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Master Thesis in International Business

"Industrial clusters and industrial ecology as growth paths for China"

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Summary of "Industrial clusters and industrial ecology as growth paths for China"

Industrial clusters have been recognized by past and contemporary authors as important leading forces in driving the growth path. Thanks to external economies, social networks and relations, joint actions, and local institutions, clusters represent a completely different and successful way of organizing economic activities. Their contribution is not confined to companies' evolution and development alone; it is also of great significance for national competitive advantage. Indeed, they affect competition within countries and across national borders.

Michael E. Porter, one of the main contemporary authors who have written about industrial clusters, defines clusters as: "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that compete but also cooperate".[1]

These industrial entities give rise to increasing returns and ever improving economic performances. In fact, they demonstrate that what happens within firms is relevant, but what happens outside co-located firms is even more relevant. Proximity of several companies gives birth to externalities, resulting in "the whole greater than the sum of the parts".[2] External economies exist when social benefits are higher than private benefits, since clustering of business activities produces advantages that are inimitable by firms alone.

More than one hundred years ago, the neo-classical economist Alfred Marshall recognized three main types of external economies: labour market pooling; supplier specialization; and technological spillovers. These are generally known as "Marshallian Trinity". Indeed, firms' clustering generates a pool of specialized skills benefiting both firms and workers. Employers are likely to base their economic activities wherever they can find good choices of workers with the necessary special skills; and employees are likely to move wherever there are employers requiring their skills. Moreover, where enterprises concentrate they can support more specialized suppliers of inputs and services. Finally, clusters facilitate technological spillovers because there is a rapid diffusion of know-how and ideas among neighbouring

[1] Porter, M. E., "Clusters and competition: New Agendas for Companies, Governments and Institutions", from *On Competition*, *Harvard Business School Press*, 1998, p. 3.

[2] Porter, M. E., "Clusters and the New Economics of Competition", *Harvard Business Review*, 1998, p. 81.

firms. “If one man starts –as Marshall states- a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas”.[3]

In a particular type of cluster, named eco-industrial cluster, phenomena of industrial symbiosis may occur. Industrial symbiosis occupies a branch of industrial ecology, which has created a new perspective on industrial development and aims at designing industrial agglomerates to resemble natural ecosystems. Furthermore, industrial symbiosis concentrates on by-products exchanges among co-located firms. It “engages traditionally separate industries in a collective approach to business and environmental management involving the physical exchanges of materials, energy, water, and by-products”.[4] Indeed, eco-industrial clusters show several eco-linkages among firms that minimize environmental harm and benefit all actors comprised in the cycle. The main goal is to pass from the traditional linear economy (where raw materials enter from one side and wastes exit from the other) to the circular economy (where wastes of certain activities become input for others).

One of the most famous cases of eco-industrial cluster is Kalundborg in Denmark. Kalundborg is a coastal industrial town characterized by spontaneous industrial symbiosis and eco-linkages among its industries. In fact, its industrial symbiosis has gradually developed and was not intentionally designed. The main impulse was given by the firms willingness to use by-products and minimize the costs of compliance with environmental regulations. Also, firms here have had the chance to generate important savings due to the fact that differences in cost of by-products relative to virgin alternatives are less than the costs of waste management.

Kalundborg town was built around four principal industries: Asnaes Power Station, which is a coal-fired power plant; Statoil, which operates a large oil refinery; Novo Nordisk, which is a maker of pharmaceuticals and enzymes; and Gyproc, which is a plasterboard manufacturer. These main companies, together with other actors within the municipal area, have traded waste streams and energy resources, recycling by-products as raw materials. In 2004 Kalundborg estimated resource savings were: 2.1 millions m^3/y groundwater; 1.2 million m^3/y surface water; 20,000 tons/y oil; and 200,000 tpy natural gypsum.[5] Each of Kalundborg

[3] Marshall, A., “Principles of Economics”, New York, *Macmillan*, 1920.

[4] Chertow, M. R. and D. R. Lombardi, “Quantifying Economic and Environmental Benefits of Co-Located Firms”, *Environmental Science and Technology*, 2005, p. 6535.

[5] Chertow, M. R. and D. R. Lombardi, “Quantifying Economic and Environmental Benefits of Co-Located Firms”, *Environmental Science and Technology*, 2005.

linkages has created an economic advantage for firms, while minimizing hazardous impacts of industrial activities and resources consumption.

In addition, the Asnaes power plant offers an example of Combined Heat and Power (also known as Cogeneration). "Combined Heat and Power integrates the production of usable heat and power (electricity), in one single, highly efficient process".[6] Conventional ways of generating electricity waste vast amounts of heat since all power plants, during electricity generation, must produce a certain quantity of heat that is then released into the natural environment. CHP is instead able to capture some, or all, of the by-product heat for heating purposes, offering an environmentally friendly and cost-effective alternative. It reduces fuel consumption guaranteeing at the same time quality and reliability of energy supply to users. Moreover, consumers face lower expenses for their energy requirements.

In order to foster the presence and growth of industrial symbiosis two approaches can be followed: a top-down and a bottom-up approach. Michael E. Porter and Claas van der Linde support a top-down approach, while Pierre Desrochers demonstrates the effectiveness and efficiency of the bottom-up approach.

The so-called "Porter Hypothesis" is based on the concept that innovation can be triggered by properly designed environmental standards leading to increased competitiveness, as this in fact rests on the capacity to innovate and grow. Innovation then can offset the costs of complying with strict regulations and lead to advantages over firms not obliged to respect those rules. It may be unclear the reason why regulations are needed, since these lead to innovation and competitive positions. Nevertheless, firms do not always take profit-maximizing decisions, because they do not operate in a perfect competition regime where information is fully accessible to each economic actor. In reality, firms have to face incomplete information, changing technology, organizational inertia, and control problems.

Innovation as a consequence of environmental regulations can occur in two forms: companies understand how to deal with pollution and waste management; or they can converge towards more environmentally desirable products and processes. In the first case firms learn to process and treat hazardous materials and to minimize toxic emissions. This form of innovation just leads to reduction of costs of compliance with regulations, but does not bring any "innovation offset". Instead, the second case shows innovation offsets, which are

[6] Combined Heat & Power Association: www.chpa.co.uk/what-is-chp_15.html.

conducive to competitive advantage. These offsets can be of two types: product offsets and process offsets. Product offsets exist when, together with lower environmental impacts, higher-quality products or safer products are supplied to customers. Process offsets occur when reduced pollution accompanies higher resource productivity, such as better utilization of by-products, lower energy consumption, material savings, and higher process yields.[7]

On the contrary, Desrochers explains that market incentives supported by enhanced private property rights can mitigate hazardous impacts of business activities. If flexibility and freedom are guaranteed, profit-maximization and competition will conduce to effective and efficient resources utilization through closed-loop initiatives. Indeed, the development of "win-win" products and processes is merely the result of profit-pursuing decisions. By-products linkages are not only useful to deal with environmental issues, but even encourage firms' clustering since they can turn a loss into a profit. Recycled products impose lower costs on companies than virgin products do, cheapening the cost of finished offerings and securing advantage over rivals. Furthermore, proximity of firms guarantees the presence of a vast supplier base, allowing entrepreneurs to choose the more valuable by-product to put again into the production process.[8]

Since studies have shown how clusters benefit the economy and how by-products exchanges are useful to minimize environmental harm, latecomers, like China, have to base their economic development on these two themes. Thus, they need to translate a late arrival into a profitable way to discover and study their pattern.

China is a latecomer country searching for strategies to catch up with developed nations. However, economic predictions forecast China as one of the future leading countries of the world. Indeed, this notion can be easily realized by China exploiting its latecomer advantage through clusters and industrial symbiosis. The term latecomer refers to a country that has started its industrial upgrading many decades after developed countries. Although, the late arrival does not have only negative aspects, it also has positive advantages. As noted by Mathews, developing countries face the opportunity to draw from western organizational and technological models, ideas, and management systems by linking with global actors,

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[7] Porter, M. E. and C. van der Linde, "Toward a New Conception of the Environment-Competitiveness Relationship", *The Journal of Economic Perspective*, 1995.

[8] Desrochers, P., "Did the invisible hand need a regulatory glove to develop a green thumb? Some historical perspective on market incentives, win-win innovations and the Porter Hypothesis", 25th Celebration Conference on Entrepreneurship and Innovation – Organizations, Institutions, Systems and Regions, Copenhagen, 2008.

leveraging their national resources and learning from these repeated activities. More importantly, they do not have to encounter the long pattern and spend the same energy, time and economic resources employed by western inventors. And at the same time, these countries enjoy low cost advantages.

In a globalized world an emergent firm constantly faces the opportunity to be part of global value chains and to connect with "lead firms" (firms able to coordinate and manage global value chains, large transnational corporations influencing the global economy), which are always looking for cutting costs and enhancing flexibility of operations through outsourcing. Moreover, through the linkage with advanced players the emergent firm can secure more than merely revenue: it can acquire knowledge, technology, and market access. Thereby, a firm's capacity to obtain more than it puts in, allows to leverage resources and capabilities and provides the opportunity to become a global player as well. The continuous and repeated practice brings then to industrial learning: an emergent firm understands how to move in the worldwide scene and is ready to become a global competitor.[9] But more importantly, Mathews states that the entire phenomenon is augmented if the latecomer firm is located within a cluster, because the multiple linkages of each member of the cluster create automatically opportunities for the others. Moreover, firms can cooperate to jointly adopt strategies of catching up.[10]

Since the 70's, Chinese government has supported industrial agglomeration and proximity through Special Economic Zones. In fact, in peripheral countries clusters do not always arise spontaneously, but, on the contrary, they develop within industrial parks. An industrial park is defined as "a planned industrial or technologically-based district of a city; usually intended for light manufacturing, industrial usage, research, or for warehousing; often located in open land near the city or in a renovated urban area".[11] Substantially it coincides with a cluster in all features and the two terms are often used as synonymises. However, the term industrial park always refers to a purpose-built entity, whereas the term cluster can refer either to intentionally planned or unintentionally grown entities. Functioning within an institutional entity such as an industrial park can be really advantageous for firms wishing to run their

[9] Mathews, J. A., "Competitive Advantages of the Latecomer Firm: A Resource-Based Account of Industrial Catch-Up Strategies", *Asia Pacific Journal of Management*, 2002.

[10] Mathews, J. A., "The Hsinchu Model: Collective efficiency, increasing returns and higher-order capabilities in the Hsinchu Science-based Industry Park, Taiwan", Keynote Address, Chinese Society for Management of Technology (CSMOT), 20th anniversary conference, Tsinghua University, Hsinchu Taiwan, 2010.

[11] Definition given by McGraw-Hill Dictionary of Architecture & Construction.

business activities in developing countries. Indeed, enterprises can find better infrastructure and physical utilities than elsewhere in the country and, sometimes, even laws are more closely observed within parks.

At the end of the 1970's, China designated its own model of industrial park, named Special Economic Zone. This is an industrial enclave that aims at fostering economic development, offering special preferential policies to firms. Generally, Special Economic Zones are huge industrial towns occupying several square km. They accommodate all types of activities, including tourism and retail sales, allowing people to live within the area, guaranteeing better infrastructure than in the rest of the country and several incentives and benefits. In 2006 China employed 40 million people in SEZs, registering an increase of 10 million people since 2002.

Since the end of the last century, a particular type of industrial park, named Eco-industrial Park, started to emerge in China. An Eco-industrial Park is simply an industrial park showing phenomena of industrial symbiosis. Their establishment has been promoted by the national government, which has been increasingly focused on environmental protection and closed-loop initiatives. Indeed, the current Premier, Mr. Wen Jiabao, and all the Chinese government are greatly committing to respond to climate change and protect the environment. For this reason, they are working to develop low-carbon technologies, rely on renewable energy resources, expand China's forests, implement the circular economy, and internationally cooperate to address climate change and environmental issues.

The circular economy's concept was first introduced in China at the end of the 90s. Indeed, in 1994 Germany enacted the "Closed Substance Cycle and Waste Management Act" that promoted closed substance cycle waste management in order to conserve natural resources and to ensure environmentally compatible disposal of waste. Consequently, basing their analysis on German experience, Chinese scholars begun to introduce concepts as recycling economy or circular economy at the end of the decade. Thereafter, other impulses arrived from Japan, which in 2000 issued the "Basic Law for Establishing a Recycling-Based Society" articulating fundamental matters for making policies for establishing recycling-based society and clarifying the responsibilities of the State, local governments, businesses, and the public. The aim of the law was to restrain the consumption of natural resources and reduce the environmental load as far as possible. As a result, in China circular economy became a fashionable topic and captured the attention of SEPA (State Environmental Protection

Administration of China), which advocated the philosophy of closed-loop initiatives at the beginning of the century. SEPA, the first central government agency to foster the concept of circular economy, then started to support studies on this theme, submitted it to important stakeholders as the State Council, and in 1999 begun to launch pilot projects.

Analyzing Chinese legal framework, three fundamental laws were approved by the country. The Law of Environmental Protection, passed in 1989, underlines the possibility for each local administrative unit to enact laws and regulations addressing environmental issues in accordance with local economic development and characteristics of environmental problems. Moreover, the Cleaner Production Promotion Law, approved in 2002 and effective from 2003, encourages cleaner production, resources utilization's efficiency, and sustainable development, while discourages pollutant agents. Cleaner production is supported not only at the firm level, but even at the inter-firm level and regional level, substantially providing the ground for eco-industrial development. Furthermore, circular economy became the subject of one legal provision adopted in 2008, when China enacted the "Law for the Promotion of the Circular Economy" that came into force on January 1, 2009. The aim of the law is to boost sustainable development by passing from the linear economy, where the environment provides raw materials and receives industrial and household waste, to the circular economy, where wastes of certain industrial activities are converted into inputs for others generating both ecological and economic efficiency. This provision represents the first national law throughout the world proclaiming a different model of economy. Indeed, countries as Germany and Japan have already embraced similar regulations addressing environmental issues, but the Chinese law is the first one considering circular economy a pattern of socio-economic development.

In order to implement the law promoting the circular economy, Eco-industrial Parks are the best tools. The first EIPs were approved in 2001, such as Guigang and Nanhai. Thereafter, other four parks, including Lubei, were created in 2003, seven parks, including Suzhou and Tianjin, in 2004 and other three in 2005. In 2008, the Ministry of Environment Protection together with other two ministries had already designated 30 Eco-Industrial Parks (EIPs). The most famous cases are: Guigang group; Pingdingshan coal mining group; Lubei chemical group; Suzhou Industrial Park; and Tianjin Economic Technological Park.

The present work focuses on Guigang Group, Suzhou Industrial Park, and Tianjin Economic-technological Development Area. These are three succeeding examples of industrial growth coexisting with eco-linkages and environmental protection. They show implementation of the circular economy law, since they are characterized by by-products exchanges and renewables exploitation. Moreover, they confirm Desrochers theory, which counters the well-known "Porter Hypothesis". The three cases here studied demonstrate that only profit-maximizing decisions, taken either by private or public entities, have led to these great examples of industrial symbiosis.

The Guigang group (GG) is a sugar company in southeastern Guangxi Zhuang Autonomous Region, which controls one of the largest Chinese sugar refineries. The GG was founded in 1954 as a state-owned entity producing cane sugar, but then in 1994 the group was turned into a stock company and in 2001 had an ownership change in favour of a private company. The group is characterized by two value chains: sugar processing and paper processing. Moreover, it shows high integration of material and energy by-product exchanges, which led to good profit and limited environmental burden.

The GG developed both internally, by establishing new processes able to reutilize by-products, and externally, by building close relationships with suppliers (mainly sugarcane farmers) and the local government. Indeed, the group has always looked for a close relationship with its main suppliers in order to obtain adequate raw materials with high quality. Furthermore, it has aimed at producing high quality products, vital to gain market share and optimal economic benefits, while it has taken full advantage of the sugarcane, developing all industries able to use by-products and residual products. As a result, the Guigang Group produces the best quality sugar in China according to colour, sulphur, and impurity content, sharing a large market and establishing an average sugar price higher than that of other Chinese sugar refineries. Altogether the group produces annually 120 kt of sugar, 85 kt of paper, 10 kt of alcohol, 330 kt of cement, 8 kt of alkali, and 30 kt of fertilizer.

Arguably, the Guigang Group is a case supporting Desrochers theory. Indeed, the development of industrial symbiosis has occurred as a consequence of profit-maximizing business decisions. First of all, the loop closing reduces the quantity of raw materials to buy, since a great part of inputs is obtained by threatening by-products of other industrial processes. Secondly, thanks to by-products utilization, disposal costs are greatly neutralized. Finally, appropriately addressing environmental issues provides the company with a better image

and it can then enlarge its market share. Therefore, the entire system has been created by people pursuing economic interests, which meanwhile had the chance to operate in an environmentally desirable direction. The central government arrived later; only when it realized the symbiosis was functioning well and that it could offer an example of environmentally friendly industrial activity, it nominated the group an Eco-Industrial Park. Certainly, by-products utilization targets set by the local government make some pressure on the GG, but the public effort toward Guigang industrial metabolism, whether central or local, has occurred only because the private effort has shown how economy and ecology could develop together, each one fostering its own objectives.

The Suzhou Industrial Park is located near the city of Suzhou, about 100 km far from Shanghai. The place is particularly favourable, because Suzhou lies in the resource-full Yangtze Delta region, also called the "Golden Triangle". In 1994 the China-Singapore Suzhou Industrial Park was formalized by three agreements made by the Chinese and Singaporean governments. It was viewed as an important project in fostering economic cooperation between China and Singapore. Indeed, the main developer (China-Singapore Suzhou Industrial Park Development Co., Ltd) was a joint venture between a Singapore consortium and a Chinese consortium. From January 2001, the Chinese consortium has owned 65% equity stake of the joint venture and the Singaporean consortium the remaining part.

Economic performance is impressive: in 2002 it showed an average economic growth of 47% and its GDP achieved RMB 25.2 billion (21 times of that obtained in 1994); in 2008 import and export totalled over US $65 billion (increasing by 14% and 11% compared to 2007); in 2010 GDP reached 133.02 billion yuan with a year-on-year growth of 14%, import and export accounted for US $73.82 billion, and urban per capita disposable income grew by 12.6%.

The park was formally approved as EIP in 2004. It has attracted both local and foreign firms, counting 2,400 foreign-funded enterprises. It shows the presence of several industries, such as chemical, pharmaceutical, health care, machinery, electronics, IT, and software. SIP currently produces 16% of IC Chinese products and is the largest Chinese export base of LCD panels. Furthermore, firms in the park are well integrated in complex value chains. For instance, the IT value chain consists of upstream electronic chemicals manufacturers, semiconductor and TFT-LCD producers and downstream producers of finished products, while it is able to implement e-waste recycling. Moreover, the largest Chinese gas-fired cogeneration plant is in Suzhou park, functioning as a power generator, a heating system for

both industrial activities and residents, and converting treated waste water into cooling water.

In accordance with the 12th Five-Year Plan, Suzhou Industrial Park adopts a growth path based on technological innovation, circular economy, resource conservation, and environmental protection. The results are clear: for 10,000 yuan GDP correspond 0.33 ton of standard coal (one-third of the national average); Chemical Oxygen Demand per 10,000 yuan is one-eighteenth of the national average; and sulphur dioxide emission is one-fortieth of the national average. In February 2011, SIP was elected by the provincial government as one of the ten industrial parks experimenting low-carbon economies. Indeed, recently it has attracted industries related to low-carbon economies, energy saving firms, and green enterprises, gathering, therefore, the attention of prestigious universities such as Tsinghua University, Shanghai Jiaotong University, and Renmin University to locate their service platforms within SIP.

SIP as well as Guigang group confirms Desrochers theory. In this specific case, environmental laws did not give any impulse toward eco-industrial initiatives. For instance, the park was recognized as an EIP after it was already operating environmentally friendly business activities. Certainly, once the local and central government acknowledged the relevance of its ecological effort, they have started to foster the development of the park by means of programs funding and establishment of research centres. However, the economic benefits resulting from industrial ecology implementation have been of great significance, and have continuously provided incentives and motivation for both private companies and public-owned entities towards this growth path.

Tianjin Economic-Technological Development Area (TEDA) was founded in 1984. It is located on the Chinese northeast cost within the Tianjin Binhai New Area (TBNA), in the municipality of Tianjin city. TEDA is about 45 kilometres east of Tianjin downtown and 130 kilometres southeast of Beijing city.

Since 1984 until now, 76 multinationals have established 158 enterprises, 4,864 foreign-funded companies have been approved, and 9527 domestic firms have grown in the area. By the end of 2010, the total cumulative investment since the early stages accounted for 61.6 billion dollars, while the real foreign investment registered 25.73 billion dollars. In 2009, the GDP was 127.40 billion yuan, the gross industrial output value corresponded to 420 billion yuan, and the gross export value accounted for 13.34 billion dollars.

The most important industries are: electronics (accounting for more than 40% of total gross industrial output); automobile & machinery (about 30%); biotechnology & pharmaceutical (about 5%); and food & beverage (about 3%). Electronics is largely TEDA primary anchor, and important brands as Motorola, Samsung, Fujitsu Ten, and Panasonic have built their own plants within the zone. The automobile industry has developed thanks to the German SEW-Eurodrive and to Toyota Motors and FAW (an important Chinese automaker), which in 2000 have decided to jointly invest in auto-making facilities. The biotechnological and pharmaceutical cluster has grown since 1994, when Novo Nordisk created one of its production bases within the park. Thereafter, other companies such as GSK and Servier have entered into TEDA. Finally, Coca-Cola, Nestle, Kraft, Pepsi, and Tingyi dominate TEDA food and beverage sector. In particular, the Taiwanese Tingyi has become the Chinese market leader in instant noodles, ready-to-drink teas, and sandwich crackers.

TEDA's focus on eco-industrial development is merely due to economic reasons. Indeed, TEDA has been aiming at consolidating its leadership among national economic-technological development zones and, therefore, has decided to enhance its investment climate and public image by adopting environmentally friendly business strategies.

Since the early 1990's, TEDA has conserved and made efficient use of critical natural resources as water and usable land. The earliest symbiotic relationships were formed spontaneously across industrial companies in order to obtain economic cost-savings, while the ecological benefits were recognized later due to the environmental degradation of near areas. For instance, nearby rural zones have faced severe farmland degradation because of the transfer of great amount of topsoil to the industrial area. Thereby, TEDA has developed a well-integrated symbiotic system, where water, energy, and materials are greatly exchanged. TEDA shows a total of 81 exchanges, energy exchanges accounting for 9%, water exchanges for 15%, and material-based exchanges for 76%.

TEDA case supports Desrochers theory, demonstrating that the sustainability of TEDA industrial symbiosis relationships depends heavily on their economic feasibility. Certainly, public institutions have the chance to foster and help symbiotic exchanges through incentives, lower fees, educational and training programs, and regulations, but they would not be able to establish from the early stages successful industrial symbiosis examples. When symbiotic benefits do not include economic savings, no one will engage in eco-industrial initiatives.

Multiple studies and examples have shown how protecting the environment and its resources can positively affect industrial performance. The Chinese government has already perfectly understood the importance of the natural environment surrounding us and providing the necessary resources for business activities and human life. And, also, it has perfectly understood that safeguarding the environment can even accelerate industrial growth and profit accumulation. Within eco-industrial parks the benefits characterizing traditional clusters tend to be added to the benefits of industrial symbiosis, ultimately generating a green and successful way to further develop. Indeed, Marshallian external economies offer advantages that firms cannot find elsewhere; and eco-linkages among co-located firms reduce wastes and lower input prices and transaction costs.

China is exploiting its latecomer advantage by grounding its growth path on industrial clusters and industrial ecology. By linking economic profit to environmental protection, China is laying down its successful pattern in a cleverer and more creative way than developed countries. The late arrival has allowed the country to learn and imitate, as in the case of German and Japanese environmental regulations or of Danish Kalundborg example. Indeed, these models have offered China the chance to study, absorb, apply, and improve. Even if the industrial symbiosis concept comes from the western world, no country has demonstrated the same legal and institutional framework and the same number of eco-industrial initiatives as China's. Linking to global actors, leveraging its national resources, and learning from its western competitors, the country has learned and ameliorated their technologies, information, and ideas without having to make similar errors, thus sparing the amount of time, energy, and economic resources developed actors needed to discover them.

This emergent dragon has already taken its decisive step toward a new and sustainable era: the law promoting circular economy and successful cases as those provided in this work prove to the world how this country is greatly determined to go beyond, better than before and further than before. Without any doubt, it is one of the future leaders of the world economy.

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