Title	Catch up strategy for latecomers by open innovation
Sub Title	
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Publisher	慶應義塾大学大学院経営管理研究科
Publication year	2016
Jtitle	
JaLC DOI	
Abstract	
Notes	修士学位論文. 2016年度経営学 第3187号
Genre	Thesis or Dissertation
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO40003001-00002016-3187

慶應義塾大学大学院経営管理研究科修士課程

学位論文（　　2016　年度）

論文題名

Catch up Strategy for Latecomers by Open Innovation

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（論文題名）

Catch up Strategy for Latecomers by Open Innovation

（内容の要旨）

Today, in many industries, open innovation strategy gets importance for creating competitive advantage. But in spite of the importance, the successful open innovation cases are limited. At the same time, the crucial conditions for taking successful open innovation are unclear. This paper focuses on outbound open innovation and semiconductor industry. It tries to state the proposition on conditions to take successful open innovation strategy by qualitative and quantitative analysis on the industry and the company.

The derived proposition is that it is important to have the fully consistency in environment, internal resources and the strategy.

Master Thesis

Catch up Strategy for Latecomers by Open Innovation

Naohiro Nakashima

Kazuhiro Asakawa seminar, Keio Business School

Feb. 2017

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Catch up strategy for latecomers by open innovation

Naohiro Nakashima

Feb. 2017

1. Introduction

TOPICS

Importance of innovation gets increased now days, especially for Research and Development (R&D) intensive industries. One of the hot topics of innovation management is “Open Innovation”. But Open Innovation theory still contains many aspects, which should be argued, based on many cases of companies.

This paper tries to point out the importance of Open Innovation on commercialization for creating sustainable competitive advantages. In semiconductor industry, one of the high technology and R&D intensive industries in the world, Open Innovation approach for innovation management is very general. Most of companies succeed in technology invention by Open Innovation. But only few of them succeed in commercialization, but many companies fail to create competitive advantage by using their invention. Key success factor for penetrating the difficulty on commercialization is also in Open Innovation. This paper researches on great case of Open Innovation in ARM holding (Founded in 1990, UK) to figure out the conditions to crate competitive advantages.

Background of The Topics

Open Innovation paradigm has gotten very popular. This tendency is no longer only for as academic term, but also business term. Even in Japan, the word “Open Innovation” has been used to in both way, industry policy in government and private enterprise business.

For example, METI (Ministry of Economy, Trade and Economy) and NEDO (New Energy and Industrial Technology Development Organization) issued white paper for Open innovation as industry policy of the government in 2016. On the other hand, in private enterprise, many companies regardless its size, try to exploit the advantage of Open innovation. For a large company, Komatsu, well known Machinery Company, is working on Open Innovation for creating new customer value proposition. For a startup company, CREWW is working on setting up matching platform of Open Innovation for large company and many entrepreneurs. So Open Innovation spread out all companies across its industry and market, from

the business-to-business market to the business-to-consumer market.

However, in spite of the importance and the attention from all players in public government and private enterprise, the conditions to execute successful open innovation for creating competitive advantage in industry is unclear. In the white paper of open innovation issued by METI and NEDO, it says that "*open innovation strategy is essential strategy to Japanese company"*, but is it true? We have already known that for creating competitive advantage by using some strategy, it always needs certain conditions and consistency in company's activity. The conditions usually based on either or both a positioning in industry, and or company resource. Open innovation can't be magical wound for creating competitive advantages. Therefore, this paper is planned to suggest the conditions for executing successful open innovation by analyzing the case of specific industry and company.

Motivation on The Topics

There are two reasons why I think this topic is worth for this master thesis.

First reason is that it will be good to understand how ARM became great company in semiconductor industry. The company is unique because they were relatively latecomers and had less resource, but made excellent success. There were big gap between their goals and their original position at the bingeing. But they never gave up and compromised by modifying their goal to achieve ease. They had and organized right vision, strategy and resource for adopting environment to achieve their goals. There are few researches on ARM so far, so it will be worth to learn the key success factors and consistency of their activities. And I also believe that some of the tips in the success will be utilized to different company and industry.

Second reason is that I am the right person who can research this field by using my knowledge on this industry and innovation strategy. I have experience of work in semiconductor industry for 8 years. So I have fluent technical and industrial knowledge. In the beginning of my carrier, ARM holding was my competitor. At that time, I was in charge of Japanese Semiconductor Company and promoted their product to General Consumer Electronics Company. From our technical points of view, there were no big differences between ARM CPU and Japanese Semiconductor's CPU. Japanese Semiconductor Companies were still competitive in technology. But after few years, the market share of ARM had increased and achieved high performance in profit, while Japanese Semiconductor Company lost profit. I couldn't answer to the question at that time, but now it's time to figure out by this research.

GAP Between Theory and Practice on The Topics

When we look at the reality, many of semiconductor companies take Open Innovation strategy by alliance, M&A, joint venture and collaboration with University. If the strategy works in all company, they have to achieve competitive advantage or competitive equilibrium at least. But we easily notice that it is impossible that all company could achieve the same result even if all of them take Open Innovation. It naturally let us have this question that what is the difference between the success and failure. This is also gap between the theory and reality.

My assumption for filling the gap that why many of them took Open Innovation strategy but there were the big differences in their performance is Open Innovation on commercialization. Open Innovation on commercialization makes your invention, idea and knowledge have many opportunities to monetize. It also leverage your resource by utilizing others resources. It naturally absorbs uncertainty of technological change in the future by dispersing your knowledge to different customers and field.

For example, if we look at case of ARM, the gaps on research and development capability between ARM and others were very slight or nothing but the gaps on profits and market share became big was that Japanese Semiconductor Companies failed commercialization, not invention. For testing my assumption, I hereby research this topic.

2. Literature Review

Definition of Innovation

According to the definition of Innovation by Allan Afuah (2002), innovation is "the use of new knowledge to offer a new product or service that customers want. It is Invention + Commercialization."[1] It means that innovation is not mere an invention, related to technology. Innovation must be planned to success on commercialization intentionally. In other words, Innovation has to include views, both product-out and market-in.

For the importance of Innovation, he says, "for many firms, competitive advantage is gained and maintained trough innovation. It is also lost when firms do not innovate and their competitors do."[2] It means that for analyzing the difference of company performance, it is good way to focus on their activity and capability on innovation.

Regarding the innovator, he also says "the debate over who is most likely to innovate dates back to, at least Schumpeter, who first suggested that small entrepreneurial firms were the sources of most innovations."[3] Therefore, ARM holding, relatively latecomer in the semiconductor industry is worth for this research.

Definition of Open Innovation

Open Innovation, which was proposed by Henry Chesbrough in 2003. In 2006, He defined that "Open Innovation is the use of purposive to inflow and out flow of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively."[4] (Chesbrough, 2006)

The paradigm that assumes that firms can and should use external ideas as well as internal ideas and internal and external path to market, as they look to advance their technology, is well known. He also says, "Open Innovation explicitly incorporates business model as the source of value creation and value capture."

According to Seiji Manabe's literature reviews (2010), open innovation can be distinguished to 2 types, Outbound Open Innovation and Inbound Open Innovation. This classification is based on the direction of knowledge. When the direction of new knowledge or new idea is outflow from inside of company to outside, this type is Outbound Open Innovation. When the direction of new knowledge or new idea is inflow from outside to inside, this type is Inbound Open Innovation.

For example, licensing, joint venture and spinoff from large company are

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1 Allan Afuah, (2003), "Innovation management " Page 13
2 Allan Afuah, (2003), "Innovation management " Page Ⅶ
3 Allan Afuah, (2003), "Innovation management " Page 14
4 Chesbrough. H, (2005), "A new paradigm for understanding industrial innovation"

categorized to Outbound Open Innovation. On the other hand, M&A, licensing-in and alliance are categorized to Inbound Open Innovation.

For the question that why Open Innovation are necessary, Doz and Wilson (2012) say " a more open innovation approach should provide a good understanding of the latent needs the innovation might serve in different or unfamiliar market and alert the company to the opportunities, technologies and knowledge that it can bring into the innovation." "A more open innovation approach is a better suited to complex problems that have systematic solutions."[5] Open Innovation approach is very good strategy of innovation management for semiconductor industry. Because, the industry always needs new market and solve complex problems.

Research Question

Overviewing semiconductor industry, many companies succeeded in invention of CPU (central processing unit) technology. But many of them, except for ARM, failed to create sustainable competitive advantage by innovation, due to commercialization failure. As a result, many CPU companies and their processor have gone.

My assumption for this question is that Outbound Open Innovation contributed to commercialization. Outbound Open Innovation supports new idea or new knowledge to find new market or new customer. It lets them adapt to new environmental change as well. But ARM was not only company who conducted on Outbound Open Innovation. Other companies also tried on commercialization by Outbound Open Innovation. The issues are complicated and needed to analyze in detail, therefore, I break down into some research questions.

The main question is "what is the key success factor for ARM holding to create sustainable competitive advantage?"

For answering this question, following questions are set.

Did ARM holding really succeed in creating sustainable competitive advantage?

What was the deference in Outbound Open Innovation between ARM holding and others? How did the Outbound Open Innovation of ARM work on commercialization? By answering those questions, this paper suggests propositions for successful Open Innovation.

[5] WILSON.K DOZ.Y, 2012, "MANAGING GLOBAL INNOVATION" P175

3. Data & Method

Method for Answering Research Question

For revealing the key success factors and conditions on Open Innovation, this research focuses on inductive approach. That makes sure differences between successful case of ARM and failure case of other company.

ARM had succeeded in creating sustainable competitive advantage in semiconductor industry. And the deference whether they could create competitive advantage or not, it depends on how they could succeeded on Outbound Open Innovation. For clarifying the conditions of Outbound Open Innovation, analysis from multiple aspects, environment, company vision, resource and strategy, are conducted.

Did ARM Succeeded in Competitive Advantage in Semiconductor Industry?

Before having case study, it is needed to analyze financial performance of ARM by comparison with other firms to confirm that the company is worth for analysis. Competitive advantage means the company has higher or outstanding performance than industry average. And for making precise comparison, it needs to select proper companies from tons companies in semiconductor industry.

Categorization on Semiconductor Industry

The proper categorization is based on value chain activity and type of their product for avoiding comparison of apple and orange. Semiconductor industry is composed of fundamental 3 deferent activities. The first activity is inventing and developing base knowledge, technology and blueprint for basic parts or block in a semiconductor, called intellectual property (IP). Each IPs realizes different and specific functions. For example, CPU IP is in charge of processing, Memory IP is in charge of data storage, Wireless IP is in charge of data communications.

The second activity is designing whole architecture of semiconductor. A semiconductor, especially for integrated circuit (IC) contains several different types of IP. For example, Micro Processor contains CPU and Memory IP for realizing controlling electric product by processing technology and data storage. Application Processor contains CPU, Memory and Wireless IP for realizing mobile phone functions. The third activity is production. Based on the architecture, it produces a semiconductor.

Another aspect of categorization is based on product. Semiconductors can be categorized to several groups of product by their specification. In this paper, the categorization follows “world semiconductor trade statics”[6]. But for making this

[6] https://www.wsts.org/

comparison, classification based on value chain has priority, because value chain axis impacts on the financial performance rather than product axis.

Comparison Data on IP Company

According to the result of analysis, figure 3-1 shows top 5 companies of excellent performance out of 11 companies in IP Company. This analysis defines the degree of company's excellence as growth speed, profitability and efficiency of activity. It decides representative index as proxy variables of them to asset growth, operation margin and ROA. Those index are quoted from annual reports of each companies from 2002 to 2013.

Index	
Asset growth	Growth speed
Profit margin	Profitability of their business
ROA	Efficiency
Number of company	11[7]
Term of target data	Year from 2002 to 2013

Figure 3-1

		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ARM Holdings plc	Asset Growth	–	4.9%	90.3%	61.2%	44.6%	29.8%	18.8%	17.6%	16.7%	16.4%	17.8%	19.6%
	Profit Margin	27.8%	14.9%	18.1%	15.6%	17.3%	16.0%	22.3%	13.0%	26.0%	30.0%	35.9%	22.1%
	ROA	19.8%	8.7%	3.8%	4.4%	5.6%	6.7%	11.5%	4.7%	10.4%	12.1%	12.8%	8.5%
CSR plc	Asset Growth	–	20.4%	103.4%	109.8%	86.2%	72.8%	48.4%	49.0%	41.1%	37.9%	33.1%	30.5%
	Profit Margin	−3.5%	23.3%	23.2%	21.1%	17.9%	7.1%	−2.9%	−0.4%	−5.4%	10.8%	−5.0%	12.8%
	ROA	−38.6%	−4.6%	31.1%	27.1%	29.0%	23.4%	9.6%	−2.0%	−0.3%	−4.1%	10.2%	−5.0%
Altera Corporation	Asset Growth	–	−3.1%	5.2%	9.4%	12.5%	4.2%	0.7%	3.6%	8.1%	8.1%	9.4%	13.0%
	Profit Margin	13.7%	24.0%	31.0%	28.7%	23.4%	21.8%	29.6%	25.5%	44.4%	41.2%	33.2%	26.8%
	ROA	7.4%	14.4%	18.7%	16.5%	13.3%	16.0%	24.5%	13.5%	24.9%	20.4%	11.7%	7.2%
Synopsys Inc	Asset Growth	–	−11.5%	−0.6%	0.4%	4.6%	1.5%	1.1%	0.8%	0.5%	3.1%	5.5%	6.9%
	Profit Margin	16.6%	8.2%	−5.3%	2.7%	9.7%	16.4%	15.3%	13.3%	13.9%	10.8%	12.6%	12.1%
	ROA	9.2%	4.4%	−2.3%	1.4%	4.7%	8.6%	7.3%	6.2%	6.6%	4.5%	5.4%	4.9%
MIPS Technologies Inc.	Asset Growth	–	−7%	6%	11%	14%	5%	−10%	−10%	−3%	0%	–	–
	Profit Margin	−69%	1%	23%	14%	6%	−122%	30%	22%	25%	20%	–	–
	ROA	−25.6%	0.3%	10.9%	6.0%	3.0%	−87.0%	31.6%	23.2%	17.3%	10.8%	–	–
Indsutry avarage	**Asset Growth**	**–**	**0.3%**	**29.0%**	**29.8%**	**26.0%**	**19.2%**	**10.0%**	**12.3%**	**13.0%**	**12.6%**	**14.8%**	**15.9%**
	Profit Margin	**−11.1%**	**5.0%**	**7.1%**	**6.4%**	**−8.9%**	**5.5%**	**−2.3%**	**5.1%**	**23.2%**	**16.7%**	**9.5%**	**12.5%**
	ROA	**−9.6%**	**−0.8%**	**4.0%**	**3.6%**	**3.6%**	**−2.6%**	**3.6%**	**5.5%**	**12.8%**	**8.1%**	**6.1%**	**4.8%**

ARM mostly marked higher index than industry average for 10years and it can tell that they succeeded in creating sustainable competitive advantage. And compared with other 4 companies, ARM's performance is more stable than others. In generally, semiconductor industry is not stable in terms of business environment. Many players enter the industry and exit or acquired easily. Therefore, the stable performance of ARM means the company adopted to changing business environment successfully.

[7] 11 companies; ARM Holdings plc., MIPS Technologies Inc., Imagination Technologies Group plc., CSR plc., Synopsys Inc., Altera Corporation, Rambus, Inc., Rambus, Inc., Virage Logic Corporation, Mentor Graphics Corporation and Mentor Graphics Corporation

What was The Difference in Outbound Open Innovation Between ARM and Others?

For narrowing down the deference of ARM and others, this paper researches the aspect of output. The first point is whether there is difference on impact to their customer performance. If ARM could give positive impact on customer's performance, there must be difference in the activity of Outbound Open Innovation. ARM is one of the CPU IP invention company, but they are not only one company, other firms also invented CPU IP by themselves. MIPS technology inc.,ST microelectronics Hitachi and NEC are representative company for CPU IP firm. According to their annual reports or press release, all of them conducted Inbound Open Innovation. But for the activity of Inbound Open Innovation, Hitachi, ST microelectronics and NEC were limited, in terms of the scale of customers or market share. One of the assumptions why they couldn't succeed in Outbound Open Innovation is the influence of their CPU IP to customers. If so, there is the gap of internal capability for the Inbound Open Innovation activity. This is the way of research in this chapter.

Impact on Customer Performance

ARM gives positive impact on their customers by providing CPU IP, while other IP companies don't. For confirming the impact of ARM CPU IP to the performance of their customers, this research choses multiple regression analysis and T-analysis. Multiple regression will explain the impact of each variables to the performance of customers. T-analysis proves the deference of company performance between the company using ARM IP and the company not using ARM IP.

First, in multiple regression analysis, it is needed to create model for explanation of customer's performance. For doing so, some of variables are selected in terms of internal factors and external factors as follows.

<Multiple Regression Model>

$$Y=a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+e$$

<Variables>

Y	= Operation profit	
b_1	= R&D capability	(Number of granted patents[8] in US)
b_2	= CPU strategy[9]	(ARM CPU=1, Non ARM CPU=0)
b_3	= Diversification strategy	(Number of M&A and Joint Venture)

[8] Source: United states patents and trademark office

[9] Source: Product information on home page of each companies

b_4 = Market size of mobile phone (Number of unit quantity in the market[10])
b_5 = Market size of Automobile (Number of unit quantity in the market[11])
b_6 = Market size of LCD-TV (Number of unit quantity in the market[12])

Number of company in this analysis	13[13]
Number of samples in this analysis	135
Term of target data on this analysis	Year from 2002 to 2013

In this research, for controlling impact of market growth to unrelated company, if the company didn't enter the market, the variables automatically become "0". For example, semiconductor company Qualcomm released their product only for mobile phone market in 2002, the variables x_4 is "423.4", which is the market size, but variables x_5 and x_6 became "0". Another control for right analysis is timing. Patent always is granted after invention and application, it is needed to adjust timing. The patent, variables $b_{1(n)}$ contributes to $Y_{(n+2),}$ 2 years behind to the year. Observed companies are limited to design company who had opportunity to get CPU IP from other companies including ARM or original CPU IP.

Figure 3-2

Linear Regression

Regression Statistics

R	0.65538
R Square	0.42953
Adjusted R Square	0.40279
S	124,780.01234
Total number of observations	135

.5379 + 531.3323 * + 109453.3126 * CPU strategy + 504.7561 * multipolarization strategy + 89.9209 * mobile phone + 0.0005 * Automobile - 812

ANOVA

	d.f.	*SS*	*MS*	*F*	*p-level*
Regression	6.	1.50056E+12	2.50094E+11	16.06248	1.03362E−13
Residual	128.	1.99297E+12	1.55701E+10		
Total	134.	3.49353E+12			

	Coefficients	*Standard Error*	*LCL*	*UCL*	*t Stat*	*p-level*	*H0 (5%) rejected?*
Intercept	−53,552.53786	32,532.88423	−117,924.40755	10,819.33182	−1.6461	0.1022	*No*
R&D capability	531.33231	224.55107	87.01966	975.64497	2.3662	0.01947	*Yes*
CPU strategy	109,453.3126	38,203.62105	33,860.92126	185,045.70393	2.865	0.00488	*Yes*
Diversification strategy	504.75605	1,724.24755	−2,906.96232	3,916.47442	0.29274	0.77019	*No*
mobile phone	89.92091	25.7868	38.89732	140.9445	3.48709	0.00067	*Yes*
Automobile	0.00052	0.00047	−0.0004	0.00145	1.11685	0.26615	*No*
LCD-TV	−812.06243	162.62485	−1,133.84349	−490.28138	−4.99347	0.	*Yes*

[10] Source: Gartner
[11] Source: JAMA
[12] Gartner
[13] 13 companies; Qualcomm, Renesas, Texas Instrument, MTK, STM, NXP, BCM, MARVELL, ATM, Microchip, Freescale, Mstar and INFINEON

According to the result of Multiple Regression, the variable b_2 has significant and positive impact on customer's performance. It implies one of the differences between ARM and other firms is the impact to the operation profit of customers.

And for avoiding the noise of customer's company size, and checking the significant deference on CPU strategy, T-Analysis analysis was conducted with ROA index.

<T-Analysis>

Target Group	0 = without ARM CPU, 1 = with ARM CPU
Observed variables	ROA
Number of company in this analysis	13
Number of samples in this analysis	135
Term of target data	Year from 2002 to 2013

Figure 3-3

t−検定: 分散が等しくないと仮定した2標本による検定

	ROA_ARM_IP	ROA_NON_ARM_IP
平均	0.114046523	0.026080085
分散	0.013173079	0.034854229
観測数	52	83
仮説平均との差異	0	
自由度	133	
t	3.39020495	
P(T<=t) 片側	0.000459839	
t 境界値 片側	1.656391244	
P(T<=t) 両側	0.000919678	
t 境界値 両側	1.977961264	

The result of T-Analysis also shows the significant deference of ARM CPU IP on performance of customer (ROA).

Regarding the impact on customer performance, ARM gives positive impact on them. Why the difference is appeared? For answering the question, this paper researches on internal differences of Outbound Open Innovation in each company.

Internal Resource and Conditions on Open Innovation

This analysis shows that the importance of consist activities and focused approach on Outbound Open Innovation. The internal resources should adapt to business environment and their strategy. As the way of research, an inductive and qualitative comparison approach is adopted. For the points of analysis, following factors are observed.

Observed Factors

Followings are three factors, which are assumed to relate the result of Outbound Open Innovation. The industry of customer, Product Specialization and Business Specialization.

The first factor, customer industry means the industry their customers belong. Strategy always needs preferable environment. This factor will provide preferable environmental factors for Outbound Open Innovation. The second factor, product specialization means their flexibility level of product. If the company does vertical integrated business mainly, the flexibility level of knowledge is very low, and it will make it difficult for the company to adapt their knowledge to new business environment or new customers. On the other hand, if the company does proper specialization with their product, it let naturally the flexibility of knowledge high and will make opportunity to discover new environment to be adapted their knowledge. The third factor is business specialization means the rightness of their business model for expanding its knowledge to the world. In this analysis, it focuses on value chains of the company. Improper value chains destroy company profit and opportunity of business by extra unnecessary activity. Proper business model creates business ecosystem and save extra money. It makes it possible for them to focus on their right business and value creation activity.

Observed Company

In this research, elected company for the analysis follows above standards for the qualitative analysis. Then, MIPS (located in US), Hitachi (located in Japan) are elected to observed company from many companies who invented CPU IP. Other company, some of them have already gone mostly but elected company still maintains their CPU IP in 2016. And all of them are popular and leading company as well.

Customer Industry

In this section, this research shows the main industry of customers for each company and their characteristics. ARM holding and Hitachi sell their IP to mobile phone industry mainly. Of course, Hitachi sell their product, semiconductor to all industry generally. But in terms of CPU IP, SH-mobile IP (Hitachi's CPU IP), their main customers are in mobile phone industry[14]. For the characteristics of the industry, the speed of core technology has changed rapidly. In the very beginning of the product, communication and baseband technology was core value. After that, the communication technology was standardized, then the next differentiated technology changed to hardware functions, big screen LCD, battery power, size and lightness. After the satiation of the change on design and physical function, software including OS and application become differentiated technology. As a result of those change, various companies from different industry have entered the market. In the first place, data Communication Company, NOKIA, NEC and blackberry started to release mobile phone product to the market with data communication base. After that, Electronics Company (Samsung, Sony and others) and PC Company with software (Apple, Google and Microsoft) released their product.

On the other hand, MIPS mainly sells their CPU IP to Game industry[15]. For the characteristics of this industry, the core technology is not changed well. Main core technology of this industry is mostly CPU and graphics processor. And a few companies dominate the market. Microsoft, SONY and Nintendo are main players on this industry for long term. Of course there were many small players in the industry once, but their market share was very limited.

Product Specialization

ARM and MIPS specialized on CPU IP, which keep their product level very raw. They never purchase other IP from IP supplier and develop semiconductor IC itself. Therefore, they can focus on invention and development on IP. Hitachi expanded their product level from IP to semiconductor product, because Hitachi also kept capability of manufacturing. ARM, MIPS and Hitachi sell their CPU IP as Outbound Open Innovation by licensing to their customer, while only Hitachi also sell their IC product.

14 Nikkei Electronics magazine
15 Nikkei Electronics magazine

Business Specialization

ARM leveraged other firms, semiconductor companies and foundry companies, to their business. They could only focus on CPU IP invention. And fortunately, their CPU IP were very standardized, so many 3rd party (companies) could develop their business by developing software, development tools and evaluation board. Those firms also help ARM to focus on CPU invention by taking over the work of ARM. ARM strategically promote to increase semiconductor companies who develop IC with ARM IP, foundries who produce IC including AMR IP and 3rd party who develop their own business related to ARM business. They were called ARM partners and the relationship was called “ecosystem”. In the ecosystem, ARM was not leader to order other firms. All firms had their original strategy and goal to the vision and future. ARM tried to leverage their activity and resources by out bounding their CPU IP. It led ARM’s business sustainable.

MIPS also only sold their CPU IP as well as ARM. But they were more vertical integrated style than ARM. MIPS developed not only their CPU IP but also software, development tool and evaluation board. MIPS had to work on several tasks, so they couldn’t purely specialize on IP invention.

The reason why the company failed specialization is rooted to their customer, the game industry. The threat of customer was strong in the game industry, because a few company dominated the market but the market size was very big. There was no standardization on the spec of game product, game companies could develop it very differently with their competitors. Therefore, the customers make their CPU supplier, MIPS, develop and sell customized CPU IP to each customer. MIPS had to follow the customer. For the characteristic of product, the CPU IP was customized and it couldn’t be standardized, number of companies who bought MIPS CPU was limited. At the same time, it was impossible to develop the ecosystem for ARM, because other companies couldn’t create their strategy by using MIPS IP, because the product was customized to specific customers and the information of product always top confidential information.

Hitachi sold their product as both CPU IP and semiconductor IC to customers. They had much capability, big factory, to produce semiconductor. It produces not only CPU IC with IP for mobile phone market, but also other semiconductors to different markets. They didn’t need ecosystem, because they had subsidiaries and subsidiaries, companies who followed Hitachi strategy. Hitachi was more vertical integrated business style than MIPS.

Result in the Market

As a result, the market share of each CPU IP shows how the difference worked to their company performance.

In generally, ARM is only company of them who succeeded in maintaining high market share and sustainable company management. But MIPS and Hitachi couldn't penetrate to the market.

ARM has expanded their market share in mobile phone industry mainly. After the fusion of the market with game industry (it gets closed to different area, mobile phone) and electric industry, ARM started to penetrate to those markets as well.

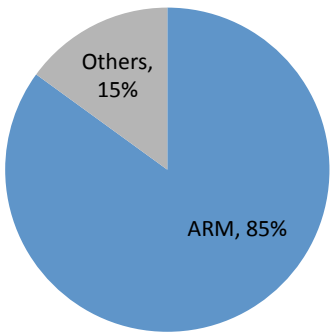
MIPS once expanded their market share in both game industry and multimedia product in electronic industry. But they couldn't make their business profitable by achieving market share. (Figure 3-1) Their profitability was quite bad, due to the customization, support time and wages for their customers. They were ended up acquired by Imagination Technologies, UK Company in 2012.

Hitachi couldn't penetrate mobile phone market by their CPU IP. Only some of Japanese mobile hone companies adopted it to their architecture. After the invention, the company started Joint Venture Company with ST microelectronics for selling their IP. But it didn't work well, and then they dissolved the alliance. After that Hitachi separated their semiconductor division and merged it with Mitsubishi and NEC. Current market share of SH mobile IP is very limited.

As a summary, only ARM CPU became de-facto standard in the mobile phone market by Outbound Open Innovation. And they also expand their business area to game, electric product, car and factory automation industry, while other companies can't.

Figure 3-4

Market share of CPU IP in mobile phone in 2015 (sales amount base) [16]



[16] Softbank press release (2016)

Figure 3-5

Market share of CPU IP in digital consumer products in 2015 (sales amount base)[17]

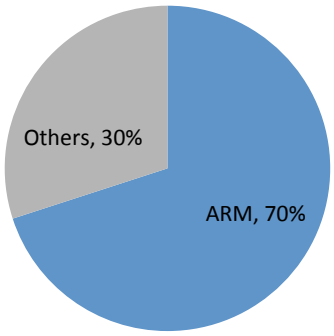


Figure 3-6

Comparison chart

		Conditions				Result
Company	Main Market	Product Specification	Licensing Biz	R&D inbound-OI	Customer support	De facto-Standard
ARM	PDA/Mobile	Yes	Yes	Yes, with University	Partners	Successful
MIPS	Game	No	Yes	Yes, with M&A	Direct	Limited
Hitachi	PDA/Mobile	No	Yes	Yes, with STmicro	Direct/Subsidiary	No

[17] Softbank press release (2016)

Case Study of ARM[18]

For narrowing down ARM's success with Outbound Open Innovation, let's see the inside of the company and reveal their secret by case study. The first crucial key incident of their success was that the company penetrated the mobile phone market by leveraging large company's reputation in early stage. Their technology was adapted to Texas Instrument (Leading Large Semiconductor Company, based on US). The second crucial key incident was that the ARM CPU was adapted to standard part of Symbian OS. Symbian OS, which dominated the mobile phone market as a de-facto standard OS once, only worked with ARM CPU. Then the OS promoted the ARM CPU unconsciously by expanding its market share.

This chapter answer to the question that why ARM could achieve those big chances and how it relates to their Open Innovation.

Company brief introduction[19]

Lets start to explain that how the company, ARM was founded.

ARM was founded in 1990 in Cambridge, United Kingdom. The company originally started as an internal division for CPU invention in Acorn computer before ARM's foundation. They were planed to develop CPU internally for personal computer of Acorn. After they invented several CPU for their company, 12 engineers of them decided to independent from Acorn computer. At that time, they didn't have much resource. They were lack of engineers, capitals and factories. After the independence, they experienced to face financial crisis due to the lees resource and customer in their beginning stage. But they overcame the difficulty by their unique strategy and grew the company rapidly. Figure 3-7 and 3-8 shows how the company grew rapidly.

After they dominated the mobile phone market, they started to penetrate to other industries. Their characteristic of CPU IP, the balance of power consumption and computing speed is great. It brings much benefit to mobile product, not only for mobile phone but also mobile game and LCD TV. And we checked on the previous chapter, there is ARM ecosystem. It helps ARM to expand their market and to grow rapidly.

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18 This section based on book, Nenni.D (2015) "mobile unleashed"

19 Nenni.D (2015) "mobile unleashed" P40-41

Figure 3-7

ARM sales amount from 1996 to 2015 (million JPY)[20]

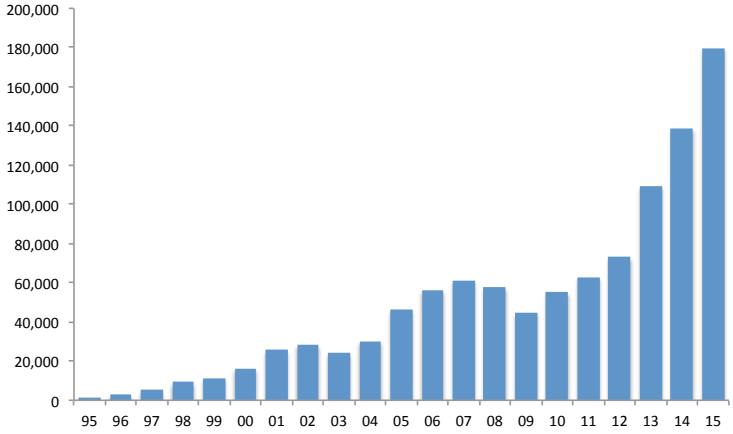
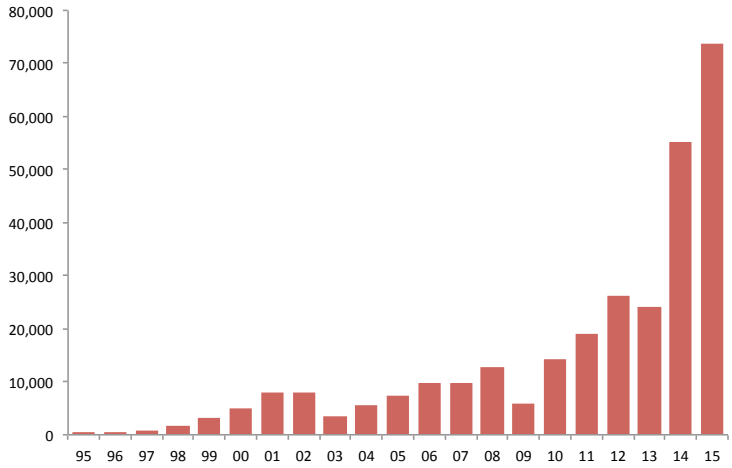


Figure 3-8

ARM operation profit from 1996 to 2015 (million JPY)[21]



[20] ARM annual report from 1995 to 2015
[21] ARM annual report from 1995 to 2015

Key success in the market

First story[22] is about their first sensational project with Nokia and ARM; In 1990s, the big change was emerging in mobile phone industry. Previously, the communication between one place to another place by mobile phone was done by analog data communication. But the new technology called GSM (2G) with digital communication were invented and developed. At that time there were 3 large companies, Nokia, Ericson and Motorola, who dominated the market.

Among them, Nokia was the most positive company toward the technology change. On the other hand, Texas Instrument (TI) regarded the change as chance. They had their own technology DSP (digital processing processor). Their first market for the technology was defense communications and medical market. But they sought higher volume market for the DSP as a next step. Naturally, both company, Nokia and TI started the project to develop the GSM phone together. But in the project, they faced difficulty in processing technology. The CPU technology of TI didn't fit the requirement of GSM mobile phone. If TI decided to prepare the CPU by themselves, they had to develop the technology from scratch. But it assumed to be a huge investment. For saving huge money, TI decided to invite CPU IP supplier, ARM holding, to the project. After the start of joint project, they succeeded to develop GSM phone. It was the first mobile phone, which support GSM in the world. For ARM, before the joint project, they faced the difficulty. The company was small company and they didn't have reliance from customers due to the lack of result.

But after the release of first GSM phone from Nokia in 1997, ARM got very popular in semiconductor industry. Mike Muller, previous ARM CTO, commented that "*After the announcement of NOKIA's phone, inquires were flooded by Semiconductor Company"*.[23]

Second story[24] is about their trigger of explosive growth; In early 2000s, the there was a demand in mobile phone industry to have operation system. As mentioned before, mobile phone had grown rapidly and the function got complex. The need of software diversion from different application to mobile phone was emerged. For Mobile Phone Company, it was hard to develop software from scratch by their every model change. The product cycle of mobile phone is very short. OS saves those software development fee and time for it. Nokia, SONY Ericson, Motorola and many mobile phone companies established Joint Venture Company, called Symbian, for developing de-facto standard OS. And the mobile phone alliance

[22] Nenni.D (2015) "mobile unleashed" P57-60
[23] Nenni.D (2015) "mobile unleashed" P69-76
[24] Nenni.D (2015) "mobile unleashed" P69-76

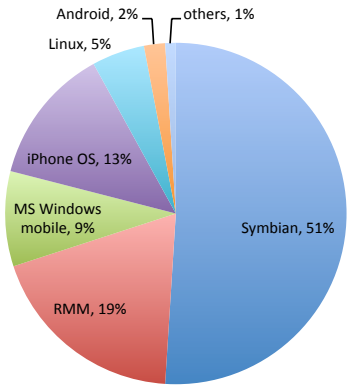
decided to adopt operation system of EPOC, which was developed by Psion (handheld company) to the foundation of Symbian OS.

Few years before the big change of mobile phone OS, ARM promoted and tried to expand their CPU IP to various industry. They had promoted their CPU IP to Psion. Then, Psion developed their handheld product series based on ARM. The EPOC, OS for handheld, was also developed on ARM architecture. ARM became only company who could support PISON OS and it's successor Symbian OS. Therefore, once Symbian got 50% of the market share, ARM achieved the same share in the market (Figure 3-9). After the Symbian, iOS from Apple and Android OS from Google penetrated to the market, but they needed to leverage existing software resources in the market, the both OS also based on ARM architecture. This the order how ARM became de-facto standard in the market.

Of course ARM couldn't predict that the mobile phone alliance decided to invest Psion and EPOC but the activity with foresight helped ARM to be excellent company. In both story ARM had helped by outsider and the incident was unexpected things like serendipity for ARM. The mechanism of casing preferable situation for ARM rooted the company strategy. Next chapter analyzes the mechanism.

Figure 3-9

Mobile phone OS, market share in 2009[25]



[25] Gartner

Company Vision and Strategy

ARM took unique strategy for filling the gap between their vision and resource. Of course, Outbound Open Innovation was their main strategy. This chapter explains why they took the strategy and how it worked on creating sustainable competitive advantage by checking the company vision as their goal first. After that check their resource of the begging, then the gap become visible and makes it possible to analyze the strategy for filling the gap.

First, the first generation CEO of ARM, Robin Saxby, and 12 engineers fixed their company vision as “create a global embedded CPU standard”. ARM engineers had fluent experience of technologies but they had no idea on managing the firm. Saxby had a business idea of CPU designing service, when he was in Motorola. The idea was very close to the vision of engineers, and then ARM accepted the CEO who had the same vision with their engineers.

Second, as their starting position of the company, the resource of ARM was very limited. The company didn’t have much capital, human resources and facility to produce semiconductors. But their goal was to be a global embedded CPU standard. So there were big gap between them.

ARM invented the innovative strategy to fill the gap. For creating a global embedded CPU standard, they thought that they needed many partners who promote and expand their CPU technology to all over the world, instead of them. How? For creating partners in all over the world, they had to sell IP knowledge instead of the semiconductor chip. Selling semiconductor to all over the world, they needed to their factory for produce their own chip, but the company didn’t have it. At the same time, they didn’t have much capital to hire sales staff as well. Then for selling IP knowledge, they started licensing business. For selling IP to customers, ARM decided not to follow Acorn’s product road map and got autonomy from the parents company and targeted semiconductor companies as their customer.

The uniqueness of their strategy is that they didn’t regard their customer as just it is, regarded as a partner who promotes their IP to all over the world, instead of ARM. As evidence, from their beginning stage, the number of partners is always their KPI on managing company. And that’s the reason why the company kept their technology level as raw and standard level, not customized.

4. Findings

This research has revealed 3 points, related to Outbound Open Innovation on ARM. First point is the achievement of Outbound Open Innovation. Second point is the conditions for the success. Third point is the mechanisms, how each condition work interactively. ARM succeeded in sustainable competitive advantage by using Outbound Open Innovation. It made both ARM and their customers competitive in the market for long term. (Figure 3-1, and 3-2)

Comparison Result

ARM's Outbound Open Innovation style is licensing CPU IP. The licensing business, itself, was not monopoly business. Other companies struggled the same way. The factors, which made difference on their result was conditions and surroundings of the business. That is environment factors based on industrial characteristics and company capability including (lack of) resource.

ARM was not only company who invented original CPU. MIPS technology, American CPU IP Company and Hitachi, Japanese vertical integrated Company also invented their CPU. But the conditions and results were different between in them. For the analysis on customer, ARM and Hitachi's main customer were Mobile Phone Company while the customer of MIPS was game industry.

For the analysis on value chain, ARM and MIPS were specialized company for IP invention and development. But Hitachi was vertical integrated company covered from IP invention to production. For the analysis on innovation, all 3 companies invented CPU and licensing business by it as well. For the analysis on open innovation, all three company conducted inbound open innovation and outbound open innovation. The performance as a result, ARM only succeeded in global de-facto standard. Those result leads following findings. (Figure 3-6)

Environmental factors

The preferable environmental factor for successful Outbound Open Innovation is fast changing industry. Fast changing industry requires all company to acquire new technology. Most new technologies come up from different field. And the environment also requires all company to save time and development cost by Open innovation.

Another preferable environmental factor is the market where many customers exist. In this case, the market prefers standardized condition for customer convenience, rather than chaotic condition. Because, the chaotic condition gives bad influence to customers and market by causing confusion.

Company capability and resource

The key success factors in ARM were specialization and ecosystem. The specialization on CPU IP expands the business opportunities widely and it makes their knowledge more fluidity and agility (DOZ.Y & KOSONEN. M, 2008). The difficulty for all company is to access all information and business chance in the world. And finishing product, IC, sometimes makes difficulty to adopt new technology or environmental changes, due to the concreteness. The fluidity and agility on CPU IP covers those problems.

That makes their knowledge penetrate to the market and adapt to fast change environment. The image of this is like liquid. Solid object can't be changed rapidly but fluid object can be changed and adopted to anything.

The shortness of the resource calls for specialization to ARM. The shortness emerged the needs of partnership with other companies to build the business together. And it emerged the capability by the fluidity and agility.

Mechanism

ARM arranged all activity to cover their shortage of resource and achieve their goal. Followings are how it related and worked.

ARM targeted their customer based on the vision "create a global embedded CPU standard". For aiming the segment, they adopted their product level as low (IP) and customized level as standard. (Figure 3-10)

"Figure 3-11" explains the whole mechanism in ARM. The arrangement in product let ARM to have opportunities to sell and spread their IP to many customers in semiconductor industry. (Figure 3-11-①)

Those customers in semiconductor industry develop IC with ARM IP and promote it to end customers, electronic company. This mechanism allows ARM to access many electronic companies via semiconductor companies. (Figure 3-11-②)

Ecosystem saves ARM to spend extra cost for supporting their customer by providing development tool, software and technical support. Ecosystem leverages resource and strategy of other companies by giving standardized CPU IP. (Figure 3-11-③) That let other firms to build their own strategy and business based on ARM business. It ended up fill the lack of resource in ARM.

Figure 3-10

Product strategy and potential customers

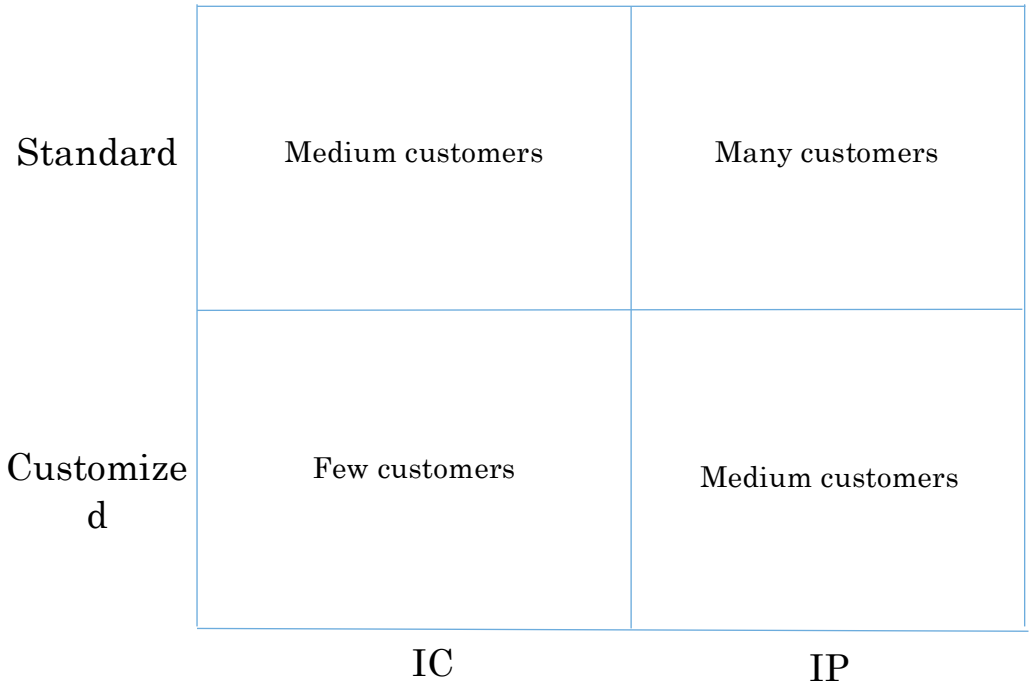
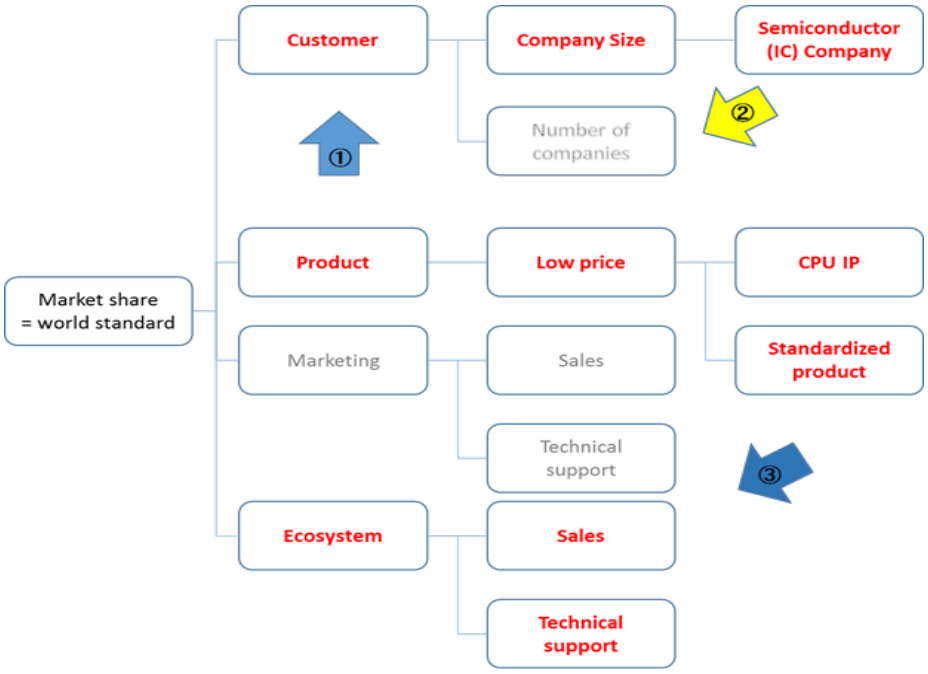


Figure 3-11

Mutual relationship between target, internal resource and external resource



(Blue: Direct effect, Yellow: Indirect effect)

5. Discussion and conclusion

Discussion

Successful Outbound Open Innovation brings competitive advantage via commercialization of Innovation. Especially for latecomers without fluent resource require Outbound Open Innovation for expanding their business. Outbound Open Innovation let them leverage outside resources. But the strategy needs following conditions.

Outbound Open innovation requires consistent activities. The consistency means that appropriate environment, customers, strategies and resource. The preferable conditions of them are fast changing environment, the market existing many customers, specialization and right resource (not too much). Lack of consistency in activities occurs conflict and difficulty to the company.

Fast changing environment provides many chances to latecomers to expand their business by Open Innovation. It creates open mindset to all company to acquire new technology from both inside and outside of industry[26]. For example, in semiconductor industry, most of IC companies are latecomers in mobile phone market now, while still most of IC companies are first movers in automobile market.[27]

Competitive market, existing many customers, gives positive impact on Open Innovation as well. It naturally led suppliers powerful on negotiation to customers. But more important factor in the context of Open Innovation, that let suppliers get autonomy from customers. The autonomy makes the company innovative on invention and commercialization.

Specialization also provides business opportunities to access many customers by keeping the product fluidity. That expands business network widely. Lack of specialization occurs cannibalization on their business internally. Internal cannibalization might be caused by price problem and resource utility rate. Specialization always provides reasonable price by outsourcing to customers. If vertical integrated company tries Outbound Open Innovation with specialization, their sales amount of IP will be lower than their IC. And it will also give negative impact on utility rate of its factory. As a consequence, it makes insider dissenters and they will cause unfavorable result. This phenomenon will be universal in other industry and product. On the other hand, for latecomers, they should take advantage of being nothing to lose (lack of resource) by specialization.

The specialization brings the merit of selection and concentration. The specialized company can focus and invest on one activity. For ARM, that is

[26] Refer to Note5 in chapter7
[27] Refer to Note6 in chapter7

invention on CPU IP. That made ARM CPU IP differentiated from others by taking long term. But that has pros and cons. Concentrated invention and activity makes the firm strong in certain point but it creates curtail disadvantage as well. For ARM, it was sales, marketing and engineering support. But the ecosystem can cover those disadvantages to build many firms working on them. Sometimes that calls serendipity as well. (ARM's first success was brought by TI). The ecosystem always gives autonomy to those members and let them have their own strategy for the growth by using the knowledge of owner.

Conclusion

In conclusion, Outbound Open Innovation is tied with commercialization. That's the key of successful innovation for creating sustainable competitive advantage. But there are important conditions in executing. That is consistency in business environment, customers, right activity and appropriate internal resource. Therefore, company must predict external environment and recognize internal resource rightly. That is the first step to create and execute right strategy.

And if the conditions are preferable to latecomers, the fluidity and agility on resource for adapting the fast changing environment are necessary. Appropriate activity brings competitive advantage to latecomers against large company in the condition.

Limitations

The research took inductive approach, the number of companies subject to analysis is limited. For resolving this issue, and to prove the conditions for successful Open Innovation, quantitative research will be future research.

Another limitation is data, which used to the quantitative analysis in chapter 3. Due to the data access limitation, subjected company and data also had limitation in terms of term. And this research couldn't access to private company who didn't disclose the company data. Also it was impossible to access failed company who ended their business or acquired by others.

Contributions

New topics

Research of Outbound Open Innovation is seldom. And the target company ARM is also new company to be researched by business administration field. This paper introduced brief business model of ARM and analyzed their core competent strategy as a topics of Open Innovation by researching their beginning stage, environmental situation and comparison with their competitors. (In chapter 3)

Analyzing the mechanism

This research revealed the mechanism and causality of successful open innovation. It explained how each activity contributed to creating sustainable competitive advantage through Open innovation with existing theory, while other papers just introduced cases of alliance or partnership and couldn't analyze the causality. (In chapter 3)

Suggesting conditions

Many articles referred the importance of Open Innovation, but they couldn't suggest the conditions to execute it successfully. This paper suggested the conditions for it as consistent environment, activity and resources by qualitative and quantitative analysis. That contributes to the Open Innovation paradigm by suggesting new concept and adding a case study. (In chapter 3&5)

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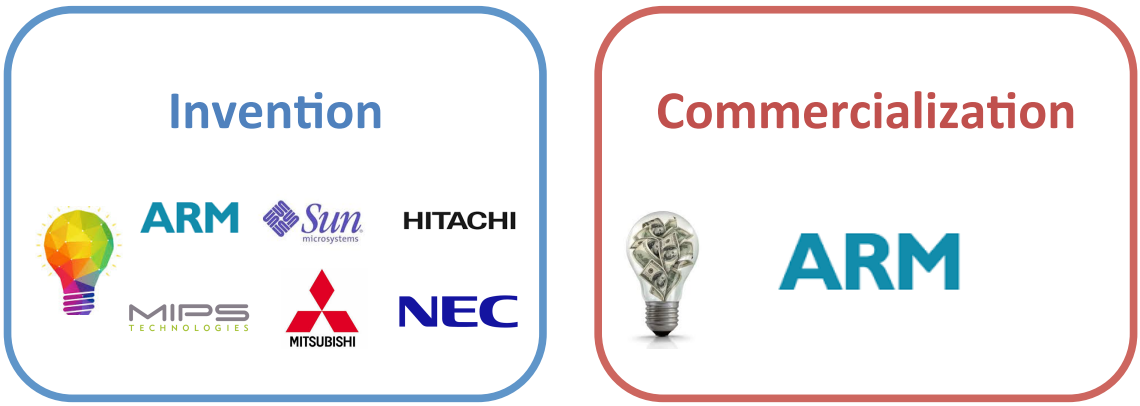
7. NOTE

NOTE-1

Innovation is Invention + Commercialization

As a below chart-1, innovation is Invention + Commercialization. Sun microsystems, Hitachi, MIPS, Mitsubishi, NEC and ARM succeeded in invention of developing CPU IP, while ARM only succeeded in commercialization, in terms of CPU IP business. This paper tried to reveal that why the gap emerged.

(Chart-1) Successful invention companies and successful commercialization company



NOTE-2

Business Model of Semiconductor Industry

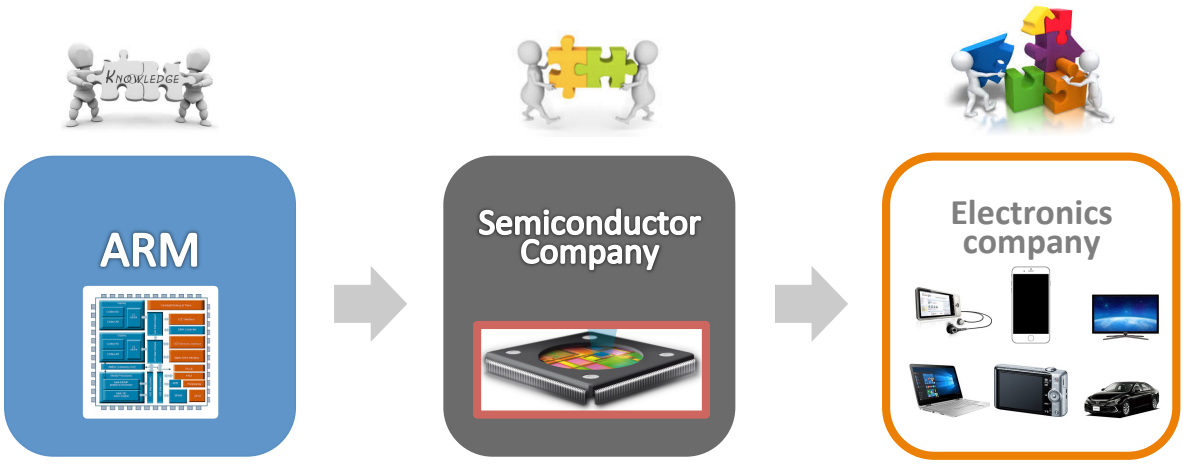
Semiconductor industry is composed by CPU IP supplier, semiconductor company, and their customer. Those 3 types of companies provide different level of product.

The fist player is CPU IP supplier. ARM is one of the CPU IP suppler. CPU IP suppliers invent and develop knowledge based on blueprint of CPU, and sell their knowledge by licensing.

The second player is Semiconductor Company develops their IC design. The design is different from the blueprint of IP supplier's. The design of Semiconductor Company covers whole product system of semiconductor.

The third player is Electronics Company. They purchase the semiconductor from Semiconductor Company and use the semiconductor as a part for their finishing product. Those company produce mobile phone, PC, LCD-TV, automobile and others.

(Chart-2) Image of Semiconductor Industry

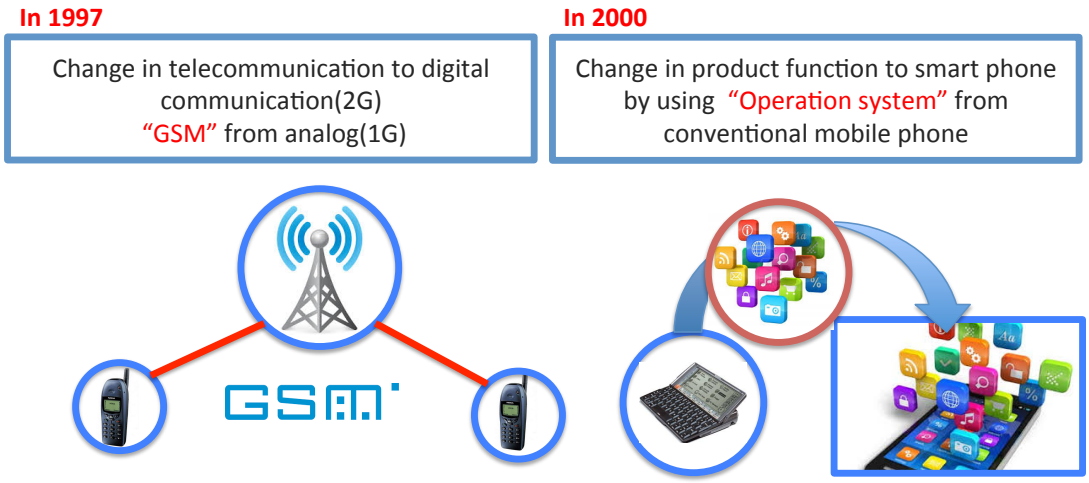


NOTE-3

Environmental Change

ARM experienced big environmental change twice. First change was GSM technology. The change occurred on communication signal between a mobile phone and another mobile phone via telecommunication base. (Chart-3) Another change in need was emerged by rapid product development of mobile phone. It required operation system on mobile phone to absorb various software, which are invented and developed by various companies inn all over the world.

(Chart-3) Image of Semiconductor Industry



NOTE-4

ARM's Ecosystem

Their ecosystem are composed by three types of companies.
Silicon partner, design support partner and software training consortium partners. Silicon partner means semiconductor companies and fab companies who produce IC using ARM IP. Design support partner is the company who produces supportive product to sell ARM CPU IP to customer. The product includes technical developing kit or professional software for ARM's customer. Software training consortium partners means users or engineers who develop their product based on ARM. They share many information spontaneously and help each other in ARM consortium.

(Chart-4) Image of ARM's Ecosystem[28]

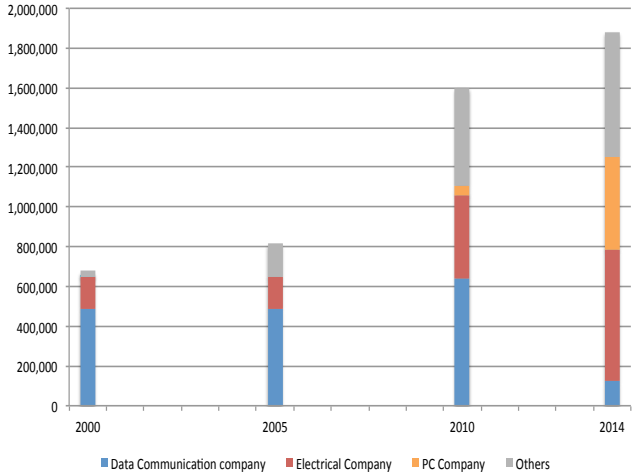
[28] ARM's company presentation

NOTE-5

Many electrics companies entered mobile phone market

Mobile phone industry required many types of industries. At the very beginning stage, Telecommunication Company dominated the market (blue). But after that, Electronics Company started to penetrate the market. Then PC Company followed. Cart-5 shows how fast growth and developing industry required various technologies from different field.

(Chart-5) Mobile phone market based the company background[29]

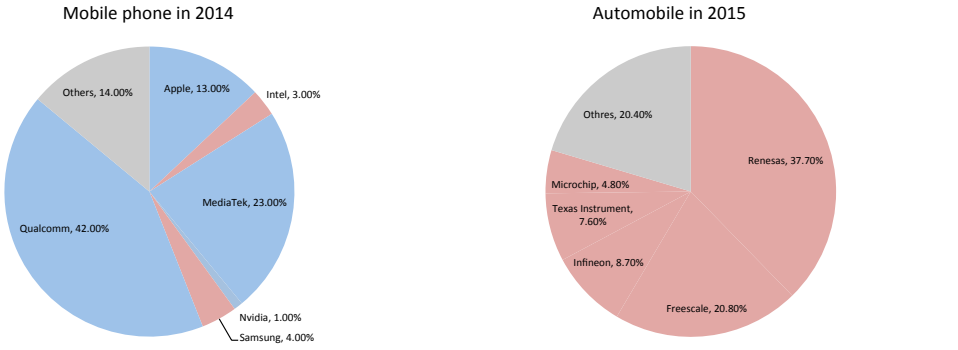


NOTE-6

Current semiconductor players in mobile and automobile market

Newcomers (Blue color company) dominated mobile phone market, whine still fast mover of semiconductor company dominated automobile.

(Chart-6) The Difference on Dominant Players In Each Market



Reference : http://www.eetimes.com/ & Renesas HP

[29] Gartner, numbers are based on shipping unit