish a joint venture, DEMAG-Haitian corporation, in the same year and take a positive learning technology strategy. During the process of joint venture, Haitian made some creative improvement of the PIMM based on the domestic market demand and technical feasibility. In 1998, they cooperated to develop the full hydraulic PIMM, which indicated that Haitian's technology had reached the mid-1990s level. We found that strong ties (i.e., joint venture) are more important in the stage.  

3) Innovation mode: At the same time, Haitian mainly adopted exploitative innovation pattern via technological cooperation with multinational companies. Even while producing its own brand, Haitian continued to production with DEMAG. In addition to solidifying Haitian’s position as the dominant PIMM manufacturer in China, it also provided Haitian with the opportunity to closely scrutinize foreign product designs and customer responses.

4.3 The third stage (2001-now): Moderate market uncertainty, strong and weak ties, exploratory and exploitative innovation.

1) Market uncertainty: After stepping into 2001, all of the major multinationals are establishing more of their operations in China, either through joint ventures or, more recently, wholly-owned subsidiaries. So, the competitive intensity is more drastic than the previous two stages. At the same time, the market in China is more and more regular. Together, the market uncertainty is moderate than before.

2) Tie strengths: In the stage, strong and weak ties are important equally. In the face of decreasing advantages to domestic firms and increasing competition from foreign competitors, Haitian developed a large-scale and low-cost manufacturing capability to ensure its cost-competitiveness in the face of the foreign and domestic competition that was intensifying during this period.

First, Haitian turned to strengthen the technical cooperation with university, carry out creative research study and changed to in-house R&D. Since it has gained the advantage of backwardness but yet was hard to get more advanced technology abroad. For example, the "Haitian Plastics Machinery Engineering Technology Research Center", established in 1998, was elected provincial level in 2000 and national level in 2005; and the "Haitian Beihua Institute" was established with Beijing Chemical Industry University in 2004. Meanwhile, Haitian positively exported products oversea and promoted the product development and upgraded the innovative capability through building weak ties with relative industry association.

Second, Haitian had direct contact with its important customers such as Haier, Hisense, TCL, CHINT GROUP etc., and other distributors. In addition to observing customer buying habits and choices, Haitian also actively sought out customer input to help guide its product development activities. Suppliers also are the other strong ties. Haitian acquired leading production technology from its extensive imports of manufacturing equipment, along with extensive training by its suppliers.

3) Innovation mode: Exploratory and exploitative innovation exists simultaneously in this period.

On one hand, Haitian research new products with some universities. In order to become the leading global company, Haitian begins to think about how to take advantage of the global resources for the leading development. Haitian established Haitian Institute in Germany in 2006, and invited the former CEO in DEMAG to be the vice president of corporate strategy and the president of research center in Germany.

On the other hand, Haitian continuously improves its products through dense contact with its customers and suppliers. The close interaction between the two innovative modes enabled Haitian to implement its two-pronged strategy of low-cost manufacturing and innovative products matching the Chinese market.

5 Discussion

Based on the theory review and the analysis of Haitian, the paper analyzed the suitability of different network configurations for different innovation aims, i.e., exploration and exploitation. Fig. 1 concludes
our frame of reference. Specific hypotheses are developed.

![Diagram](image)

**Fig. 1. Theoretical frame of reference**

Whether Enterprises can effectively carry out exploratory innovation or exploitative innovation depend on the information features provided by the technological innovation network. It is beneficial to exploratory innovation for enterprises if information provided by network is heterogeneity. While the information is similar to the knowledge structure of the enterprise, it is conducive to the deepening and development of existing technology, in turn promoting exploitative innovation.

Hypothesis 1: Strong ties are valuable in environments that require exploitation, while weak ties would be more appropriate for exploration.

Hypothesis 2: The lower levels of market uncertainty, strong ties are more positively related to exploitative innovation.

Hypothesis 3: The higher levels of market uncertainty, weak ties are more positively related to exploratory innovation.

6 Conclusion

In this paper, the impact of strong and weak ties in interfirm network on the pattern of technological innovation in Haitian Group is analyzed using the experience of technology innovation. The main conclusions are such as:

Firstly, Strong or weak ties are characterized by synergistic evolution. The dynamic changes of tie strengths will affect the pattern of technological innovation, and enterprises choose a different pattern of technological innovation also need the corresponding changes of tie strengths.

Secondly, from a single project, firm needs the support of weak ties to conduct exploratory innovation, while exploitative innovation need the firm to construct relative strong ties. From the firm as a whole, exploration and exploitation are two essential innovative models, under which firms need make a reasonable choice between them according the development stage, market environment, innovative objective and industry characteristics, and maintain the number of strong or weak ties at a reasonable proportion.

Additionally, this study is just an exploring research. The model should be empirical test through a large sample in the future.

References:


