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Post Catch-up with Market Cultivation and Product Servicizing: Case of Taiwan's Transportation Equipment Industries

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Abstract

This paper sets out to examine a key issue: how a latecomer, like Taiwan may develop its industry in a post catch-up manner. We make intensive inquiries into this issue via case studies on two sectors in Taiwan, namely the bicycle industry and the electric vehicle industry. One challenge to post catch-up is related to the situation where innovation model and path are at the fluid phase and where scarce opportunity for imitation is present. This has led us to giving special account to fuzzy front-end at the industrial level and how market cultivation and innovative business models come to play an important role in shaping the innovation path for post catch-up. For a couple of leading players in Taiwan's bicycle industry, a key issue they faced was how to transform themselves and local setting in Taiwan to become a leader in high-end bicycles, in an attempt to fend off escalated international competition. In the emerging EV industry, the Taiwanese players try to overcome its structural weaknesses in the mainstream automotive industry to explore the possibility of levelling the playing field with the forerunners in the advanced countries. Our case studies suggest that technological catch-up is not necessary a prelude to post catch-up, depending on the nature of new innovation trajectory and entry modes of the emerging industry. While the way in which a latecomer's industry to rise in a post-catch-up manner has something to do with path dependence, something can be done to overcome the path dependence. Our analyses also lend support to the importance of product servicizing as a means of post catch-up, especially from the perspective of market cultivation. On balance, for post catch-up at an industrial level, a latecomer's innovation system and its boundaries have to be shaped in line with the country's level of technological accumulation, constituent firm's strategy, the complexity of the innovation at issue, and the way in which the focal industry is emerging.

Key words: Post catch-up, technological catch-up, product servicizing, market cultivation, business model

1. Introduction

Economic catch-up at the industrial level is not just a developmental process but also an iron-cage of developmental path and mindset. As stereotypes, latecomers in their industrialization process climb the catch-up and industrial upgrading ladder by either taking part in the global production/innovation network or forging indigenous innovation, especially in the equipment or capital goods industry (Mu and Lee, 2005; Kim and Lee, 2008) to eventually prevail in the international market. In these ways, the market and developmental trajectory are generally well-explored and/or well-defined by the leading player in the advanced country. More recently, increasing attention has been paid, especially by scholars of technology management, to an issue whether or not a latecomer can leapfrog or outcompete its advanced counterparts by approaching the technological frontier (Lee and Lim, 2001; Hobday, Rush and Bessant, 2004; Lee, Lim and Song, 2005) or at least level the playing field with the existing leading player in an emerging sector (Choung, Hwang and Song, 2014).

Post catch-up requires "innovation activities in which the latecomer countries establish new technological trajectories for innovation in a changing competitive environment where scarce opportunity for imitation is present." (Choung et al., 2014). Some literature on technological catch-up has addressed this issue under the scenario of "leapfrogging", and in conjunction with several other factors, such as technological regimes (Lee and Lim, 2001; Park and Lee, 2006; Wang and Tsai, 2010), the development of the equipment or capital goods industry (Mu and Lee,2005; Kim and Lee, 2008; Choung and Hwang, 2007) and indigenous industrial standards (Gao, 2014; Choung, Hameed and Ji, 2011; Choung and Hameed, 2012). In a word, leapfrogging can occur with a window of opportunity (Perez and Soete, 1987), with which firms in a latecomer have to effectively deal with the risk of choosing right technology and that of initial market creation (Lee, 2005). Despite the risks specified, much of the literature tends to focus on the way in which technological capabilities in the leapfrogging country is shaped and transformed to become a forerunner or approach the technological frontier. In our opinion, if one takes the risks seriously, as a departure from the catch-up model, post catch-up involves a scenario where a latecomer with few steps behind with the advanced country strives to explore "fuzzy front-end" in industrial innovation (Chang, Chen and Wey, 2007; Stevens, 2014), hopefully in a head-to-head manner. To do so, the latecomer has to deal effectively with such issues as market cultivation and the articulation of developmental trajectory with appropriate business models for the new industrial innovation involved. In particular, there is increasing awareness that innovative business models

are not only essential to an innovator's value creation and value capture but indispensable to the birth of an emerging industry (Teece, 2010; Kley, Lerch and Dalliner, 2011; Lenfle and Midler, 2009). These issues will become more complicated if the industrial player in the latecomer has stuck to the comfort zone of being part of the existing global production/innovation network or producing modules/products with open product architecture, as the typical case of the manufacturing industry in Taiwan.

This paper sets out to examine a key issue: how a latecomer, like Taiwan may develop its industry in a post catch-up manner. We make intensive inquiries into this issue via case studies on two sectors in Taiwan, namely the bicycle industry and the electric vehicle (EV) industry. The two sectors in Taiwan differ in their developmental stage and come across different issues in their transition period. Special attention is given to issues arising in their transition period to post catch-up. In doing so, we borrow the idea of fuzzy front-end, which used to be discussed mainly at the project level (Stevens, 2014; Chang et al., 2007; Alam, 2006; Khurana and Rosenthal, 1997). Detailed account of fuzzy front-end at the industrial level draws our attention to several issues surrounding market cultivation and innovative business models. We suggest that in the process of market cultivation, different business models, either product-oriented or service-oriented, have to be tested by the market, distilling lessons for continuous improvements or refinement of the business model. Our cases studies indeed highlight the significance of market cultivation and product servicizing (or termed as the servitization of manufacturing, Vandermerwe and Rada, 1988; Quinn, Doorley and Paquette, 1990; Chen, Wen, Yu and Yang, 2013).

The paper is structured as follows. Section 2 goes through selected literature to present our conceptual framework for post catch-up industrial development. The two industrial case studies are presented at Sections 3 and 4 respectively. In Section 5, we discuss a few issues in conjunction with post catch-up, based on a comparison of the two cases. Finally, the paper draws conclusions.

2. From Catch-up to Post Catch-up: Fuzzy Front-end and Product Servicizing

Catch-up by latecomers has been an important subject for studies of economic development on industrialization and research of technology management As well-documented, from the perspective of economic development, latecomers' catch-up has much to do with their developmental strategy of export-orientation versus import substitution, incorporating into the global production/innovation network, via learning and absorbing external source of knowledge and accumulating

and generating indigenous technological capabilities (Amsden and Chu, 2003; Chen, 2002; Ernst, 2006). In the field of technology management, technological catch-up has become a focal issue and has been discussed in conjunction with several other factors, such as technological regimes (Lee and Lim, 2001; Park and Lee, 2006; Wang and Tsai, 2010), the development of the equipment or capital goods industry (Mu and Lee, 2005; Kim and Lee, 2008; Choung and Hwang, 2007) and indigenous industrial standards (Gao, 2014; Choung et al., 2011; Choung and Hameed, 2012). Of interest to note is a sharp contrast between South Korea and Taiwan in their path and way of catch-up. On the one hand, Taiwan's achievements in catch-up has much to do with its ICT sector, which in turn is featured by inter-organizational platform-based development under a regime of modular and open architecture and active participation in the global production/innovation network (Chen, Wen and Chen, 2013). On the other hand, for South Korea, not only have its branded chaebols gained international outreach but also the country has become a strong player in a few sectors characterized by closed product architecture and complex system (Kim and Lee, 2007; Choung and Hwang, 2007). Even in the semiconductor industry, in which both countries have surged, institutional roots and technological regime can still account for their different paths, as evident in their US patents (Park and Lee, 2006; Wang and Tsai, 2010).

More recently, increasing attention has been paid, especially by scholars of technology management, to an issue whether or not a latecomer can leapfrog or outcompete its advanced counterparts by approaching the technological frontier (Lee and Lim, 2001; Hobday, Rush and Bessant, 2004; Lee, Lim and Song, 2005) or at least level the playing field with the existing leading player in an emerging sector (Choung et al., 2014). Hwang and Choung (2013) go further to initiate discussions on the possibility and framework condition for post catch-up by a latecomer. Compared to the stereotype catch-up situation where the market and developmental trajectory are generally well-explored and/or well-defined by the leading player in the advanced country, post catch-up requires "innovation activities in which the latecomer countries establish new technological trajectories for innovation in a changing competitive environment where scarce opportunity for imitation is present" (Choung et al., 2014).

Long ago, Perez and Soete (1987) proposed a leapfrogging scenario where emerging technological paradigms serve as a window of opportunity for catching-up countries that are not locked into the old technological system to grab the new opportunity to surge in the emerging industries (see also Amsden and Chu, 2003; Lee, 2005; Lee et

al., 2005). Lee (2005) has identified two risks associated with leapfrogging, namely the risk of choosing right technology and the risk of initial market creation. However, post catch-up can take place at different levels. For example, Hwang and Choung (2013) classify post catch-up innovation activities into four levels, including: (1) new knowledge and value: not only creating new artifact and knowledge but also creating new value through new combination of existing technologies; (2) new organization of the production system: major changes of existing technologies/production by introducing brand new organization methods; (3) architecture innovation: activities which pursue the innovation of an end product by innovating key components or combining existing unit technologies based on the existing dominant design; (4) social innovation: those creating a new trajectory based on unique regional demands or traditional industry of latecomer countries. Referring to this classification, one can argue that post catch-up should be interpreted and examined from more than just technological perspective. Instead, a broader context of innovation is needed, especially if post catch-up is not to become a remote possibility for most of latecomers.

A key issue of the paper is how may a latecomer like Taiwan to develop and/or transform its industry in a post catch-up manner. The Taiwanese case is interesting in its own right, given the fact that Taiwan's industrial innovation is associated mainly with the technological regime of modular and open architecture and active participation in the global production/innovation network (Chen et al., 2013b), while most of technological catch-up cases tend to focus on the capital goods industry, complex systems and industrial standards, where South Korea and China are particularly active. In the following discussions, the authors would like to propose a conceptual framework for post catch-up industrial development (see Figure 1), by borrowing a few existing concepts as our building blocks.

The first idea we draw from the literature concerns fuzzy front-end. Fuzzy front-end as a research concept and topic has been studied mainly at the project level (For example, Stevens, 2013; Chang et al., 2007), referring to the so-called pre-phase zero (preliminary opportunity identification, market and technology analysis), phase zero (product and concept definition) and phase one (product definition and planning) of the R&D process for new product development (Khurana and Rosenthal, 1997). At these specific stages, high fuzziness is related to the technical, market and management aspects (Nelson and Kahn, 2003), including customer preference, environment, competitors' actions and reactions, technological solutions, and management support for new ideas (Stevens, 2013). In addition, there are at least

three types of fuzziness, including uncertainty, equivocality and complexity. In particular, equivocality occurs when managers are unable to interpret or make sense of events, facts, and data or put inappropriate interpretation frame around specific situations. Complexity refers to a situation when a large number of parts interact in a non-simple way (Zack, 2001; Stevens, 2013; Chang et al., 2007). Much of the literature has addressed the way to manage (Chang et al., 2007) or remove (Alam, 2006) the fuzziness from fuzzy front-end, for example through customer interactions.

It is worth a while to discuss the term complexity. The complexity of fuzzy front-end may be illustrated by referring to a dichotomy of autonomous innovation versus systemic innovations (Chesbrough and Teece, 1996). Compared to autonomous innovation, which can be pursued independent from other innovation, systemic innovations by nature require "interrelated changes in product design, supplier management, information technology, and so on". While Chesbrough and Teece (1996) tend to suggest that systemic innovations are better managed in a hierarchical fashion, some authors emphasize the importance of open innovation (Maula, Keil and Salmenkaita, 2006) and coordination of the business network across different spheres (Vesa, 2006; Chen, Wen and Yang, 2014) in generating systemic innovations. In addition, the distinction between systemic innovations and autonomous innovation applies to not just manufacturing but also services (Vesa, 2006). In Spohrer and Maglio's (2008) words, one challenge to this type of service innovations is "the interdisciplinary nature of service, integrating technology, business, social and client (demand) innovations". Therefore, systemic service innovations often involve multi-stakeholders, playing different roles (Chen et al., 2014).

For us, fuzzy front-end may also make sense at the industrial level. Utterback and Abernathy (1975) divided the cycle of product and process innovation into "fluid phase", transition phase" and "specific phase". The fluid phase occurs from the development of a new product to the emergence of a dominant design. By nature, the early stage of an emerging industry is a fluid phase in innovation terms, bearing a resemblance to fuzzy front-end. However, one should not just take a linear view towards the cycle of product and process innovation. For one thing, a new "S Curve" or innovation trajectory can surge or be created in the existing product life cycle (Kash and Rycroft, 2002). For another, Christensen (2003) has drawn our attention to an issue that outstanding and leading companies can still lost their market dominance because of new market trajectory and disruptive technologies. While disruptive technologies may be considered as "innovations that result in wore product performance, at least in the near term, but are generally cheaper, simpler,

smaller, and frequently, more convenient to use". Christensen (2003) goes further to explore the Bottom of the Pyramid innovation (Prahalad, 2005) in the context of disruptive technologies versus sustaining technologies, suggesting that innovations based on disruptive technologies could be the appropriate means and playing field for new entrants to serve and expand the lower tiers of the market overlook by the incumbents, giving rise to a post catch-up scenario.

In addition, to effectively deal with the fuzzy front-end at the early phase of industrial development requires the formation of meaningful and innovative business models to be tested by the market, some of which may eventually prevail at the industrial take-off and later stages. In fact, "the right business model is rarely apparent early on in emerging industries" (Teece, 2010: 187) and will eventually prevail with an experimentation and evolutionary process (Bohnsack, Pinkse and Kolk, 2014). A problem is that the literature on technological catch-up and post catch-up tends to overwhelming focus on the product-oriented business model, pay scant attention to the service-oriented business model. In fact, a few studies have pointed out that for EVs to gain a viable market foothold, against the dominance of conventional cars, there is a need to move from product-based to service-based business models (Ceschin and Vezzoli, 2010; Bohnsack et al., 2014; Kley et al., 2011).

Actually, in the manufacturing sector, physical goods are increasingly associated with complex services that may enhance the product value for customers and provide commercially viable business models for manufacturers (Vandermerwe and Rada, 1988; Brax, 2005; Chase and Erikson, 1989; Quinn et al., 1990; Lenfle and Midler, 2009). There is indeed a substantial body of literature on such terms as the servitization of manufacturing, product servicizing, product service system, integrated solutions to highlight the trend towards blurred boundaries between manufacturing and services (for a review of the literature, see Chen et al., 2013a). Some leading companies such as IBM, GE, and Apple have pioneered different models for the servitization of manufacturing with success (Wise and Baumgartner, 1999), but it should be noted that transformation towards the servitization of manufacturing is far more complicated than the traditional product and process innovations, and involves systemic innovations in the intra- and inter-firm context. In essence, the servitization of manufacturing may involve issues such as strategic realignment at the corporate level, the rearrangement of intra-firm and inter-firm organizations and institutional relationships, capability-building, and new pricing and revenue models (Chen et al., 2013a). In other words, for most of the manufacturers, the march towards the servitization of manufacturing amounts to a substantial

departure from the transaction and offering of tangible goods alone. They may find themselves stepping into an unfamiliar territory, full of uncertainty (Brax, 2005), let alone substantial gaps in capabilities, institutions, networking, even in innovation governance, to be filled.

Moreover, there are two facets of the servitization of manufacturing and/or product servicizing. One is corporate strategy of transformation for individual manufacturers, which is widely received, and the other is related to the nature and way of manufacturing development, such as total solution and customer-oriented offering, for a few emerging sectors. For example, while LED manufactures in East Asia (Taiwan and China in particular) tend to adopt a cost-down and product-centric approach to promote LED products/modules in the marketplace by accelerating the technological dynamism, Dutch Philips has been devoted to an integrated energy management services, based on available LED products/modules. At the turn towards third generation mobile communications, Apple pioneered app services (known as the App Economy), which have not only boosted the popularity and proliferation of smartphones but also demonstrated the significance of applications and user experiences to mobile communications. Apple follows other players' (for example, Nokia's 3G) industrial standards at the architecture level, but the company's success in iPod, iPhone and iPad lies in its proprietary platforms, iTunes and App Store, and providing software design kits for numerous external developers to design applications with customer experiences. This implies that the mobile communications sector, in terms of both service and device, has become more application- and service-driven than ever. In a same vein, a few studies (Bohnsack et al., 2014; Kley et al., 2011) have highlighted the significance of product-service system configurations in the emerging business model for EVs, especially for entrepreneurial car makers.

Post catch-up also requires an appropriate framework condition in place. Referring to the case of South Korea, Hwang and Choung (2013) have outlined changes in the innovation system required to support latecomers' post catch-up activities. They suggest "a post-catch-up innovation system in the transition of a latecomer country to a more advanced economy must encompass the socio-economic system that surround the country's techno-economic activities" (Choung and Hwang, 2014: 158) in order to facilitate the creation of new technological knowledge and economic value. An interesting question for us concerns the extent to which the new innovation system required is confined by the national boundary, especially when one takes into account the effect of lock-in and path-dependence. As a tentative

hypothesis to be explored in this paper, the answer for this depends on a few issues such as individual country's level of technological accumulation, organizational capabilities, focal firm's strategy, the way in which the industry at issue is emerging, and how complex the innovation is (Kash and Rycroft, 2002).

Taken together the above discussions, Figure 1 outlines our conceptual framework for post catch-up industrial development. For initial conditions, post catch-up entails a window of opportunity as suggested by Perez and Soete (1987) and Amsden and Chu (2003). The window of opportunity has to be grasped by industrial players and/or policy makers with insightful vision for industrial transformation. They have to stand up to the challenges of fuzzy front-end at the industrial level in an effective way.

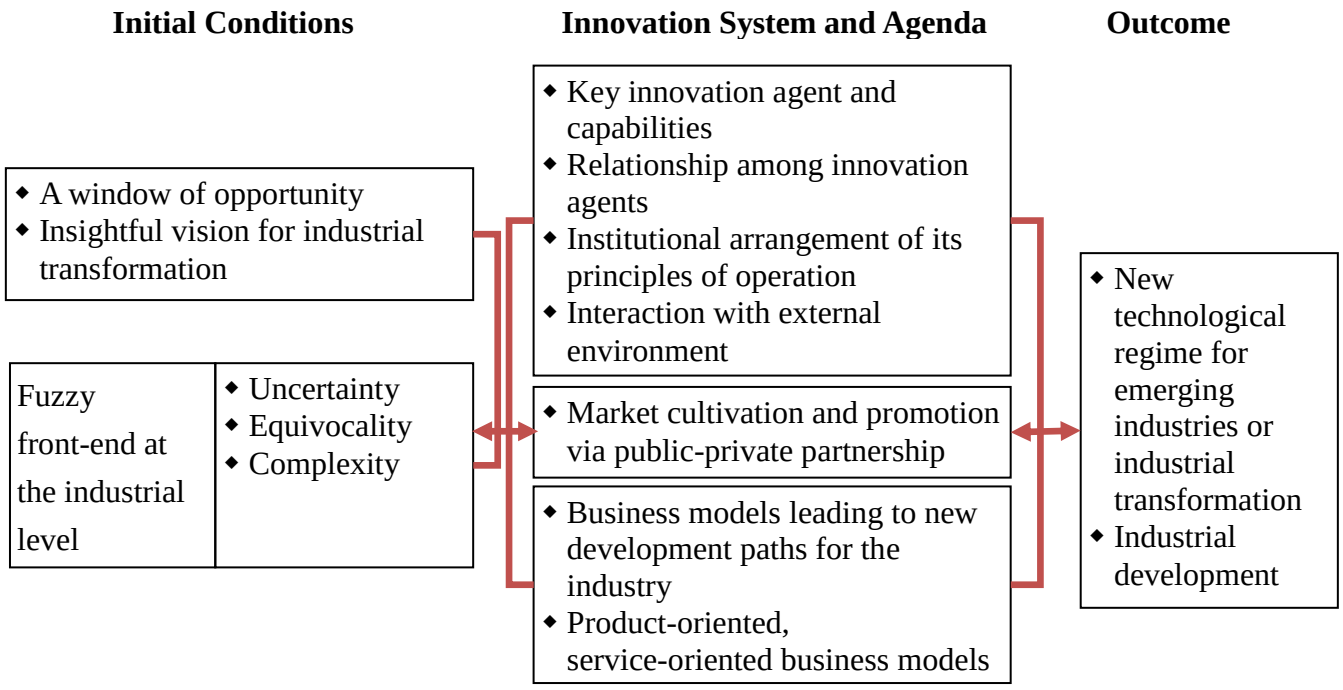

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Figure 1 A Conceptual Framework for Post Catch-up Industrial Development

The second part of our concept framework concerns appropriate innovation system and agenda for post catch-up. Following Hwang and Choung (2013), changes in the innovation system take place along dimensions of key innovation agent and capabilities, relationship among innovation agents, institution arrangement and its

principles of operation, and interaction with external environment. In addition, given the market fuzziness of fuzzy front-end and the risk of initial market creation (Lee, 2005), it is essential for the industrial player in pursuit of post catch-up to cultivate and promote the market. In an emerging industry, such market cultivation in a latecomer country often may benefit a great deal from policy support, bringing about public-private partnership. In the process of market cultivation, different business models, either product-oriented or service-oriented, have to be tested by the market, distilling lessons for continuous improvements or refinements of the business model.

Finally, iterations of the initial conditions and the innovation system and agenda will bring out, apart from industrial development in the latecomer, an outcome of new technological regime, under which industrial players from both the latecomer and advanced countries will engage with each other in a new way. Technological regime is a well-established term in the field of technology management, which defines the nature of technology and explains the specific way in which innovative activities of a technological sector are organized (Nelson and Winter, 1982; Malerba, 2002).

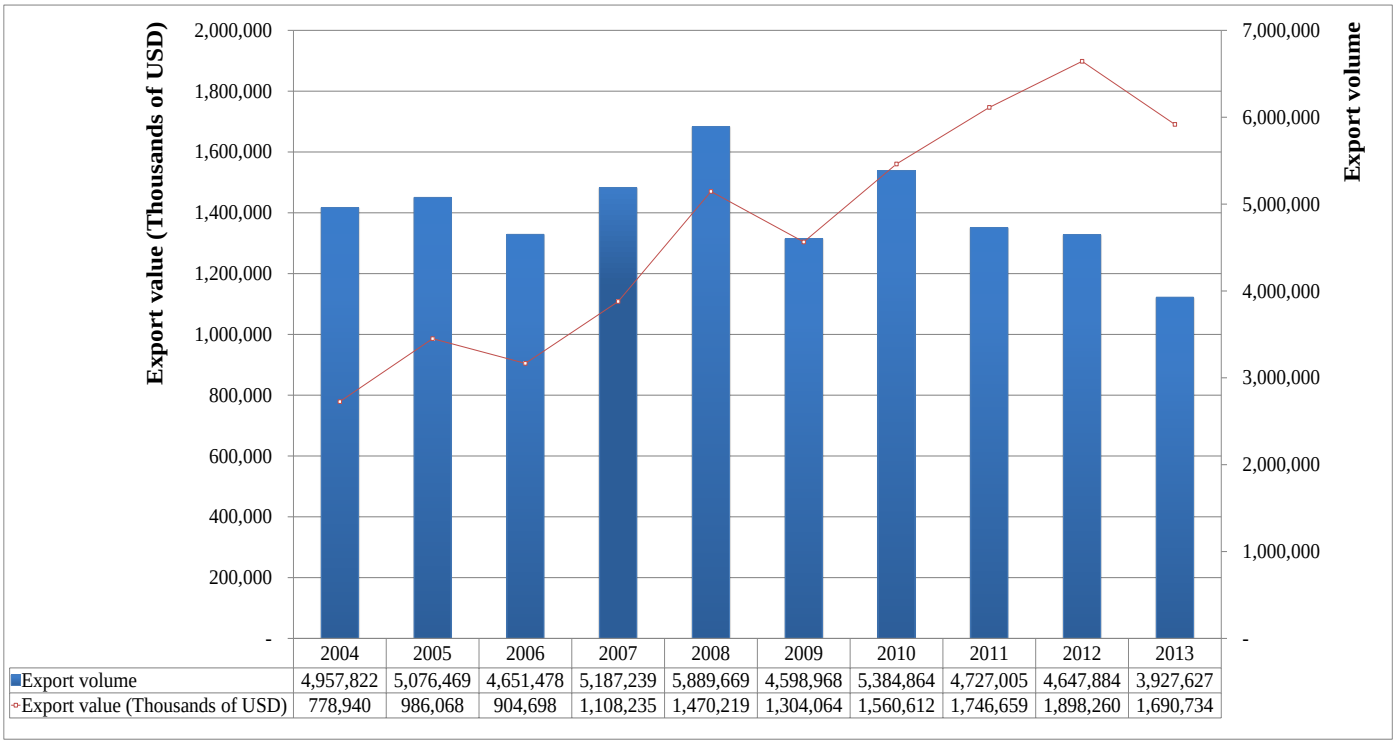
In essence, our concept framework provides an integrated view on the key issues to be addressed in a latecomer's transition to post catch-up. We incorporate fuzzy front-end, business model for industrial development and market cultivation as our building blocks, which have been largely ignored in the literature of technological catch-up and leapfrogging. In addition, special attention is drawn to the importance of service-oriented business model, specifically the servitization of manufacturing and product servicizing, instead of just product-oriented business model. In the next section, we shall present two cases in Taiwan's transportation equipment sector, the bicycle industry and EV in the automotive industry, to elaborate on our conceptual framework.

3. The Bicycle Industry: A-Team and Industrial Transformation with Market Cultivation

Over the last one and half a decades, the bicycle industry in Taiwan has gone through a period of dramatic transition. At the turn of this century, the industry was on the verge of falling apart, but nowadays Taiwan has become an international hub of high-end bicycles, in terms of not just production and exports but experience economy of cycling. Specifically speaking, Taiwan's export of bicycles plummeted substantially from its all-time peak of about 10 million units in 1991 to 5 million units in 2003, with year 2000 alone registering a negative growth rate of -28.98%. This was attributable to stiff competition from China and industrial offshoring by many of the

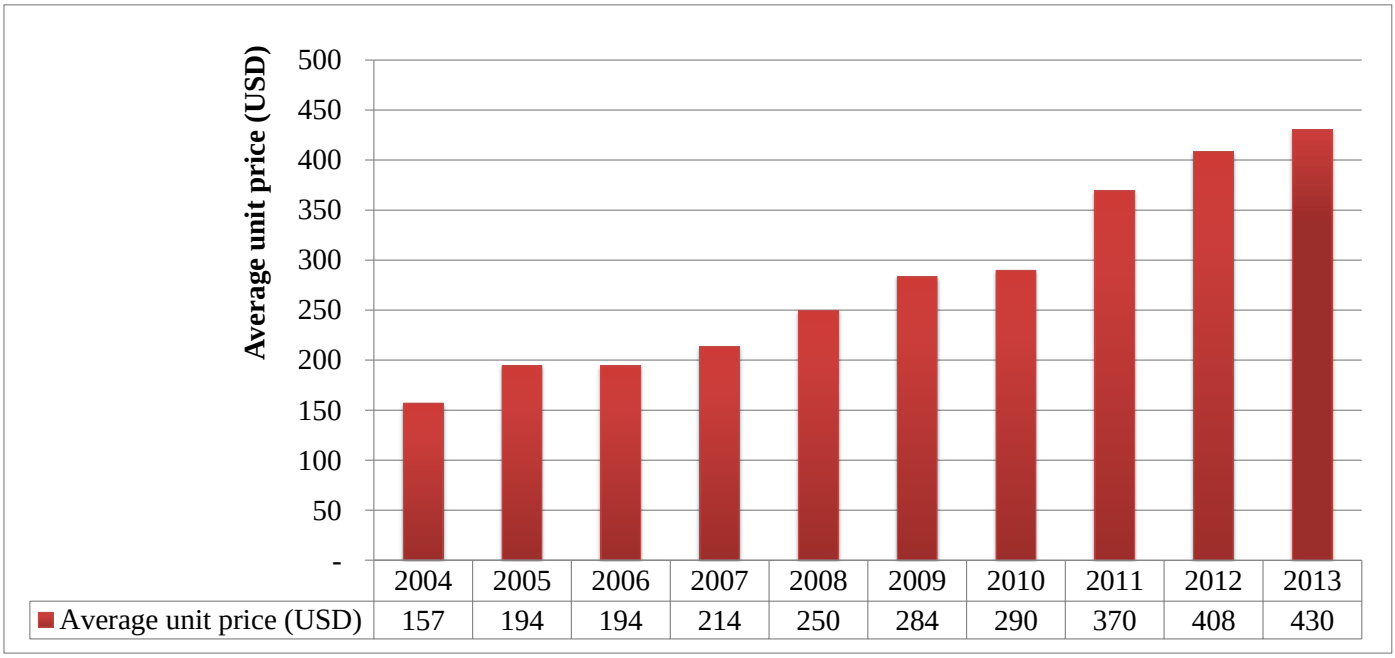
Taiwanese players. In contrast, while the export volume has afterwards remained flat or declined a bit recently, its export value has been on a rising trend from US$789 million in 2004 to US$1,691 million in 2013. As a result, Taiwan's export per bicycle for 2013 totaled US$430, compared to US$157 for 2003 (see Figure 2). Nowadays Giant and Merida are top two bicycle manufacturers globally, with well-established brands. While Hu and Wu (2008) have given special account to technological innovation in explaining Taiwan's transition to leadership in high-end bicycles, for us the whole picture, centered around A-Team, is much broader and more meaningful and is in line with the transition of post catch-up. A-Team was initiated by local firms, Giant and Merida, with partial support from the Ministry of Economic Affairs (MOEA) to upgrade the bicycle industry in Taiwan. Due to A-Team's persistent effort, Taiwan has become a manufacturing base and leading exporter of high-end bicycles, through not only industrial upgrading but also stimulating local demands via public-private partnership (PPP).

The drastic plummet in Taiwan's export volume of bicycles (for example -28.98% in 2000) triggered the transition process. That time was also a turbulent period for the bicycle industry in the Western world, where well-established firms, like Specialized and Derby either went into bankruptcy or were merged, costing their Taiwanese suppliers long-term OEM contracts (Hu and Wu, 2008: 7). Giant and Merida, two leading bicycle makers in Taiwan, were reluctant to follow their peers' step to relocate production overseas. Instead, they opted to transform themselves and Taiwan to become providers and a lead market of high-end bicycles, where they used to be inexperienced. To do so, Giant and Merida worked together with a few component suppliers to form A-Team in 2003, based on the model of Toyota Production System (TPS). Its members nowadays are made up of more than 20 major companies both at home and abroad (for example, Trek, Specialized, Colnago) in the industry, who are not only partners but also competitors. Alongside with Giant and Merida, there are also niche high-end bicycle makers in Taiwan, such as Pacific Cycles, pioneering and dedicated to compact/folding bikes with own control over the product architecture.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Export volume	4,957,822	5,076,469	4,651,478	5,187,239	5,889,669	4,598,968	5,384,864	4,727,005	4,647,884	3,927,627
Export value (Thousands of USD)	778,940	986,068	904,698	1,108,235	1,470,219	1,304,064	1,560,612	1,746,659	1,898,260	1,690,734

(A) Export volume and value



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Average unit price (USD)	157	194	194	214	250	284	290	370	408	430

(B) Average unit price of export

Source: Authors.

Figure 2 The Export Performance of Taiwan's Bicycle Industry, 2004-2013

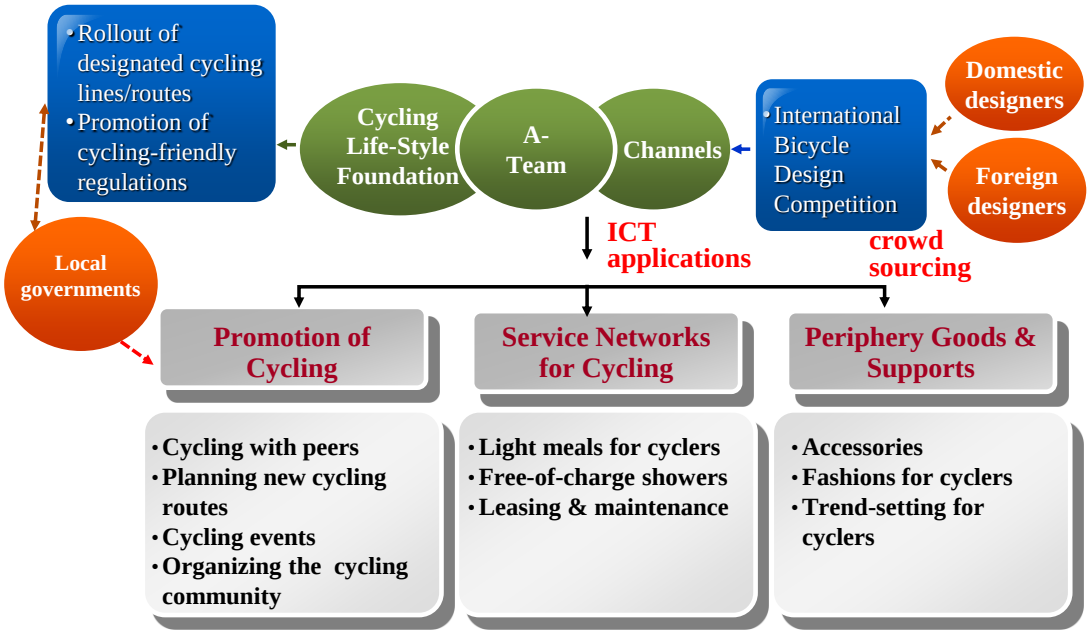
In a sense, the transition of the bicycle industry in Taiwan is not so dramatic as surging in an emerging industry, instead it comes to resemble exploring a new innovation trajectory for the existing Taiwanese players. Given the turbulent situation in the Western world in the late 20th century, their chance for imitation was limited, while market space for transition beyond catch-up became available. In addition, the technology and market over time went through a fluid phase, from urban bicycles, mountain bicycles and more recently to racing bicycles. Bicycles have also been shifting from a means of transportation to a sporting, recreational, and fitness products, leading bicycles to becoming a "fashionable and creative product". As a result, high value-added bicycles have gone from initially being a niche to a broader market space featured by wide choice with short lifecycle and a number of varieties.

A-Team has gone through three stages of development. At the first stage, a "Just-In-Time" (JIT) management system was introduced to integrate upstream and downstream resources to tighten the partnerships among factories, suppliers, and distributors. The second stage came with a joint design platform of product data management (PDM) set up to develop new products in a collaborative design manner and to shorten time to market. At the third stage, A-Team worked more closely with independent bicycle dealers rather than warehouse stores to segment A-Team's products from those of warehouse stores. According to Brookfield, Liu and MacDuffie (2008), A-Team has created integrated, co-innovative supplier networks with two features that differentiate them from traditional modular, symbiotic supplier networks. First, whereas traditional supplier systems have emphasized cost control, integrated, co-innovative supplier networks appear to focus more on value creation through co-innovation. Secondly, by adopting a more integrated network structure, such supplier networks appear to have a greater ability to resist imitation. In their integrated co-innovative supplier networks, a couple of international leaders of bicycle gearshift solutions, Shimano and SRAM have been active partners. It is even difficult or not possible for the Taiwanese flagship bicycle makers to keep distance away from Shimano because the latter holds a market dominant position, as Intel in the personal computer industry.

What's more, with an aim to cultivate market for premium and trend-setting bicycles, A-Team has worked together with the central and local governments and research institutes to implement Cycling Island Initiative (see Figure 3). In doing so, Giant established the Cycling Life-Style Foundation to promote an island-wide system of bike routes. As a result, a new life style of cycling has gained popularity and has been

highly appreciated by the lay people in the country. The new life style is actually being “exported” to China. In fact, according to Giant, all Giant managers throughout the world are required to get involved in cycling so that more people can be lured to embrace the fun of cycling. To further promote the market, A-Team takes own initiative to organize various events, fan communities and activities to embed cycling as part of Taiwan’s socio-economic system by means of product servicizing. In particular, by setting up own travel agencies, major bicycle manufactures have actively promoted cycling tourism and the round-Taiwan rides, which have attracted many local dwellers as well as foreign visitors. As a result, the enthusiasm for cycling in people’s daily life has been widespread in Taiwan.

With bicycles becoming a “fashionable and creative product”, a key issue for the flagship firms in the A-Team is how to generate innovative products to drive and meet changing market demands. Apart from internal R&D, they have taken advantage of International Bicycle Design Competition, organized by a research institute and the industrial association to capitalize on innovative design ideas from both home and abroad. Actually, some of the prize-winning designs have been turned to pilot products for market testing and even production.



Source: Authors.

Figure 3 A-Team and Cycling Island Initiative

The MOEA has proposed a 2020 vision for Taiwan, with four reference models as a set of portfolio for the country's future development, with one of them being "Pioneer of New Life Style". This reference model refers to a new development mode to take advantage of own local milieu and social settings to form influential innovative solutions with elements of experience economy (Pine and Gilmore, 1999) to serve both domestic and international customers. A-Team and Cycling Island Initiative together can be considered a case related to "Pioneer of New Life Style", thanks to their essence of both industrial transformation and market cultivation. Nowadays, a few other sectors in the country are trying to replicate the success of A-Team.

In summary, Taiwan's catch-up in the bicycle industry was attributed to a few factors, such as cost advantage, export orientation, OEM/ODM subcontracting with foreign leading brands, plus technological innovation. Its accumulated advantage was challenged by newly catch-up countries, like China. To fight for their fortune, a few leading players with vision for industrial transformation embarked on transition to high-end market with fuzzy front-end in a way different from their previous paths. Organizational innovations within the community of A-Team have turned the loosely coupled production networks under a regime of modularity (Hu and Wu, 2008) to integrated, co-innovation supplier networks (Brookfield et al., 2008). More importantly, while the typical export-oriented model of industrial development in Taiwan tended to downplay the role of the domestic demand, A-Team has been devoted to the cultivation and promotion of domestic market for premium and trend-setting bicycles with series efforts of product servicizing. In this way, a lead market has been created out of the local milieu and social settings in Taiwan, which has eventually become an essential part of the ecosystem for the transition to leadership in Taiwan's bicycle industry.

4. The Electric Vehicle Industry: A Process of Post Catch-up with Divergent Innovations

Taiwan is by no means a strong player in the mainstream automotive industry. The industry in Taiwan has actually been dominated by foreign car makers, especially Japanese ones, with strong control over their product architectures and supply chains. Not until recent years, has a newly home-grown brand, Luxgen, brought about seemingly-promising breakthrough with domestic root. Meanwhile, the commercialization of EVs at a pilot but notable scale, which has resulted from the marriage of electronics and automotive technologies and that of innovative business models and technologies, has brought about a window of opportunity for some of

the Taiwanese industrial players to penetrate into this emerging sector. Admittedly, it is too early to judge their success, but their race to a post catch-up territory shows some interesting paths.

In recent years, there has been a strong presumption in favor of bring EVs to market as an important strategy to reduce CO_2 emissions. This has come with an increasing awareness that to jump start the new market for EVs, innovative business models are required, especially those featured by service-orientation (Bohnsack et al., 2014; Cohen and Naor, 2013; Boons and Ludeke-Freund, 2013; Christensen et al., 2012). EVs, as a promising alternative to conventional cars, as assumed, are not without own problems, notably limited driving range. EV makers, with a variety of policy support, hence have to find creative way to circumvent the drawbacks of EVs (e.g. cost, range, charging time). The industry is nowadays driven mainly by some incumbent car makers and entrepreneurial firms, such as Tesla, in the advanced countries. After examining the evolution of business model for EVs, Bohnsack et al. (2014) have highlighted the significance of product-service system configurations, especially on the part of the entrepreneurial firms. Generally speaking, many EVs are still in the pilot phase and there is much dynamism (Mock and Yang, 2014). Against the above backdrop, some Taiwanese industrial players taking advantage of a very supportive setting have jumped on the bandwagon, are trying to level the playing field in a divergent and distinct manner, as summarized in Table 1.

Among the entrepreneurial firms, Tesla is currently an eye-catching forerunner. Tesla, based on electronics technologies and software capabilities, first hit the market with its luxury electrical sport car, Roadster. Its following models have been well sold in the EV market. Tesla ventured its business, starting as a Silicon Valley-based company with few connections with the mainstream car industry. The company came to Taiwan to forge collaboration with a few Taiwanese firms specialized in motor and electronics technologies which were willing to co-work with Tesla in a customized development and batch-production manner. Notable examples at issue include electric motors produced by Fukuta, and battery control units, motor controllers and testing equipment from Chroma. While those Taiwanese players are still largely unknown in the developed world, they have taken advantage of the rise of Tesla as an entrepreneurial EV maker and emerging platform leader (Gawer and Cusumano, 2002) to penetrate into the EV ecosystem. On the other side of the coin, Tesla's venture into EV business from scratch had formed a relatively open innovation network, different from the typical closed one in the mainstream automotive industry, enabling the Taiwanese players eventually to become part of Tesla's supply

chain.

There is also entrepreneurial EV maker in Taiwan. A newly home-grown car maker, Luxgen, set a departure from its parent group's OEM business for foreign car makers to promote its own brand. Luxgen developed and produced own EVs, by taking advantage of available foreign solutions, for example, ACP's powertrain, and by leveraging Taiwan's existing strengths in motor and electronics technologies. Right now, Luxgen is the key player in the EV pilot-run project, sponsored by the government. Their EV user field trials take place at a few sites in Taiwan, with a special focus on service-oriented business models as well as fleet management. For the time being, more than a few hundred EVs produced by Luxgen have been tested in the field trials, but no EVs are sold to the household.

Of note is an unorthodox approach by some of the Taiwanese players to venture into EV business (see Table 1). For example, Noveltek, an electric-powered material handling equipment maker, provides total solutions for the electrification of diesel-powered flat-bed trucks (off road) used within a large-sized fruit and vegetable wholesale market. Before this electrification project, the diesel-powered flat-bed trucks generated serious pollutions and noises, endangering the health of people working for the wholesale market. The electrification of those atypical and niche vehicles means that "powered by electricity" offers a broader perspective of sustainable and "good-enough innovation" (Chen, Wen and Tsai, 2013; Gadiesh, Leung and Vestring, 2007) beyond the typical commercial value creation, set by the forerunners. In another example, Teco, an industrial motor maker in Taiwan, has won a contract to provide motor solutions for the electrification of e-trikes and e-jeepneys used in the Philippines. Jeepneys are the most common form of public transport throughout the many islands of the Philippines. In the greater Manila area alone, there are estimated to be about three hundred thousand Jeepneys on road. For two years to come, Teco is scheduled to deliver one thousand e-jeepneys annually plus complementary fleet management solutions to the City of Manila. In a word, what Teco intends to explore is a market at the Bottom of the Pyramid (Prahalad, 2005), overlooked by the forerunners of EV makers.

With particular regarding to product servicizing, some lessons learned from the EV pilot-run projects in Taiwan and elsewhere seem to have gained wide acceptance. On surface, EVs looks like a tempting and promising alternative to conventional gasoline-based cars. In fact, the switchover of EVs in the global market as well as Taiwan is much longer than expected. It is well-noted that EVs' limited driving range

gives rise to “range anxiety”. There are other downsides of EVs that may bring about what may be termed “ownership anxiety” because of factors such as uncertainty about battery lifetime, the end-of-life value and safety of EVs. The ownership anxiety may not be solved simply by widespread rollout of charging station networks for EVs. A question to be addressed then concerns whether or not EVs nowadays can straightforward rival conventional cars. Is it comfortable for a critical mass of end customers to actually own an EV without hesitation? In other words, there is market uncertainty and equivocality in bringing EVs to the market, which may need to be partially circumvented or mitigated by the experimentation of different service-oriented business models. Better Place’s battery swapping model once looked promising (Christensen et al., 2012), but the company eventually went bankrupt, even with active supports from a few national governments. In our opinion, the fall of Better Place had much to do with the fact that Better Place run into conflict with car makers over the control of product architecture of vehicles and run the risk of bearing huge investment and appreciation costs of the batteries.

Given the fact that no EVs produced by Luxgen are sold to the end customer, there is shift in field experimentation in the Taiwanese pilot-run projects towards some other specific service-oriented business models. For example, e-mobility car-sharing model, demonstrated at a large-scale field trial in Paris by Autolib (Weiller, 2012), has come to focal attention. With a business model of the servitization of mobility in urban area, Autolib has by far formed the largest EV fleet in the world. With the service system, EVs are available for short-term leasing in the greater Paris area to any member of the public with a subscription. As of the end of 2013, about 110.000 subscribers had had access to 2,000 EVs at 850 stations. This model coincides with our advocating view in Taiwan that the initial introduction of EVs to the marketplace had better take place at somewhere within manageable limited ranges and environment. In fact, among the pilot-run projects sponsored by the Taiwanese government, Toyota’s car-sharing model in the Sun Moon Lake, a famous tourism hotspot with a relatively closed environment has gained much more acceptance than the other projects. We therefore tend to suggest that EVs are nowadays better positioned as a complementary mobility services to the existing transportation system than a direct rival to conventional cars. Still EVs makers, both the incumbent and entrepreneurial ones, intermediaries, such as Better Place and Autolib, and alike have to stand up to the challenge how to cultivate the market with appropriate service-oriented business models. From the perspective of product servicizing, they need to integrate the product functionality with appropriate mobility services by mobilizing and integrating complementary assets to prevail in the industry.

Table 1 Diverse Paths of Taiwanese Firms' Involvement in the Electric Vehicle Industry

Player	Highlight of the Path	Progress Made
A few Taiwanese component suppliers (e.g. Fukuta, Chroma) + Tesla	• A few Taiwanese players take advantage of the rise of Tesla as an entrepreneurial EV maker and emerging platform leader to penetrate into the EV ecosystem.	• A few Taiwanese suppliers have become part of Tesla's supplier chain.
Luxgen	• A newly home-grown car maker produces own EVs to be tested in the government's EV pilot-run project.	• More than a few hundred EVs produced by Luxgen have been tested with service-oriented business models, but no EVs are sold to the end customer. • The company is also to experiment with new service-oriented business models in additional sites.
Noveltek	• An electric-powered material handling equipment maker provides total solutions for the electrification of diesel-powered flat-bed trucks (off road) used within a large-sized fruit and vegetable wholesale market.	• About 800 diesel-powered flat-bed trucks in use are scheduled to be electrified within two and half a years.
Teco	• An industrial motor maker provides motor solutions for the electrification of e-trikes and e-jeepneys used in the Philippines.	• For two years to come, one thousand e-jeepneys annually plus complementary solutions will be delivered to the Philippines.
Delta	• A power electronics firm provides a few different solutions for EVs, especially charging solutions for EVs.	• Some of the solutions have been installed under pilot run projects in Taiwan and Thailand. • Fast chargers have been sold to the EU, USA, Japan and China.

Source: Authors.

Most of the Taiwanese players did not come from nowhere. For example, Delta has long been a well-established electronics and power system company in Taiwan with global outreach. Apart from its charging solutions for EVs, the firm has even demonstrated its comprehensive EV solutions for turning an existing model of BMW's into an EV version. Another firm, Teco, based on its existing capabilities in power

systems, has become an electrification solution provider for well-adopted niche vehicles in a less advanced market. Their strategic intent seems to aim for a position of tier 1 or tier 2 suppliers-to-be in the emerging EV industry. In other words, the development of EVs enables some domain knowledge outside the mainstream automotive industry to be incorporated into the industrial ecosystem. For those working with Tesla, they had to transform their existing capabilities and products by co-working and co-developing with Tesla in the fluid phase.

In summary, for the first time in history, EVs have researched an industrial level of development. In this transition period, a few Taiwanese players are in the middle of levelling the playing field with the forerunners in the advanced countries. Since, Taiwan lacks a strong base and track records in the mainstream automotive industry, with a strongly supportive setting in Taiwan, their paths towards post-catch-up collectively tend to take an approach similar to the entrepreneurial firms. There are however some distinct elements in their diverse paths, including co-innovation with an emerging platform leader and the exploration of an underserved market. Above all, it has become an established trend that firms in the EV industry have to pay attention to the specific need in the application context, shifting their focus from sale of product to service-oriented business model. From the perspective of product servicizing, the key stakeholders to cultivate the market need to integrate the EV product functionality with appropriate mobility services by mobilizing and integrating complementary assets to prevail in the industry.

5. Discussions

For our following discussions, Table 2 presents comparisons of the two cases with a few dimensions: developmental stage of the sector, strategic intent of the key players, key issues at the fuzzy front-end, key actions taken, and performance achieved. Based on these comparisons, we would like to discuss a few issues in conjunction with post catch-up.

Developmental stage and post catch-up: The literature on technological catch-up has paid particular attention to such an issue as how latecomers to climb the technological ladder and eventually overtake the forerunner by approaching the technological frontier (Lee and Kim, 2001; Lee et al., 2005; Hobday et al., 2004). Following this, catch-up, leapfrogging, and/or post-catch-up often occur in a phased manner, referring particularly to different stages at the product life cycle (Lee, 2005). If one takes a broader perspective of innovation, post catch-up and leapfrogging can take different form from the archetype discussed in the literature. In case of the

bicycle industry, post catch-up became an issue for the Taiwanese players to address. This transition was facilitated by the process of transforming their products from middle-end to high-end, and from urban bicycles, mountain bicycles, to racing bicycles. This came along with a new "S Curve" or innovation trajectory surging or created in the existing product life cycle (Kash and Rycroft, 2002). In the EV case, a window of opportunity became available, when EVs entered the industrial level of development. The Taiwanese players are trying to seize this opportunity to level the playing field with the forerunners. In doing so, they either co-evolve with the emerging platform leader or explore an underserved niche in a less advanced market. Admittedly, their technological capabilities may not be so superior as the existing leaders, but the development of EVs enables some domain knowledge outside the mainstream automotive industry to be incorporated into the industrial ecosystem. What they are trying to achieve is find a way or forge good-enough innovations (Christensen, 2003; Chen et al., 2013c) to hold a favorable position within the ecosystem-to-form when the market and industry are still at a fluid phase. An implication of above discussions is that technological catch-up is not necessary a prelude to post catch-up, depending on the nature of new innovation trajectory and entry modes of the emerging industry.

Path dependence and post catch-up: The Taiwanese cases suggest the way in which a latecomer's industry to rise in a post-catch-up manner has something to do with path dependence. Taiwan's structural weaknesses in the automotive industry, for example being short of well-established car makers and the ability to control the product architecture do form constraints on the players' innovation paths towards the emerging industries. Apart from Luxgen, other players with capabilities in module or component technologies have to find other ways to enter into the industry than being a genuine EV maker. On the other hand, the flagship firms in the bicycle industry have managed to overcome problems associated with path dependence. It is worth a while to notice discussions in Taiwan about branding versus ODM, in terms of industrial upgrading. Referring to the ICT industry, Chu (2009) threw out the issue: "can Taiwan's second movers upgrading via branding (in a natural way)?" In the end, she reached the conclusion: "the evolution of the (ODM) firms' organizational capabilities led to path dependence in further development. As the second mover builds up organizational capabilities as a subcontractor, these capabilities become the guiding and limiting factors influencing the firm's strategic choices in further expansion (p.1064)." Obviously, the Taiwanese case of the bicycle industry has proven something can be done to overcome these capabilities gap. Their recipe for both upgrading with branding and post catch-up arguably are linked to multi-facet

transformation under the umbrella of A-Team, which has involved a process of reinvention, requiring across-the-board changes including goal-setting, new product and service development, and a massive cultural change and organizational restructuring (Brookfield et al., 2008; Chen, Wen, Liu and Lin, 2006).

Table 2 Comparisons of the Two Cases

Dimension	The Bicycle Industry	The EV Industry
Developmental stage of the sector	• A well-established industry in Taiwan engages in a transition to leadership, when facing stiff competition from other latecomers.	• EVs reached the industrial level of development in the automotive industry, giving rise to leapfrogging for new entrants and entrepreneurial firms, apart from the incumbents.
Strategic intent of the key players	• The key players aim to transform themselves and local setting in Taiwan to become a leader in high-end bicycles.	• With no strong base in the mainstream automotive industry in Taiwan, a few domestic industrial players aim to explore the possibility of levelling the playing field with the forerunners in the advanced countries.
Key issues at the fuzzy front-end	• How to cope with product transition, from middle-end to high-end, and from urban bicycles, mountain bicycles, to racing bicycles? • How to cultivate a lead market in Taiwan, making high-end bicycles from a niche market to a much broader market space?	• How to get involved in the emerging innovation networks? • How to deal with the fuzziness of market for EVs in terms of business models?
Key actions taken	• With organizational innovations, to turn the loosely coupled product networks to integrated, co-innovation supplier networks • Via PPP, to cultivate and promote the domestic market for premium and trend-setting bicycles with series efforts of product servicizing	• In a setting of strong policy support, to explore and refine meaningful and valuable business models, with service-orientation • To explore an underserved niche in a less advanced market • Co-innovation with an emerging platform leader
Performance achieved	• Taiwan has become a lead market for high-end bicycles with experience economy. • The flagship firms have become global leaders with well-established brands.	• Despite of some progress made, the industry and market are still in the pilot stage with dynamism, hence the Taiwanese players' future remains to be written.

Source: Authors.

Service-oriented business model, market cultivation and post catch-up: It has well-accepted that innovative business models are not only essential to an innovator's value creation and value capture but also indispensable to the birth of an emerging industry (Teece, 2010; Kley et al., 2011; Lenfle and Midler, 2009). While the literature on technological catch-up has noted the risk of initial market creation (Lee, 2005), delicate considerations of the role of business models in catch-up and post catch-up in an emerging industry and industrial transformation are still needed. This requires a holistic view to the non-technological and market cultivation aspects of the sector involved (Chen et al., 2014). To compete and prevail in a post catch-up manner, as discussed above, there is indeed market uncertainty and equivocality in bringing EVs to the market, which may need to be partially circumvented or mitigated by the experimentation of different service-oriented business models. EV Pilot-run projects orchestrated in Taiwan and elsewhere have set up a playing field for various key players of EVs to cultivate and interact with the market.

In addition, referring to Chesbrough and Teece's (1996) dichotomy of systemic innovations versus autonomous innovations, we tend to think that it is more meaningful to discuss post catch-up in conjunction with systemic innovations because this type of innovation presents more challenges of fuzzy front-end. Spohrer and Maglio (2008) have suggested that one challenge to this type of service innovations is "the interdisciplinary nature of service, integrating technology, business, social and client (demand) innovations". In fact, the resurgence of the bicycle industry in Taiwan involves not just product innovations but cultivating a lead market in Taiwan by shaping the local milieu and social settings to form influential innovative solutions with elements of experience economy.

Our Taiwanese cases go further to suggest the important of product servicizing as a means of post catch-up. As noted earlier, there are two facets of the servitization of manufacturing and/or product servicizing: corporate strategy of transformation for individual manufacturers and the nature and way of manufacturing development for a few emerging sectors. A few studies (Bohnsack et al., 2014; Kley et al., 2011) have indeed highlighted the significance of product-service system configurations in the emerging business model for EVs, especially for entrepreneurial car makers. Likewise, the market cultivation of the pilot-run projects in Taiwan takes the same flavor. A-Team in the bicycle industry has also been devoted to the cultivation and promotion of domestic market for premium and trend-setting bicycles with series efforts of product servicizing. Even complex systems, where the literature on

technological catch-up is particularly interested in (Choung and Hwang, 2007; Mu and Lee, 2005), intrinsically involve a great deal of system integration of both upstream and downstream business offerings, bearing a resemblance to servicizing and the servitization of manufacturing (Chen et al., 2013a).

Market segments and post catch-up: A sharp distinction between the two cases concerns their target market segments. On the one hand, A-Team in the bicycle industry focuses mainly on a high-end market segment, with series efforts to transform it from initially being a niche to a broader market space featured by wide choice with short lifecycle and a number of varieties. On the other hand, a few players, such as Teco and Noveltek in the Taiwanese EV industry opt to explore a market segment with good-enough innovation, underserved and overlooked by the forerunners of EV makers. In fact, good-enough innovation has been particularly linked to such latecomers as China and India. Existing evidence suggests that China's severe uneven development in both spatial and social terms can be leveraged to generate the Bottom of the Pyramid Innovation (Prahalad, 2005) and/or good-enough innovation (Gadiesh et al., 2007; Chen et al., 2013c) that may be able to challenge the status quo in the industry (Christensen, 2003). In a same vein, a few of the Taiwanese EV players are trying to offer good-enough electrification solutions to a niche market at home and in a less advanced market in the Philippines. Moreover, referring to our view that EVs are nowadays better positioned as a complementary mobility services to the existing transportation system than a direct rival to conventional cars, good-enough innovations may arguably be a feasible path for the industrial take-off and commercial deployment of EVs.

Platforms, national boundaries and post catch-up: In reviewing the literature in Section 2, we threw out a question concerning the extent to which the new innovation system required for post catch-up (Choung and Hwang, 2014) is confined by the national boundary, especially when one takes into account the effect of lock-in and path-dependence. Our cases tend to suggest that post catch-up by a latecomer had better go beyond a self-sufficient view, especially when one takes into account the pattern of inter-organizational platform-based development in a cross-border manner (Chen et al, 2013b). In fact, even the rise of Tesla as a leading EV entrepreneurial firm, has benefitted a lot from its links to Taiwan's domain in component technologies at the development and production stages. From the Taiwanese perspective, this means co-innovation with an emerging platform leader (Gawer and Cusumano, 2002). Not to mention, systemic service innovations often involve multi-stakeholders, playing different roles (Chen et al., 2014).

Regarding the market side, while A-Team has been devoted to the cultivation and promotion of the domestic market for trend-setting bicycles with series efforts of product servicizing, they still depend on the gearshift solutions provided by foreign leading players, such as Shimano and SRAM. International Bicycle Design Competition also provides a platform for A-Team to capitalize on innovative design ideas from abroad as well as Taiwan. In the EV industry, to explore good-enough innovations in a less developed market, market cultivation and interactions in the host country are essential part of the innovation system for the Taiwanese EV player. By implication, for post catch-up at an industrial level, a latecomer's innovation system and its boundaries have to be shaped in line with the country's level of technological accumulation, constituent firm's strategy, the complexity of the innovation at issue, and the way in which the focal industry is emerging.

6. Conclusions

As a few fast followers or latecomers have caught up with the advanced countries in one industry or another, an issue worthy of scrutiny concerns how they are to engage with the existing forerunners in an emerging industry or in the following industrial migration. This issue has been addressed mostly by the literature on technological catch-up with special focus on leapfrogging or competing for the technological frontier. As a result, technology creation has been spotlighted as a dominant factor for this transition. There is also implicit presumption that technological catch-up is a prelude to leapfrogging.

Choung and his colleagues (Choung et al., 2014; Hwang and Choung, 2013) initiated the discussion on post catch-up with a broader perspective of innovation than just technology. For us one challenge to post catch-up is related to the situation where innovation model and path are at the fluid phase and where scarce opportunity for imitation is present. This has led us to giving special account to fuzzy front-end at the industrial level and how market cultivation and innovative business models come to play an important role in shaping the innovation path for post catch-up.

With industrial case studies, the paper has discussed a new pattern of industrial development in the Taiwan's transportation equipment industries, which seems to demonstrate a strong flavor of post catch-up. The bicycle and EV industries differ in their developmental status and stage, facing different developmental issues. For a couple of leading players in Taiwan's bicycle industry, a key issue they faced at the turn of this century was how to transform themselves and local setting in Taiwan to

become a leader in high-end bicycles, in an attempt to fend off escalated international competition. To deal with this, they took initiative to form a consortium, called A-Team, to upgrade the bicycle industry in Taiwan. Due to A-Team's persistent effort, Taiwan has nowadays become a the leading exporter and a lead market of high-end bicycles, through not only industrial upgrading but also stimulating local demands via public-private partnership. In the emerging EV industry, the Taiwanese players have been trying to overcome its structural weaknesses in the mainstream automotive industry to explore the possibility of levelling the playing field with the forerunners in the advanced countries. Since, Taiwan lacks a strong base and track records in the mainstream automotive industry, with a strongly supportive setting in Taiwan, their paths towards post-catch-up collectively tend to take an approach similar to the entrepreneurial firms. There are however some distinct elements in their diverse paths, including co-innovation with an emerging platform leader and the exploration of an underserved market. Above all, it has become an established trend that firms in the EV industry have to pay attention to the specific need in the application context, shifting their focus from sale of product to service-oriented business model. From the perspective of product servicizing, the key stakeholders to cultivate the market need to integrate the EV product functionality with appropriate mobility services by mobilizing and integrating complementary assets to prevail in the industry.

The analyses of our industrial cases go further to suggest that technological catch-up is not necessary a prelude to post catch-up, depending on the nature of new innovation trajectory and entry modes of the emerging industry. While the way in which a latecomer's industry to rise in a post-catch-up manner has something to do with path dependence, something can be done to overcome the path dependence. Our analyses also lend support to the importance of product servicizing as a means of post catch-up, especially from the perspective of market cultivation. On balance, for post catch-up at an industrial level, a latecomer's innovation system and its boundaries have to be shaped in line with the country's level of technological accumulation, constituent firm's strategy, the complexity of the innovation at issue, and the way in which the focal industry is emerging.

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