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The Analysis of Chinese Enterprises' Upgrading From OEM to ODM: The Opportunity Windows and Paths

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Abstract

This paper discusses the opportunities and the paths of upgrading from OEM(Original Equipment Manufacturer) to ODM(Original Design Manufacturer) in China. We propose the "opportunity windows" of upgrade for Chinese enterprises by structuring a revised A-U model, analyze the environment of upgrade by a two-enterprises and two-cycle model. The article considers that as many OEM enterprises are in a period foreign technology spilling more slowly and difficultly, or the "spillover inertia"is getting dispeared. China's OEM enterprises need to strengthen their innovation level to infuse them with new power of upgrade, these ways include absorbing the technology spillover, reverse OEM, industry-university-research coordination, Independent R & D.

Key words: OEM; ODM; Opportunity windows; Upgrade; Innovation paths

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INTRODUCTION

Thirty years of development after the Reform and Opening up makes China becoming the world's manufacturing center of many products, and widely regarded as the "factory of the world". According to related statistics, over 1/3 of the OEM business are provided by China, while more than 20% of the domestic brand market use OEM (Yang, & Liu, 2009). However, Chinese companies rely more on the world's multinational corporation who have advanced design capabilities, technology, brands and sales channels to carry out OEM production, resulting in the low-end processing mode and low profit margins. With the growth of domestic economic and the development of Southeast Asia as well as other emerging countries, China's cheap labor advantage is disappearing, making it even more difficult to rely on the original OEM production mode.

Global competition makes OEM industry's unfavourable characteristic, such as weak value-added capacity, low-level technology, significantly weak brand competitive disadvantages, more significant. Therefore, OEM is urgently needed to upgrade to higher level of the value chain. Domestic and foreign scholars drawn the enterprise upgrade path from OEM to ODM and then to OBM with cases and related theories(Wang, & Mao, 2007; Hobday, 1995). In this process, the technological innovation is one of the core elements of the upgrade. If enterprises have valuable, scarce, inimitable and irreplaceable resource, they will have access to potential sustainable competitive advantage (Jiang, & Sun, 2012). Following the route of technological innovation to acquire the proprietary technology for competitive advantage, then to accomplish the upgrade to ODM model, is an important way for OEM enterprises to achieve transition towards high-tech and branded mode.

As a result, to recognize the opportunity and to find the paths upgrading from OEM to ODM is important. This paper try to construct a modified A-U model to analyze the opportunity and propose corresponding upgrading paths.

1. THE ADVANTAGE OF ODM

ODM is a production mode of which the fiduciary enterprises with basic R&D and product design capabilities design, produce and machining products in accordance with the needs and authorization of the brands enterprises. It means that the ODM also undertake business like products' depth processing and processing and designing besides assembling and simple production (Liu, 2005). Compared to the OEM, ODM enterprises have more advantages in the industrial chain.

Firstly, ODM enterprises have equivalent core competence. From the value chain point of view, manufacturer operates value chain activities mainly by development & designing, assembling & manufacturing, brand promotion & marketing etc., the modularized division of work in value chain lays a good foundation for manufacturer choosing his business scope, as well as the division of labor between manufacturers (Sun, 2007). Under ODM, enterprises could win the dominant right of development & designing with strong manufacture advantage, thereby possessing complete product capacity. Meanwhile, ODMs' down-stream enterprises, also called their custom-enterprises, could concentrate to expand the marketing channels and do better sales services, while they have the whole marketing capability. Therefore they have equivalent competence making for complement each other's advantages.

Secondly, ODM enterprises have stable transaction relationships. In the ODM operation mode, ODM manufacturers are engaged in R&D and producing activities according to ODM clienteles'requirements. ODM clientele enterprises in downstream will have to analyze the target market, to accomplish the works like production distribution, production service and brand promotion. From the point of enterprises resources, both sides' transaction should center on specific object of transaction, and distribute special investment for completing their respective business link, meeting specific market requirements. Due to the strengthening of asset specificity, the scope ODM partake in both activities will get smaller as the increasing of trade special cost, resulting in the reinforced resource capability and the more stable trading relationship.

Thirdly, ODM enterprises have stable and low-risk customer relations. ODM enterprises have a high position in value chain owing to their holding core resources and capability, they can choose their clienteles in a broader range. Stem from risk consideration, ODM often possesses many cooperative partners, and the client base is stable relatively, some changing of customer relation is not likely to affect the whole business of ODM.

Fourthly, ODM enterprises have equal status, and the profit distribution is balanced. Compared to OEM, ODM manufacturers have relative balanced cooperative relationship with ODM client under the vertical division of labor system, they have equal say so that to consult the contains and benefit distribution of related products (Deng, 2010). ODM enterprises are able to strive for the profit sharing preferably on the basis of equal contract relation.

2. THE QUALITATIVE MODEL AND THE MATHEMATICAL MODEL

2. 1 The Opportunity-window of Upgrading From OEM to ODM

In 1970s, N. Abernathy and James M. Utterback studied the interrelation between product innovation, process innovation and organization structure based on the life cycle theory, they present dynamic-evolution formation centered in product-innovation, they express this process with a model called Abernathy-Utterback innovation process model (Utterback, & Abemarhy, 1975), A-U model as shown in Figure 1.

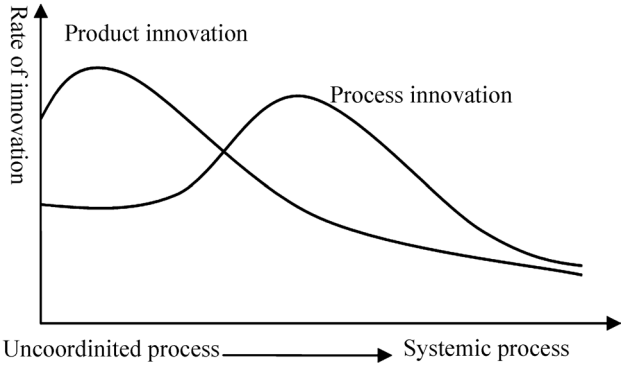

Figure 1
A-U model

The traditional A-U model reveals the inherent relationship between innovation types and industrial development stage. They believe that product innovation, process innovation and organizational evolution can be divided into the flow, conversion, and features stage, representing the process of products and industries appearing, consolidating and maturing. It was also deemed that the type of industrial innovation and degree of innovation depends on the industrial growth stage. There are scholars proposed improved model according to the traditional A-U model, Yao Zhijian, etc. (1999) described long-term A-U innovation model, considering the needs –life-cycle of the A-U model. Liu Youjin etc. (2001) considered the competition period, in which product replacement will take place, completing the recession of old products and the emergence of radical technological innovation, they also thought the upgrade and development of the industry is jumping and can be overcome.

Each generation of products will go through life cycle process containing introductory phase, growth phase, mature phase, degenerating phase, subseqently be replaced by new ones. We consider that in different markets, the

same product could present different life cycle forms (as shown in Figure 2). Especially considering the market barrier or technology barrier is relatively high, process such as original technological change, dominant design formation, should first occurs in advance market, then makes the products gradually mature. This is determined by the strong purchasing power and easy acceptance of new products. The occurrence innovative products being transferred into lagging market when the new products been digested to a certain extent by advanced market. In new market, the products possess high starting point of innovation value of inertia, the new ones root in advanced regions can find better profit margins. As the purchasing power in lagging regions cannot do better than that in advanced regions as a whole, additionally, the products is maybe gradually breaking away from the highest innovative value-added point, the total value creation of this product in lagging market will be inferior to that in advanced market. In this period (the opportunity window 1 indicated in Figure 2), many lagging enterprises take over OEM business for leading enterprises in industrial chain using the good opportunity new products entering, so as to share the interests profit from the extension of industrial chain. Enterprises in China commendably catched the opportunity by feat of his "demographic dividend" in the past years.

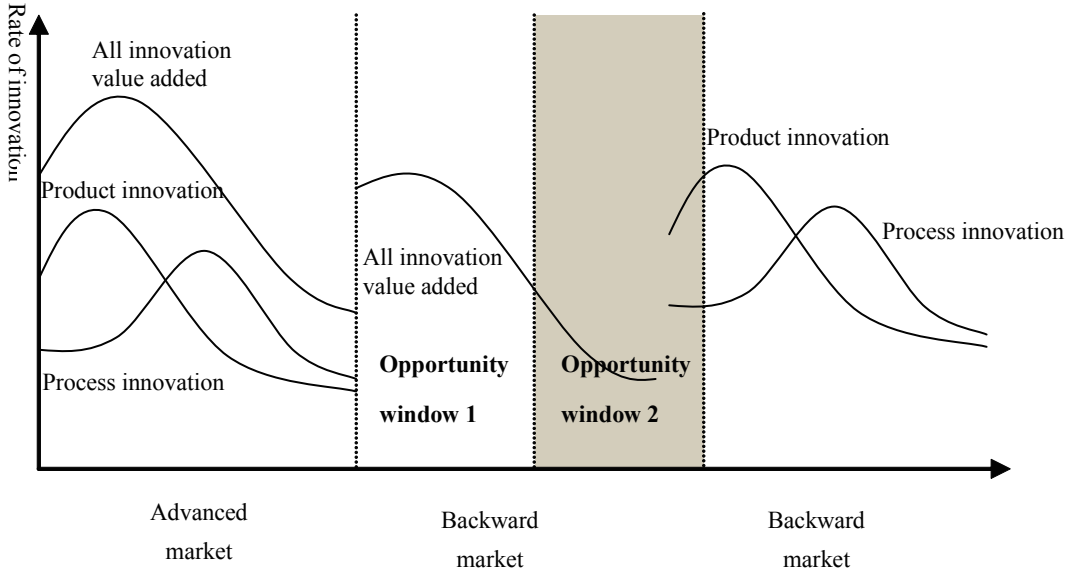

Figure 2
Modified A-U Model Based on the Market Transfer

During the "opportunity window 1"period, enterprises in lagging market can but passively accept the new products and operate non-core link business in value chain. Nevertheless, the entrance of new products would eventually bring more advanced technical standard, management concepts and new technology, with the hidden impact continued accumulation to a certain extent, new opportunity appearing (opportunity window 2). During this period, if enterprises in lagging market can integrate resources on the basis of technical standards absorption, talents introduction and reverse engineering, to conduct R&D activities with enhancing innovative ability, then it is likely to generate technical leap and upgrade, leading a new round of technological change.

Using product markets transfer and leaps rule of industry development, enterprises in lagging market can bypass some intermediate link even production link with high difficulty of technology and product creation in advanced regions, to achieve leapfrog development and shorten the chasing road even achieve the advantage of backwardness. From this perspective, the process OEM upgrading to Omnis the process it seizes the advantage of backwardness in the industry life cycle and use a new round of technological innovation to realize leaping.

2. 2 Two-stage Model of Realizing Upgrading in Opportunity Windows

As described in the previous section, backward enterprises can share the preliminary interest in the chain while they seize the opportunity of industrial chain division (like OEM) in "opportunity window 1", based on the outsourcing of products transfer. Nevertheless, backward enterprises should make a difference in "opportunity window 2"if they want high profits and dominant position in value chain. Based on the rules of technology transformation between two enterprises in two cycles, we set up corresponding models to analyze problems of advanced enterprises' innovation profit transfer and backward enterprises' technology reception and re-innovation. Among them, the first cycle is monopolistic

stage of advanced enterprise' technological innovation, showing the earlier stage of "opportunity window 1". The second cycle is learning and innovative stage of backward enterprise, which can be interpreted as later stage of "opportunity window 1"and earlier stage of "opportunity window 2". We consider that special innovation can enhance the product quality, meanwhile have positive impact on corporate profits: advanced enterprise's innovative results can spill over into backward enterprise by some means.

Fundamental assumption:

Hypothesis 1: Game variables is corporate output in current period, the volume of production of enterprise I in stage j is $q_{ij.}$

Hypothesis 2: Each enterprise's products demand is linear, the inverse demand function of enterprise i in stage j is

$$p_{ij} = a - bQ_j + A_t$$

$Q_j = \sum_{i=1}^{n} q_{ij}$ a, b>0, A_t is the unit product innovative value-added benefits of enterprise i, the value will vary because of the different sequence of innovation. Q_j is the total market demand in period j.

Hypothesis 3: Each enterprise produces homogeneous new product, the fixed cost is 0, the unit production cost of each enterprise is the same and changeless, we set it to c.

Hypothesis 4: We only consider production of two enterprises in two cycles, and the quality-difference origining from different technical levels results in the difference of product price between two enterprises. A_t means the increased profit owing to technological innovation in each stage. In a period, at should be the continuous-increasing function. As we just study cases in two periods, A_t is supposed discontinuous.

Stage 1: One-period monopoly of advanced enterprise (enterprise 1)

As the increased profit owing to technological innovation in this stage is A_1, the inverse demand function is

$$p_{11} = a - bq_{11} + A_1$$

Its profit function is

$$\pi_{11} = (p_{11} - c)q_{11} = (a - bq_{11} + A_1 - c)q_{11}$$

Set $\frac{\partial \pi_{11}}{\partial q_{11}} = 0$, we can work out the optimum output of enterprise 1:

$$q_{11}^* = \frac{a + A_1 - c}{2b} \quad (1)$$

Plugging it into formula (1), deducing the profit of enterprise 1:

$$\pi_{11} = \frac{(a + A_1 - c)^2}{4b} \quad (2)$$

Stage 2: Technology import of backward enterprise

During this period, innovative technology is getting mature gradually in enterprise 1, as a result, the innovative added-value brought to product is raised to A2(A2>A1). New technology is gradually introduced into backward enterprise (enterprise 2), while technological import often has the characteristic of lag, that is to say, the absorption of the technique needs a certain period of time, and the technical barriers are existing. As a result, enterprise 2 will not achieve enough innovative added-value as much as enterprise 1. Supposed that the product innovative added-value of enterprise 2 is A_1, which equals to that of enterprise 1 in stage 1.

The inverse demand function of enterprise 1 is

$$p_{12} = a - b(q_{12} + q_{22}) + A_2$$

While the price of product of product 2 is

$$p_{22} = a - b(q_{12} + q_{22}) + A_1$$

The profit function of enterprise 2 is

$$\pi_{22} = q_{22}(p_{22} - c) = q_{22}(a - bq_{12} - bq_{22} + A_1 - c) \quad (3)$$

We consider the situation q_{12} is given first, set $\frac{\partial \pi_{22}}{\partial q_{22}} = 0$, we work out the optimal volume of production of enterprise 2:

$$q_{22}^* = \frac{a + A_1 - c}{2b} - \frac{q_{12}}{2} \quad (4)$$

As enterprise can predict that enterprise 2 would adopt q_{22}^*, profit function of enterprise 1 is:

$$\pi_{12} = q_{12}(p_{12} - c) = q_{12}(a - bq_{12} - bq_{22}^* + A_2 - c) \quad (5)$$

The optimal volume of production of enterprise 1 is:

$$q_{12}^* = \frac{a - c + 2A_2 - A_1}{2b} \quad (6)$$

Plugging it into formula (4), deducing the optimal volume of production of enterprise 1

$$q_{22}^* = \frac{a - c + 3A_1 - 2A_2}{4b} \quad (7)$$

Plugging formula (6)and (7)into formula (5)and (3), to work out the profit of enterprise 1:

$$\pi_{12} = \frac{(a\text{-}c + 2A_2 - A_1)^2}{8b} \quad (8)$$

The profit of enterprise 2:

$$\pi_{22} = \frac{(a - c + 3A_1 - 2A_2)^2}{16b} \quad (9)$$

Along with the increase of production innovative added-value, the profit function of the two enterprises begins to change.

Discussion

• For enterprise 1, the technological spillover made its profit threatened in duopoly competition. If enterprise 1 doesn't take immediate action to propel technological innovation, its profit will be divided by continuous

competition. $A_2 = \frac{(\sqrt{2}-1)(a-c)+(\sqrt{2}+1)A_1}{2}$ is a critical value, if the technological R&D speed of enterprise 1 can be up to this standard, they may get better profit in stage 2.

• For enterprise 2, namely backward enterprise, we cannot judge the rage of formula ($3A_1$-$2A_2$), but in stage 2, enterprise 1 can get fatter profits with its more advanced and rapidly changing technology, the added value of enterprise 2 is due to outdated technology of enterprise 1, therefore, the initiative is seized by enterprise 1. If the innovative value-added is large enough (A_1>2/3 A_2), enterprise 2 can get fatter profits brought by absorbed technological spillover.

• The original innovation of advanced enterprise plays an important role in creating innovative environment, and provides motivation to realize technological spillover.

• If enterprise 2 can achieve independent technical improvement based on absorbing innovative results of enterprise 1 in "opportunity window 2 ", meanwhile, taking enterprise 2's relatively backward status into account, we can see $A_1 < A_2' < A_2$, according to the game approach in stage 2, we can work out: $\pi'_{22} = \frac{(a-c+3A'_2-2A_2)^2}{16b} > \pi_{22}$. Therefore, backward enterprises should carryout innovative activities actively and seize new opportunities to get better position and lead a new leaping development of industry.

3. THE PATHS OF CHINESE ENTERPRISES' UPGRADE IN OPPORTUNITY WINDOWS

3. 1 The Four Paths

OEMs must catch favorable time in opportunity windows to carry through functional upgrading starting with global value chain, and realize upgrading from OEM link to designing link which has fatter profits, and then they can achieve a virtually competitive advantage. This objection can be realized by paths below.

3. 1. 1 Absorbing the Technological Spillovers

Developing countries in open economy don't have technology and capital advantages. The first source OEM getting innovation capability is the knowledge transfer from the world's leading companies (Forbes, & Wield, 2001). Generally speaking, the technology innovation cost of independent R&D will higher than that of technological imitative innovation, as indicated in opportunity window 1, the advanced technology and management concept can be transferred with products and business transfer of advanced countries, as a result, the technology innovation of developing countries can begin with learning from developed countries' technology. By accepting outsourcing and absorbing the technology spillover from upstream firms, OEM enterprises can improve their technical level, organization efficiency and management skill, gradually form the "absorption-reversed R&D –independent innovation" mechanism, to realize transformation. The technical spillover of client mainly contains products development and design, production-manufacturing, brand promotion and sales service (Zhang, 2008).

Only OEM enterprises take an active part in global value chain and interact with central enterprises, embed in the division system of GVC dominated by multinational corporation to get maximum technical spillover and transferred knowledge, can they realize the rising in GVC (Cao, & Ye, 2011). The spillover absorption can be realized by several ways. Firstly, the "demonstrated order". OEM enterprises can imitate the technology, standard and ideas hidden in supplied materials from upstream enterprises, while improving the processing quality and properties of products, to carry out reversed designing towards the imported components and semi-finished products, deep learn these technology mechanism, master the designing process and complete technical absorption. Secondly, helping to bring about spillover by talents training and mobility. Talent is the carrier of innovative ability. On one sidemen enterprises set up talent training institutions by themselves or jointly with foreign merchant, to improve the labor quality of OEM and fulfill the subcontracting mission; On the other side, staff in advanced-technology OEM enterprises can enter into relatively backward enterprises, to bring into full play in terms of product process, operative skills and management, making the knowledge spreading intangibly.

3. 1. 2 Reverse OEM

When enterprises accumulate a certain level of technology in "opportunity window 1", if their capital is abundant, they can obtain technology quickly by "Reversed OEM" model. As is showed in figure 3, this is a model OEM enterprise acquiring upstream enterprises. Some practice shows that this style can effectively promote enterprises upgrading under a certain conditions (Zheng, 2006).

On the basis of having advantage of "economics of scale", large-scale production capacity, process-

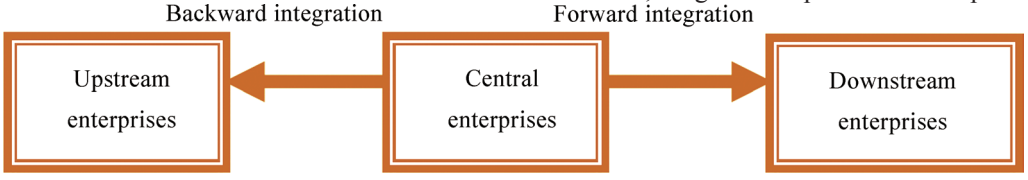

Figure 3
Forward Integration and Backward Integration of Enterprises

improvement capacity and technical digestion absorbency capacity, enterprises take advantage of their fund superiority to select and take over those enterprises which have more high-quality patents, especially have related business and potential integration with the enterprise, to occupy advanced proprietary technology and dedicated device, reduce production cost, improve the quality of products and cut the technology research and development cycle. This path can completely acquire relative even core technology compared to absorbing technology spillover, it can promote the enterprise to realize the revolutionary change. Meanwhile, there are many differences in culture, staff, standard etc. between the absorbed enterprise and the enterprise, which can lead to greater risk.

3. 1. 3 Constructing Industry-Education- Research Cluster

The controller of GVC usually seeks cluster as well as its internal enterprises which have comparative advantage to be as object of subcontracting its non-core business. The new economic geography theory, represented by Krugman, considers that the industries spatial agglomeration has technological externalities, which is conductive to realize the innovation and promote economy growth. Meanwhile, industrial cluster can and is necessary to enter the external system via GVC (Humphrey, & Schmitz, 2000). The stage innovation system theory represented by Nelson considers that the fundamental research of universities and research institutions have strong permeation to industry innovation.

The industrial spatial agglomeration features of Chinese high-tech industry is obvious, mainly in few areas such as Pearl River Delta, Yangtze River Delta, and Beijing, Tianjin (Wei, et al. 2010). However, many industry clusters are the processing plants collection which have low barriers to entry, cheap labor force and low assets specificity, their management level are low and technology level is limited. The synergy advantage of industry cluster hasn't be taken, such as technology sharing and risk sharing.

In opportunity window with multinational corporation's technology transferring, if enterprise can integrate its relevant industry-university-research institutions for collaborative innovation, and do cooperative research aiming at the technical difficulty, they will be able to improve the efficiency of R&D, realize the technical breakthrough. Such cooperation also can promote the technological spillover be sharing resource of internal cluster, and is good for the cluster technology level promotion. Meanwhile, the benign competition in cluster makes it coordinating to do independent innovation and cooperation development, and to strengthen the innovation atmosphere, reduce the enterprise's innovation inert.

3. 1. 4 Independent R&D

The most important term to form a stable coalition with core enterprise of GVC is to have strong R&D and designing capacity, as well as to provide superior and multiple products or products solutions. The methods like absorbing technology spillover, reversed OEM are just establish the basis for independent R&D. Actively improving independent R&D capacity is the core business to accept higher level of technology and upgrade to ODM. Only has strong independent R&D capacity, can OEM enterprises lead the products and industry change.

The implement of independent R&D must be based on long terms of strong technology accumulation. OEM enterprises should have unique advantages in some field of technology, such as professional technical accumulation, talents with special characteristics. Setting up R&D institutions is the organizational guarantee, to construct laboratories, research institutes, even R&D center constructed beyond the sea, the regions where there are high quality knowledge resources, to concentrate talents.

Compared with technology import and learning to imitation, independent R&D has longer cycle with more risks, continual readjustment and continuous investment will be needed. OEM enterprise should put its R&D achievements into brand strategy system (Xu, & Qu, 2005), to protect its intellectual property by applying for patents, registering trademark, putting on record in Customs, ect., which will make for furthest realizing the technology innovation value.

3. 2 The Choice of Paths and the Policy Implications

In different opportunities, enterprise should choose the right upgrading path according with the industry environment and its development level. In "opportunity window 1", as well as the stage that advanced multinational corporation subcontracting the manufacturing link, enterprises in developing countries undertaking the business and making OEM gradually mature, OEM enterprises can improve their technology rapidly by paths of absorbing technology spillover or adverse OEM. While in "opportunity window 2", OEM business is mature enough, the technology conditions are favorable, enterprise should rely on the independent R&D to improve its value. The path of Enterprises-universities-research institutes collaborative innovation can be carried out combining with the specific conditions in certain period.

As is showed in table 1, the path of absorbing technology spillover is relatively safe, but the cycle will be longer. The path of adverse OEM needs massive funds, and OEM should have good technical tolerance ability, right system and talents are also essential. Industry-education-research cluster construction needs macro-control by government, also it can be an enterprise behavior root from enterprise demand. Only enterprises have characteristics and advantage also coordinate ability, can they get to win more in the cluster. Independent R&D path need good professional technology base and strong R&D personnel, meanwhile, it is a long-term capital investment process, the investment risk is higher, but the long-term technology capacity is attractive.

Table 1
The Comparison of Various Paths

	Period of opportunity	Technologic base	Funds investment	Talents' support	Governmental and social support	Implemented risk
Absorbing technology spillover	Opportunity window 1: earlier stage of opportunity window 2	Elementary technical absorption conditions	Continuous investment	Study-oriented personnel having a certain quality	Corporate behavior, government and society can be uninvolved.	Adjust while operating to reduce risk
Adverse OEM	Later stage of opportunity window 2: earlier stage of opportunity window 2	Good technical integration environment and technology interface	Heavy investment once	Integrated management talent and Study-oriented personnel	Corporate behavior, government can help to materialize	The risks to integrate and technical matching
Constructing industry-education-research cluster	opportunity window 1: opportunity window 2:	Strong technology strength and complementary advantage	Heavy investment	Talents with broad skills	The government policy can improve the collaboration	External instability
Independent R&D	opportunity window 2:	Professional technology strength in some aspects	Continuous and heavy investment	High-level research-typed talents	Corporate behavior, government and society can be uninvolved.	The failed research and sunk cost

The paths upgrading from OEM to ODM is not unique. In the process of enterprises upgrading, these paths will be interpenetrated with one another. Enterprise can achieve the independent innovation and gain the core technology. Meanwhile, enterprises should attach importance to build the internal and external environment, to establish security for capacity building.

Firstly, OEM enterprises should ensure the steady-quality products, to strive for the technology spillover. The stable product quality is the necessary condition that OEM enterprise gaining continuous epiboly business, and the base of getting the technology spillover of auftraggeber. Enterprise should try the best to ensure quality, and create the atmosphere of technology learning and re-innovation positively, to strive for the spillover and attain independent technology gradually, build advantage of core technology.

Secondly, aiming at the most advanced technology areas, to carry out merging depending on its real situation. The OEM enterprises having scale advantage and technology accumulation can consider to merge upstream enterprises which have technology advantage after the detailed assessment, to realize the rapid improvement of technology level. However, the enterprise should assess the risks existed among them, like cultural system, personnel integration and technology matching.

Thirdly, to strengthen the cooperation in cluster and to realize the collaborative innovation. In allusion to the key point and difficult point in technology innovation, interacting with relative enterprises, universities and research instincts inside the cluster, to make use of their respective advantages and create synergetic effects, improve the technology level of OEM rapidly and efficiently. Moreover, enterprises should create favorable environment for innovation by starting research center or corporate university, to train the own R&D team which is stable and high-qualitied, laying the foundation of OEM upgrading.

CONCLUSION

OEM mode cannot support the sustainable growth of economic in China, so it is urgently needed to change the production pattern. ODM has an obvious advantage over OEM. In our analysis based on the modified A-U model, two opportunity windows appears: "Opportunity window 1" means a period new products and new technology transferred from advanced market to backward market, and enterprises in latter can accept the new products and operate non-core link business in global value chain to get profits with their own comparative advantage such as cheap labor, OEM is a good mode for developing countries in this period: In "opportunity window 2", if OEM enterprises can't achieve upgrading by technology progress, they will lose the chance of further development.

We summarized four paths for OEM to realize the upgrading to ODM, absorbing technology spillover, adverse OEM, constructing industry-education-research cluster, independent R&D. They can be used in proper opportunity window with different operation conditions. OEM enterprises and government should create conditions to realize corresponding path, then OEM can upgrade to ODM mode.

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