

Discussing from The Case of Industrial Vertical Integration, The Innovative Capacity Is to What Extent Affected by The Absorptive Capacity

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ABSTRACT

Development of third-generation semiconductor—silicon carbide—has been a hotpot, catching the attention from worldwide scholars, meanwhile, the Sanan Optoelectronics as leading Chinese enterprise made a series of technological breakthroughs. This paper will discuss about innovative capacity, which is the one of the standards to gauge the competitive advantage of a tech firm, there are three factors, demand chain, complementary technology and strategic intent will improve firms' absorptive capacity, which is a primary contributor to R&D activities. The vertical integration, as a strategy resorted by Sanan to exploit and consolidate its market position, has interrelationship with those factors and therefore the potential reason to Sanan's success, will be considered further. The research will be conducted by empirical and qualitative study, attempting to find out the cause-effect relationship between critical variables. The strategies for entrant companies to challenge incumbents will be the foremost concern and primal achievement of this research.

Introduction

The development of Semiconductor industry, which is “the foundational technology of 21st century ”said by Rasser(2020), is still laggard in China, and this can be seen as the greatest problem for which decision makers have to consider. It is notable that most of the Chinese SEMI manufacturers engage in assembling instead of designing semi-finished products. The technological dependence will be the following result, and if the geopolitical factors came into effect, taking the Huawei and SMIC as the example, the R&D of some firms will soon be blockaded. Hence, the solutions to the dilemma for challengers in China are needed in order to catch up with those dominant producers in developed countries.

Some of the past studies of how could Chinese firms leapfrog in international competition focus on indigenous innovation (Li&Feng, 2022). Although it is true that the weakness in fundamental technology can be remedied by construction innovation, the explanation isn't suitable for this domain, in which the technological chasm is not that large. Furthermore, the other researches are about acquisition strategies hold by firms — JAC and Haiyin Capital (Sehgal, 2017). While introducing technology is plausible the reason for which the firms gained the designs and exclusive patents from foreign firms, the strategy can't explain why firms can develop new series of products (路风, 2018). This paper, thus, will fill the knowledge gap and shed the light on other methods could be taken to bolster the innovative capacity.

While critical fields such as integrated circuit and lithography machine production is still lagged behind in China, its nonetheless the converse in the industry of third-generation semi-conductor (i.e., the silicon carbide). Although the researching work of wide-band gap materials has been deployed

by the Institute of Physics of the Chinese Academy of Sciences in 1997, the Wolfspeed in the US already commercialized the theory of silicon carbide(SiC) one decade earlier. The advancement of products from two countries are now, however, being equal in spite of a gap in the start point between the two, and the Sanan Optoelectronics, which is authorized as the leading enterprise in the SiC production by public media, can be a case for analysis.

Sanan is one of the most promising SiC manufacturers in China, and it can be proved by its frequent collaboration with influential companies, for instance, TCL, Media and etc. Assuming that the recognition of it from other brands could be the evidence of Sanan’s market achievement, there should be any discussion of how did the firm made it. To this question, some suggest that ESOP (employee stock ownership plan), is the reason for workers’ innovative incentives(杨曙箕, 2021), while the others indicate that the Sanan is encouraged by financial subsidies from government(卢斐璇, 2022). Nevertheless, these are not main organizational factors that push the innovation of Sanan and therefore there’s another strategy should be referred. As Kechuang Lin, the general manager of Sanan said “When competing with international giant, the vertical integration will play a role”(孙燕飏, 2010). It is noticeable that how such a strategy will work and, at some extent, this practice is only applicable in some cases.

The production of SiC can be separate into three main sections; the upstream industry includes substrate, the midstream includes epitaxy and the downstream includes terminal equipment. The upstream, which is the substrate design, is the part with highest appropriability and profitability.

Substrate	Epitaxy	Equipment
CREE(US), ROHM(Japan), STMicroelectronics(Italy)		
Coherent(US), Dow Corning(US)		Infinion(Germany), MELCO(Japan)
		Mitsubishi(Japan), Renesas(Japan), Fuji Electric(Japan), X-Fab(Germany)
Sanan Optoelectronics, SAWINK, HDSC		
Tankeblue, SICC, Synlight Crystal	EPIWORLD, TYSIC	CRCC Times, CSMC, FAIRCHICD, Starpower, BYD
BASIC, 55.CETC, 13.CETC		

Figure1. The silicon carbide industry situation

Each of the part requires trial-and-error to improve on performance, demanding high pressure and power tests, and as a result, the parameter, technique and experience are determinants of whether the new product is accessible. The strategy of vertical integration is particularly important regarding the property of semiconductor production, and absorptive capacity, which is a booster to absorptive capacity, will be garnered as a byproduct from experiments (Cohen&Levinthal, 1990). This paper therefore suggests that there are three organizational factors involved in improvement of innovative capacity: Firstly, the demand of suppliers and buyers communicated in chain of industry, inducing the following innovative activities; Secondly, the complementary technology in production chain promotes the R&D process; Thirdly, the strategic intent encourages business to partake more in innovation.

Literature Review

It is widely defined that innovation is a process that combines science, technology, economics and management, as it is to achieve novelty and extends from the emergence of the idea to its commercialization in the form of production, exchange, consumption (Kogabayev&Maziliauskas, 2017). Organization under competitive market will have to survive from the challenges of rivals in a market, and after that, the dominant position for its product will be obtained. The criteria to judge whether the firm is dynamic or not on R&D activities, is the innovative capacity, meaning that how well the corporation seek for new routines and trajectories of product design, in order to meet with ever changing demands of customers (McGrath, 2001). The absorptive capacity, at the same time, is the variable that decides if the firm had the ability to recognize the value of new, external information, and assimilate it while apply it to commercial ends (Cohen&Levinthal, 1990).

When concerning why would the vertical integration proceeded in a specific industry, it should have to be traced back to the nature of a firm, as what have been proposed by Coase(1937) that, the existence of firms is to reduce the cost of transaction through markets, and their size and scope depends on the extent of which the advantage they offered. Given that vertical integration is such a strategy enhances the function of firms by transforming organization to a successive stages of production or distribution (Gianfreda, 2020), and the combination of suppliers and retailers to one unit. Under the cut-throat competition and arduous operating environment, firms are predisposed to such a process, and also the adopters will be enjoyed with benefits, for instance, market foreclosure can render the integrated firm to engage in below-cost pricing at the wholesale level, avoiding the transaction costs (Reisinger&Tarantino, 2015). To be more specific, the objective is achieved through either M&A (mergers and acquisitions) or self-dependent business extension. The aim of the strategy, after all, is to stabilize the supply and demand chain, to keep track of technological change, and to gain ambition for managers as well as other stake-holders, for the sake of driving further innovation.

Proposition1

Recent research has shown the strong interconnection between demand and innovation, and how the R&D activities have been called forth by heterogenous preferences and needs (Bogliacino&Pianta, 2013). When identifying the wants of buyers, sellers will pull innovation by using any previous and useful knowledge, and thereafter they will invest in the procurement of equipment as well as hiring technicians. Then companies successfully meet the needs of buyers will be motivated by profits and market shares, otherwise they will be phased out by the heavy costs of running their businesses. But it is undisputed that majority of innovation attempts failed because such a process is fraught with uncertainties, which will impinge upon absorptive capacity. As what Rosenberg (1996) indicated that “technologies came into the world in a very primitive condition,” and their appearance is associated with questions about the future usefulness and economic values. As a result, people hardly foresee the potential evolution of a product but the innovative process is filled with risks, for example, if the new design wasn’t fully in accordance with consumers’ demands, the costs of research would be sunk and operational debts probably would not be paid. The fear of failure as well as the inclination to stay on the original product design are best characterized by the innovation resistance (Dibrov, 2015). However, it is important to note that demand has a counter-effort on uncertainty, helping R&D workers to get to know the precise parameter and exact scale (Nelson, 1982), and therefore the demand acted as the signal to delineate researchers a blurred image of what people really need. Furthermore, the order from downstream buyers is the signal of demand to upstream suppliers, and it is feasible that a

chain of supply is also a linkage of conveying demand. While the supply chain relationship can be interpreted as a source of mutually innovative motivations, the ecological and physical uncertainties may threaten the information transmission (Loisel&Elyakime, 2019); the information distortion, which means the retailers predict the ordering quantity according to the actual demand of customers, whereas distributor and manufacturer can only base on their downstream enterprises, so they cannot accurately interpret the demand (Zhang, Fang&Pi, 2019). However, vertical integration could internalize the purchase decision of input, and the demand of goods will be transferred into precise requirements from the corporate decision-makers. In the end, the product will iterate as finished products rather than semi-finished counterparts, and since then integrated firms can acquire the information of demand from customers directly, mitigating the negative effects of uncertainty to absorptive capacity (Arrow, 1975), improving their innovative capacity.

Proposition 2

It is often argued that technological breakthrough is the result of information exploitation, and the success of one tech discovery is normally a serendipity. The ability to evaluate and utilize outside knowledge is largely a function of the level of prior related information (Cohen&Levinthal, 1990), so normally companies will develop the breadth and diversity of their knowledge. While the question of how to acquire the wide range knowledge, as Von Hippel (2007) wrote that “suppliers of innovation-related components and materials are typical sources of innovation.” This can be seen generally that upstream and downstream producers’ technology should have considered the problem of compatibility, so improvement in a single technology will draw the changes on another, and according to Rosenberg (1996), “inventions will often give rise to a search for complementary inventions.” The most innovation occurred in incremental improvement on performance. If any of the side has laid out products with new configuration and, at the same time, the buyers or suppliers would have to respond to such a technical change, unless the competitors will be an alternative to their goods. This is the reason why technology in one supply chain is always complementary (Yang, 2020), and corporations tend to build a collaboration network for sharing information so as to confront any technological variation (Pittaway, Robertson, Munir, Denver&Neely, 2020). Given that absorptive capacity is a byproduct of production (路风, 2018), which is established on the accumulation of experiences, and firms are spurred to conduct R&D because of the occurrence of complementary technology, so as a result, the innovative capacity of a firm is improved. This assertion is particularly true in semiconductor industry, where the frequent trial-and-error on the availability of a product is required. So the SiC products not only need to be repeatedly tested under extreme outer condition, but also have to be checked, whether they can work in coordination with their complementary products. The “technological interdependency” and “technical complementarity” are both the reason for formulating vertical integration (Williamson, 1971), and it is certain that relatedness is the driver for invention, and firms also would intentionally seek for those with similarities to merger (Makri, Hitti&Lane, 2010). The Sanan, for example, didn’t have the technical capability to produce substrates at first, which are most demanding in technological threshold, but they took over indirectly the Norstel in 2016, which is a wafer manufacturer in Sweden, by assistance of Anxin—the involvement of Chinese government. While, Sanan henceforth absorbed the knowledge, and until 2019, they transferred the possession of Norstel to STMicroelectronics, which is the Europe’s leading semiconductor company, because of the international tension. The two companies therefore possessed the ability to design substrate, originating from the same source, and in 2023 they set up a joint venture factory in Chongqing primarily because their technology has intense complementarity. So it is clear that both companies didn’t have the absorptive capacity to substrate in the past, but after their

strategies of vertical integration, as a result, they improved their innovative capacity, diversifying their products.

Proposition3

It can be seen that the overarching purpose of a company can be reified by the concept of strategic intent(SI), which points out companies began with ambitions that were out of all proportion to their resources and capabilities have risen to global leadership (Hamel&Prahalad, 1990). Another word called aspiration level is akin to this concept, because they both indicate to what extent would stakeholders and investors are willing to plan for long-run business development. The firms with more explicit SI are tend to be more rational on allocation of resources(Barnett&Burgelman), and also their management practices are labeled as intuitive, inspirational, and people-oriented (Booth, Segon&O’Shannassy, 2010). These actions, all of the above, are interconnected with performance of companies, meaning that higher productivity and quality are achieved by raising their SI (Mariadoss, Johnson&Martin, 2014). Moreover, there are dichotomous views about whether environmental uncertainties, as variables, are beneficial to SI or not. While Calantone and Rubera(2011) assumed that uncertainties may encourage RD&E(i.e., research, development and engineering) as a group to collaborate, the curvilinear relationship between moderator variables has been confirmed, showing that the environmental uncertainties are negative to SI as a whole(Edwards&Lambert, 2007). Underlying factors can be, for example, transaction costs, contractual frictions, moral hazards and double marginalization problems, all of which might hamper the investment of companies due to people’s risk aversion. Vertical integration, at the same time, can be a solution to problems above, because it is able to buffer enterprises directly from environmental dependence and weaken the competition for integrated firms (Guan&Rehme, 2012; Spengler, 1960; Nagro&Sorenson, 2006). After that, the uncertainties of market are partly offset, and companies can be ambitious on pursuing joint research and product development so as to acquire necessary information, resources and capabilities (Kona&Lewin, 2000), which is meant the absorptive capacity of a firm is therefore improved. The Lightera Corporation, which was the American Packaging company in the midstream industry, and then it has been merged by Sanan in June 2013. The strategic intent of a company is highly confined to its capability (Teece, Pisano&Shuen, 1997), and Sanan speeded up its acquisition strategy after breaking into SiC industry. Since then, Sanan soon merged Formosa Epitaxy 21 days later, which was a substrate design corporation in upstream industry, and built up a joint venture with Yankton in September, which was in downstream industry. This can be a proof to my assertion that as strategic intent promoted by vertical integration, and the companies’innovative capability will be improved as well, which is supported by the recognition from any other competitors and more chances for collaboration.

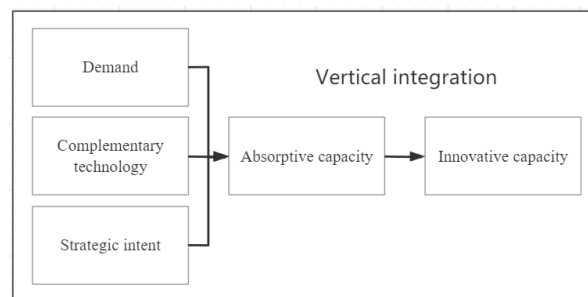


Figure2: Relationship between variables and innovative capacity

Methods

The main research is based on empirical research, which objectively elucidates why and how corporations undergone the vertical integration will benefit from this strategy, and each of the point of view is ground on the case study of Sanan Optoelectronics. This company is highly characteristic and typical to prove how effective the vertical integration is, because as what Kechuang Lin, who is the general manager of San said, “they have been preparing for this strategy ” since 2010. Although there are many other illustrious firms able to produce SiC products, for example, Tankeblue and SICC, the Sanan is the few that has the whole production line for SiC products. At the same time, the method used to conduct the research is mainly qualitative, while it seems to me that many studies relevant to Sanan are done by quantitative methods, including statistics and linear regression to confirm the cause-effect relationship. However, the case will be analyzed in the following paragraph could be neither quantified to a value, nor conceptualized to a single variable. Every decision made by executives of Sanan is interrelated with other events but, at least, the cases I selected are catering to the target of industrial vertical integration.

Results

In this paper, I’ve discussed how vertical integration(VI) strategy has functioned in the case of Sanan Optoelectronics, which is an embryonic company but challenged the position of incumbents in silicon carbide industry.

Discussion

My empirical conclusions can be referred by companies identically in semiconductor companies, and hence my paper fills the gap of how to conduct R&D efficiently, but also shows acquisition strategy that only companies with similarities in technology path can be merged.

Conclusion

By reconfiguring corporate organization, integrated firms are able to provide ultraraw materials directly to ultimate consumers, and therefore many latent uncertainties are mitigated. Thus, there are three benefits accrued from this practice, and firstly demand can be transferred from users to producers without intermediaries, for example, distributors, wholesalers and even other sectors of such industry chain. The R&D department can react to needs and wants on time, and therefore design the products fit in with market requirement. Secondly, the adjustment and optimization of a design need repetitious modification, and complementary technology gained from VI is crucial for this process, in which products with different parts can evolve as a whole, with response and feedback communicated within one single R&D lab. Thirdly, the decision-making process is highly hindered by perceived uncertainties in a market, where promising innovative projects are risky and time-consuming, and then aspiration level is weakened while managers are frightened to make long-run strategic intent. The integrated companies are, however, less influenced by uncertainties due to their simplified production process, so they can be more ambitious on innovative investment. Assuming all of the above, much external information needed for absorptive capacity is identified by integrated firms, so they can transfer their knowledge into economical ends, which means their innovative capacity is improved.

Limitations

The limitation of my research is, however, that vertical integration may not be applied as a general principle, because the managerial inflexibility of integrated structure is one of its cons, and other mass consumer product industries may tend to be decentralized. Moreover, post event explanation is the way that I analyze why Sanan has succeeded in innovation, but this method might be impossible to explain why Sanan launched VI at first, so more answers could be found when confidential documents of companies are available to the public.

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