

**Supply Chain Positioning and Innovation:  
Taiwan's Challenge\***

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## Supply chain positioning and innovation: Taiwan's challenge

### I. Innovation traps of an intermediate goods producer

We argue that supply chain positioning affects the ability and scope of innovation. This is so because positions on the supply chains affect the access to knowledge and the ability to appropriate the value coming out of innovation. Knowledge determines the capability of innovation and appropriation power determines the incentive of innovation. Most Taiwanese firms position themselves as suppliers of intermediate goods. They innovate in collaboration with end users that are typically brand marketers of final goods and services. Their innovations manifest several characteristics that are closely associated with their position on the global value chains:

#### I-1. Technology trap

Without direct contacts with consumers, the innovation of Taiwanese firms is mainly driven by technology rather than market demand. They depend on end users to provide market information to chart the course of innovation. This locks them in a position as the market followers. Taiwanese firms have rarely been the first to introduce a truly innovative product to the market, unless they do it in collaboration with their brand partners who define the products. Inability to define products is the Achilles heel of Taiwanese firms when they attempt to become brand marketers, as exemplified by one of the more successful Taiwanese brands, HTC. They can do reasonably well when innovation is technology driven rather than market driven, for example, in the semiconductor industry where Taiwanese foundry service providers have followed the "Moore Law" by moving the processing technologies forward generation after generation. But even in the semiconductor industry, Taiwanese firms cannot put their technologies to use without the cooperation of their clients, who bear

the costs of new product experiments and the risk of technological failures. Cooperation is possible only if Taiwanese firms possess frontier technologies that worth the costs and risks of experiments. Before they secured that position, cooperation with end users in innovation was rather difficult, and Taiwanese firms had to compete by price. Price competition led to imitation rather than innovation (Aghion, Harris, Howitt and Vickers, 2001). The experience suggests that for technological followers in the intermediate goods industry there is little room for innovation even if they wish to do so. If Moore's Law stops functioning one day, it is quite possible that Taiwan's partnership with end users like Apple will also crumble. In contrast to the foundry service providers in the semiconductor industry, the Taiwanese IC designers seem to have more difficulties in forming alliance with the world's leading users of IC chips because market dominates technology in driving IC design innovation. They have succeeded to some extent in the case of smart phones, where a modular type of design architecture like Android is available to allow sub-system innovations. But Taiwanese IC designers have been almost invisible in other areas such as automobiles or consumer electronics, where knowledge about the market is critical to innovation. This may be called a "technology trap."

## I-2. OEM trap

As an intermediate goods supplier, the value of innovation cannot be realized without the help of end users: In most cases, innovation is achieved in collaboration with the brand marketers, who define the products and bear the responsibility of marketing the products. While collaborative innovation reduces the risks of innovation and increases the efficiency of innovation investment, it also limits the scope of innovation. Moreover, because the value of intermediate goods innovation can only be realized by brand marketers that hold complementary assets to the said innovations, only a small portion of the value of innovations is accrued to

intermediate goods innovators. To enhance the value of intermediate goods innovation, it is imperative for innovators to seek adoptions by other brand marketers. When succeeding, it leads to a crowded market and a quick decline of the price of final goods. To cope with the price decline, the brand marketers have a tendency to source similar intermediate goods from alternative suppliers or intermediate goods based on alternative technologies. Therefore, economic rent derived from intermediate goods innovation is only transitory, making it difficult for Taiwanese intermediate goods producers to engage in long-term R&D. They are therefore trapped in a short-term collaborative R&D cycle and unable to make autonomous innovations to enhance their position on the supply chain or the value of their relational assets. Therefore, it is hard to expect that disruptive innovation will come out of this kind of collaborative R&D. This may be called an “intermediate goods trap” or “OEM trap.”

### I-3. Modular trap

Small Taiwanese firms specialize in a narrow range of technologies. Their scope of innovation is confined to product and process innovations based on technological improvements. There are few cases of business model or market discovery innovations. They are more successful in a modular system as opposed to an integrated one. By definition, in a modular system, innovation can be conducted independent of actions taken in the other sub-systems (Baldwin and Clark, 2000). They can also draw on some “public goods” in a modular system to achieve innovations. This reduces the costs of innovation and increases the success rate. However, a big drawback of the modular innovation is that innovation is not possible until the system is well structured. In other words, as a modular innovator, it is impossible to be the first mover in a new industry. An apparent example is Taiwanese firms’ struggles to break into the newly emerged IoT (Internet of Things) industry. They could not find an entry point because the architectures of smart homes, smart

cities, smart factories, and the like, are yet to be determined. Taiwanese firms lack the capacity to make system innovation, even for a subsystem. Therefore their ability to innovate is to no avail before the system architecture is clearly defined and they cannot innovate beyond the boundary of a subsystem. We may call this a “modular trap.” The modular trap applies to Taiwan’s most important ICT industry, including computers and smart phones. In this industry, their ability to innovate depends on the innovative capacity of the system architects like Windows and Android. When the system architectures stop innovating, the innovations of Taiwanese firms also stall.

## II. Recent developments

In recent years, as the pressure for innovation mounted, some attempts have been made by Taiwanese firms to escape from the aforementioned traps. As a result of such attempts, their role of innovation in the global supply chains seems to have changed somewhat. By reviewing these attempts, we can see the progress and limitations of intermediate goods innovation. The recent experience indicates that there are hopes for Taiwanese firms to escape from the OEM and modular traps, but they remain confined in the technology trap.

### II-1. Innovation enabler

Instead of offering innovative products, they offer intermediate goods to provide an impetus for innovations by end users. In other words, they enable innovations. This is best exemplified by material suppliers. By providing new materials, they allow the downstream users to make innovations based on such materials. Functional textile is a case in point. Functional textile is produced by applying new technologies in the traditional textile-manufacturing process, like weaving, knitting, crocheting, knotting, or pressing, to generate some specific qualities of textile such as anti-bacterial, moisture management, flame retardant, or water-repellent effects. The objective of

material innovation is clearly defined by functional requirements in sports wearing or fire-fighting outfits, and it is to be achieved through technologies. This falls within the capacity perimeter of Taiwanese firms. In fact, a series of innovation in functional textiles in recent years have rejuvenated Taiwan's declining textile industry, allowing it to capture a major share in high-end sports wears. The innovators do not have to worry about the details of market trends, as long as they understand there is a demand for healthy and green living. They can make innovation without any knowledge of fashion, which is to be shaped by apparel producers. However, to market the new materials to cloth designers, they have to change the conventional way of conducting business. In the past, Taiwanese textile suppliers compete for the orders from apparel makers after clothes have been designed and materials designated. Now Taiwanese textile suppliers have to persuade the apparel makers to adopt their materials to make new cloth designs. With new functions contained in the new materials, they enable apparel makers to innovate products that manifest the newly available qualities. The new materials are generic in the sense that they can be used by all apparel makers and can be fashioned by different makers as distinctive products in the market. By doing so, Taiwanese firms remain an intermediate goods supplier and their names may not show up in the final products (some do in an Intel-inside method). Nevertheless, they have escaped from the "OEM trap" in the sense that they are no longer instructed by the clients to make innovations. Instead, they innovate on their own initiatives and the clients follow. New materials create a new value to fashion brands, the owners of which can add further value with their own innovations. Brand competition no longer diminishes the value of intermediate goods innovation.

Another example is light emitting diode (LED). Advancements in LED technologies were contributed mostly by Japanese and American companies, but Taiwanese firms were pivotal in reducing the production costs and improving

light-emitting efficiency that popularize the new materials. Cost was the corner stone for the diffusion of LED lighting. Taiwanese firms specialized in processing technologies, including the processing of epitaxial wafers into chips and the assembly of chips into LEDs, or further into modules for ready adoption in designing lights. They work with different end users in various industries, and in various stages of production, to offer LED materials for innovation. LED has been applied in computers, mobile phones, automobiles, traffic lights, TVs, and household and commercial lighting, etc. Again, the contributions of Taiwanese firms are essentially functional, in terms of brightness and texture (colors) of the lights emitted, and luminous efficiency, which are to be achieved by technologies. Innovation in the downstream industries by brand marketers expands the scope of LED applications, and Taiwan has since become the largest supplier of LED materials in the world.

## II-2. Co-innovation

Although they do not initiate the innovations, they are invited to be an innovation partner from the very beginning. This happens often to components suppliers who possess the frontier technologies in certain areas, often niche areas, and the technologies are not mature enough to make industrial applications so apparent. They are invited by the brand marketers to engage in product innovations, making use of the untested technologies. Co-innovation differs from the traditional case of using mature technologies for innovation, where the technology owner plays no role in innovation. It also differs from modular innovation where innovation is conducted independently of other innovators, and is conducted only after the system architecture is in place. Co-innovation is a joint effort by partners in search for a new product design rather than an independent act under a modular system. By definition, co-innovation entails a certain degree of knowledge exchange and integration. Knowledge sharing is apparent and the partners may also jointly invest in the

exploration for new knowledge. Co-innovation is a step away from the “modular trap,” and it becomes possible because Taiwanese firms possess frontier technologies, albeit only in niche areas, to be exploited for new product development. With this move, the partnership in innovation becomes more equally footed than in the past and more value may be created out of the joint innovation.

For example, when Apple developed its first iPhone in 2007, it collaborated with a Taiwanese company, TPK, in creating the finger-impacted touch-screen panels, which are the pivotal components of smart phones. TPK was initially a component supplier in the PC industry, specializing in computer monitors. After failing in the monitor business, TPK shifted to produce touch-screen monitors used in automatic teller machines (ATM) and point-of-sales (POS) devices. The traditional touch screens were built on the resistive technologies. From around 2000, TPK started to venture into the capacitive technologies of touch screens, which allow multi-point inputs and enable instant responses to finger-applied pressures. With the only but untested technologies that seemed to fit Apple’s design of the newly conceived iPhone, TPK was solicited by Apple in 2004 to be a collaborative partner in the invention of the touch-screen panel. It took almost three years for the collaborative R&D to yield concrete results, but the results were revolutionary as they set the standard for smart phones. Until now, TPK remains a major supplier of touch screens for iPhones, despite Apple’s repeated attempts to seek alternative technologies and substitute suppliers. TPK is one of the few Taiwanese suppliers that dare to reject Apple’s request to sign an exclusive supply contract, suggesting the status of equal partnership.

### II-3. Branding attempts

Some Taiwanese contract manufacturers attempted to transform themselves into brand marketers. A few brands have been established, but their position in the world

market remains fragile. Although still young in the history of brand marketing, it has become clear that innovation is indispensable for brand success. A success formula of innovation is yet to be discovered, however. According to an assessment by Inter-brand, a consulting company, the leading five brands of Taiwan (based on brand value of 2015) are Asus (computer), Trend Micro (software), Want-Want (food), Acer (computer), and Giant (bicycle). For the first time in the history of this survey, two non-ICT companies made the top-five list. The core competence of Taiwanese ICT brands appears to be in technology. It is also interesting to note that the leading ICT brands, Asus and Acer, and HTC as well (which was ranked sixth in 2015) all have their major market in Europe rather than the emerging markets in Asia Pacific or Latin America. This suggests that markets in advanced countries still drive the directions of ICT innovation, and the emerging markets, such as China, may only offer a chance for product differentiation. In comparison, the brands in the food (Want Want) and bicycle (Giant) industries are not necessarily technology based. Progress of brand building in the non-ICT industries gives some hope that Taiwanese firms may have eventually succeed in breaking out of their technology trap, although the evidence is relatively weak compared to the case of escaping from OEM and modular traps.

### III. Opportunities and challenges of China

China has risen to become a major player in the global supply chains as well as an important market for global companies. In recent years, China has also become a major player in global innovation, as indicated by the number of patents, academic papers, and major technological developments in some specific areas. The rise of China presents opportunities and challenges to global companies in general, and to Taiwanese companies in particular. It may be expected that the emergence of Chinese market provides a chance for Taiwanese firms to overcome their Achilles heels in

making market connections. Unfortunately the experience so far generally failed to substantiate such an expectation. However, the rise of China has offered a new opportunity for developing alternative technological paths, and for accumulating strategic resources for innovation. Both seem to reinforce the basic pattern of technology-based innovation of Taiwanese firms rather than providing an impetus for market-based innovation. Two explanations are plausible for this result: First, the Chinese market is not easily accessible. Second, the Chinese market is not sophisticated enough to drive innovations that fall within the capability scope of Taiwanese firms.

### III-1. Shanzhai innovation

Market drives innovation, but Chinese market drives a special kind of innovation. Chinese consumers have a strong desire for frontier products and services but refuse to pay high prices for them. This gave rise to the Shanzhai industry, which offered products with comparable functions of the world's leading brands at significantly lower prices. Lower prices were achieved through low manufacturing costs in China, and Taiwanese firms contributed to this end by offering a technological platform that enables such kind of manufacturing. Shanzhai is not exactly an imitation, because imitation will not produce lower-cost products as many frontier products (for example iPhones) are already manufactured in China to achieve low costs. Shanzhai is an imitation in appearance, but a complete transformation of the way the product is designed and manufactured. Shanzhai products are most noticeable in the ICT industry such as DVD, MP3/MP4, and mobile phones where Taiwanese IC design houses provided IC chips to enable easy design and production of related products. Taiwanese firms played a dominant role in offering technology platforms, which had never existed before, although they did not physically manufacture or market the products.

For example, Mediatek, a Taiwanese firm specializing in mobile phone processors, provides processors that allow small-scale Chinese independent design houses to add desirable functions of their own designs without technological hurdles. Low technological barriers, together with the industry cluster which has been created by multinational firms through export platforms in Shenzhen, quickly produce a Shanzhai industry that took over the low end segment of the Chinese consumer market. For example, in the mobile phone industry, the Shanzhai products almost drove out all foreign brands in the end of feature phones era until the smart phones came to replace them. Mediatek was crowned as “King of the Shanzhai industry.”

However, to the extent that Shanzhai products mimicking after the leading products in the advanced countries, the contributions of Taiwanese firms are still technological innovation instead of product innovation. Their dominant role in the Shanzhai industry did allow them better access to the market information, but they have yet to demonstrate their ability to make use of this information for genuine product innovations. There is no doubt that the technological capabilities of Taiwanese firms have enhanced because of the Shanzhai experience, especially in the area of technology integration. It remains to be seen whether they can compete beyond product mimicking. With the advancement of technologies by Chinese firms, era, the Shanzhai smart phones have all but disappeared, Mediatek is competing now with Qualcomm, Spadtrum and others for orders from local brands such as Xiaomi and Lenovo. It is not clear whether the Shanzhai experience gave Taiwanese firms like Mediatek a competitive edge.

### III-2. Geographical dispersion of innovation

It is well noted that innovation has been more dispersed today than in the past. The reason for this to happen appears to be the increasing availability of R&D resources in the emerging markets rather than the increasing importance of emerging

markets. At least from the perspective of Taiwanese firms, this has been the case. Both China and India offer rich human resources for high-level R&D, and multinational firms have rushed to take advantage of these newly found gold mines of human resources. Globalization and the advancement of information technologies have made knowledge sharing and R&D coordination across national borders an easier task. Taiwanese firms are also active in exploring these new resources for innovation activities. Some do it through direct employment of skilled workers, some work with universities. The availability of offshore resources allows Taiwanese to diversify innovation activities and to increase the efficiency of research projects. Hon-Hai, for example, has been one of the leading patent producers in China in recent years through its collaboration with Tsinghua University. In 2000-2012, Hon-Hai produced 4912 patents granted by US Patent Office in the G (physics) and H (electronics) categories, accounting for 19.6% of all China-originated patents in these areas. Many multinational firms were equally active in conducting R&D in China, but Hon-Hai was well ahead of its competitors like Microsoft (1256 patents in the same period and categories) and IBM (707 patents) (Chen, 2015, p.10).

The collaboration may not change the basic pattern of innovation of Taiwanese firms, but it enlarges the scope of innovation, therefore increasing the opportunity of Taiwanese firms to cooperate with multinational firms, a manifestation of “alliance capitalism”. The essence of alliance capitalism is to continuously renew the firm-specific resources over time to create new opportunities for cooperation. With the renewal of firm-specific resources, the alliance partners may also change, together with the complementary resources to be linked for synergy. New partnership drives the evolution of Taiwanese firms into new business territories. Although Taiwanese firms are rarely the pathbreakers of a new industry, they are eager to embark on the new industry alongside with their partners. They used to be quick followers once a

new industry has emerged. This position is now taken over by a new league of countries, including China. In order to secure a new position in the global supply chain, they need to move into a new industry at the same time as the pathbreakers, even if they only play an auxiliary role in production. They have to be prepared when the horizon for a new industry arises, and patents in possession are their admission tickets to the new horizon. To this end, human resources in China are valuable.

### III-3. Escaping imitation

Emerging markets, such as China, provide new resources for innovation, but they also present new challenges, notably the threat of imitation. Imitation reduces the potential value of innovation and therefore undermines the incentives for innovation. Lack of protection for intellectual properties encourages imitation. In some countries, including China, imitation is even cherished as socially valuable. To escape from imitation, Taiwanese firms hide their innovations inside the products of multinational firms, which have more means to protect themselves against imitation. For example, Largan Precision, a Taiwanese company which offers the most advanced camera lens for smart phones, is relatively unknown and rarely targeted by imitators. Its technologies cannot be easily tracked down through reverse engineering because the performance of the camera is a joint result of hardware technologies of Largan and software technologies of smart phone makers. The combination of hardware and software technologies entails tacit knowledge which is hard to identify. The components are sold only to high-price brands so as to exclude the potential imitators from accessing the relevant knowledge, therefore solidifying Largan's alliance with major brands like Apple and Samsung.

Despite the fact that China has become an important market for their products, Taiwanese firms' alliance with multinational firms can be strengthened if they have the kind of components to distance themselves from the imitators. Their alliance

partners welcome and encourage innovations of Taiwanese firms that allow them to escape imitation. The supply chains of multinational firms are essentially segmented from the supply chains that serve Chinese local firms, as all are conscious of the threat of imitation. However, imitation did take place. Imitation has been more successful in the area where there is a demand for outdated and low-end products (Salazar, 2008). For example, demand for sub-quality liquid crystal display (LCD) panels by local industries, including TV receivers, provided resources to develop the local LCD industry. When imitation of intermediate goods was successful in China, it also allowed final goods producers, such as TV receiver makers, to compete with multinational firms, which in turn, will seek new technologies to escape imitation. This provided an impetus for innovation by Taiwanese intermediate goods providers, which eventually developed the 4K technologies in LCD panels. The threat presented by successful final goods imitators, like Xiaomi, Hauwei, and Lenovo, is more damaging as they undermine the traditional alliance between Taiwanese intermediate goods producers and multinational firms. Chinese final goods producers have a tendency to seek vertical integration as the China government encourages nationalization of key components through its “indigenous innovation” policy (Ernst, 2011). Therefore the Chinese final goods producers present a more serious challenge to Taiwanese firms than the intermediate goods producers.

#### IV. Future perspectives

In short, in order to escape from three traps of innovation as an intermediate goods producer, Taiwanese firms attempted to move up and down the supply chains. When moving up the supply chains, they innovate to make new materials or new components to enable the downstream users to make further innovations. The purpose of innovation is to create new functions in their products, and innovation is mainly

achieved through technological breakthroughs, which are one step up the technological ladder from their previous task of technological improvement.

When moving down the supply chains, they do some kind of integration in collaboration with their partners. In most cases, the kind of integration is also technology oriented. They put together technological resources to create new products in consortium with their partners. Co-innovation is more difficult than innovation enabling because it entails knowledge sharing and the creation of new knowledge through joint efforts. Nevertheless, co-innovation seems to present more opportunities for Taiwanese firms, which embrace alliance capitalism, to enhance the value of innovation, and with it more incentives for innovation will also be operational.

Both movements are anchored by technological progress, and the strategy will be successful only if the technological frontiers have been reached. The challenge is daunting but the road to success is clearly mapped. Some Taiwanese firms have actually succeeded in making the moves, demonstrating the feasibility of this approach. In contrast, Taiwanese firms remain weak in making market-oriented innovations in the sense of putting together different technologies to independently create final products for consumers.

In other words, Taiwanese firms remain intermediate goods producers, but they have tried to be proactive rather than passive innovators today. A proactive innovator engages in innovation on its own initiative rather than taking instructions from the clients to engage in “contracted” innovation. It requires some new capabilities to do so, which includes the ability to see the market value of new technologies and the ability to obtain such technologies.

It remains to be answered why Taiwanese firms are unable to become final goods innovators. The attempts to do so have recorded limited success if not a total failure. They apparently lack the capabilities to combine market knowledge with technologies

in order to design the products that meet the consumer demand. It is not clear what exactly these capabilities entail and how they can be acquired. However, like the technology learning that Taiwanese firms have experienced for at least half a century, it must be a slow and cumulative process. Considering that Taiwanese firms began to engage in market learning only recently, it may take some time before we see concrete results. Although final goods innovation commands more market value than intermediate goods innovation, it is also a more risky adventure.

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