HANDLING TECHNOLOGICAL INNOVATIONS

Handling Technological Innovations: China Overview

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ABSTRACT

Undertaken research is of phenomenological nature. We attempt to explore the retrospective and current trends in management of technological innovations in China by our inductive approach and arrive at conclusions. Most of the information that contained in the research work comes from the secondary sources including books, journals, and available report data from Chinese and foreign governmental or agential official websites. By exploring past and present economic development and technological advancement of China mainly focusing on possible problems, the objective of this paper is to inform government authorities of China and other countries which are following the Chinese way of development in order to make them understand discovered problems in advance and take actions. The paper embraces four logically interrelated parts. In the first section of the paper, we analyze different theoretical bases to build our own suppositions. The second part sets out to discuss how China is handling technological innovations to build innovation-driven economy, while the third part explores some challenges that China is confronting on its path to further proceed towards the intended target. The last part shares our own personal standpoints and conclusions.

Keywords: Industrialization, Learning, Clusters, Technological innovation, China, Challenges of economic development

1. CONTEXT

1.1.The Main Engine of Growth: Industrial and Postindustrial Societies

Throughout history, societies have led a long path of economic development which was not very easy to attain for the successful ones and still very challenging for the latecomers. If we take a moment of reflection upon the history of economic development of current modern human societies, we can establish that the process of industrialization has always been the key push in the creation of today's giant and powerful economies of Europe, the USA, Japan and many others. Based on several empirical and theoretical arguments, Adam (2011) classifies several features to suggest that industrialization was the main engine of growth for the emergence of economic powers:

(1) Per capita income is positively correlated to the degree of industrialization
(2) Productivity is much higher in manufacturing than in agricultural sector
(3) Technological advance is born in the manufacturing sector and diffuses across other sectors
(4) There are stronger linkage and spillover effects in manufacturing
(5) Compared to agriculture, the manufacturing sector offers special opportunities for capital accumulation
(6) As per capita income rises, the share of expenditures on manufactured goods in total expenditures increases, while the share of agricultural expenditures decreases

In general, nowadays, the term "industrialized society" is deemed synonymous with wealth, technological leadership, economic and political power and international dominance. However, in the early 1970s a new term "postindustrial society" appeared in economic science field to better illustrate noteworthy changes in some central attributes of advanced industrial societies, the changing character of knowledge, technology, occupations and the market in the social structural and economic dimensions of industrial societies (Robert, 2000). In other words, over the last fifty years, one of the main changes that occurred in the target of economic growth strategies of "industrialized societies" was the shift of emphasis towards technological innovations (Raja, 2010).

Many studies have found innovation to be of pivotal importance in the viability and prosperity of economies given the ever-increasing challenges of globalization and global competition. Centre for Process Excellence and Innovation (CPEI, 2012) defines competitiveness as two capabilities: to innovate and develop cutting-edge technologies and products; and to deploy and to better the operational processes those efficiently produce and deliver these goods and services to the customer. Improvements in economic growth and the quality of life are believed to be facilitated by stimulating and intensifying technological innovation (TIA, 2010). Designating innovation as one of the pillars of country's twelve competitiveness measurement units, World Economic Forum (2011) highlights critical importance of innovation among others stating that in the long-run standards of living can be improved only with innovation. CII (Confederation of Indian Industry) points innovation to be the only way for Indian industry to have sustainable and inclusive growth. Four main elements are categorized (Jan, 2007) in the national context to be critically important for the countries to be in harmony with global trends. One of them is the development of the strong "innovation system". Innovations are seen as the crucial factor for job creation, growth and sustainable wealth generation in business firms and in the country as a whole (Goran, 2009).

Supposition-I. Underpinned by industrialization, technological innovations have evolved to be the key factor for the countries and their companies of postindustrial era to attain stable growth and prosperity in the long-term.

1.2.Learning for Technological Innovation

Industrialization being the fundamental base for economic development, growth rates can only be further sustained through fostering innovations throughout economy. While economic advantage during the Industrial Revolution in the large part was associated with natural resources, National development in the Digital era can only be achieved with "creative" minds (GII, 2011). Thus, technological capabilities (learning), technology absorption and diffusion are regarded to be the backbones of industrialization and international competitiveness without which it can be arduous if not impossible to build innovative economy (Dani, 2006). Then, it is altogether fitting to pose the question "How can we achieve knowledge-based economy which better bolsters the birth of technological innovations as an output.

Changing attitude towards the relative importance of knowledge embodied in human capital and technology has brought up many different approaches as to how to create knowledge- based innovative economy. A prime example is National Innovation System first introduced by Freeman (1987). The system implies active cooperation among many actors (industries, government institutions and universities) whose interaction results in overall increase in learning capacity and innovative performance of the nation accordingly. Analyzing USA's NIS characteristics, Irwin (2006) points out three main actors in NIS; (a) industries as a primary performer of R&D, (b) universities as a primary performer of basic research, (c) Federal government as a primary source of funds for basic research. Examining the successful development history of South Korea, Linsu (2000) remarks high rates of investments in physical and human capital to raise modern planners, managers and engineers out of inexperienced imitators of the 1960s. According to Technology Alliance Group (TA, 2012), for economies to sustain a vivacious innovation economy that can benefit all, they should facilitate an excellent education system, strong research capacity and a robust entrepreneurial environment.

In point of fact, the world's most innovations are concentrated in just a few places around the globe (Richard, 2005). The author further states that innovation remains difficult without a critical mass of financiers, entrepreneurs, and scientists, often nourished by world-class universities and flexible corporations.

Supposition-II. Learning for technological innovation embraces active cooperation of many different actors targeting to better use of human intellect.

1.3.Industrialization for Technological Innovation

Since the importance of human intellect to better perform in innovativeness began to be more recognized and valued, we have observed a high growing tendency of high-tech production compared with that of other manufacturing industries within the global economy (CSD, 2007). According to the Pavitt's (Pavitt, 1984) taxonomy, high-tech industry belongs to science based sector of manufacturing and is characterized with its high R&D intensity (OECD, 2011).

There are several underlying reasons why high-tech production is increasingly on the focal point of many nations in their path to economic prosperity (Lawrence, 2007).

- High-tech firms are more related to innovations. The more innovative firms, the more likely they are to survive and prosper. Innovative firms can readily obtain market share, create new markets with their novel products and employ resources more productively.

- High-tech industries are associated with high value-added production. With more success rate in foreign markets, high-tech firms can support higher compensation to their workers.
- With its spillover effects, high-tech industry benefits other commercial sectors that often lead to productivity gains, business expansions, and the creation of high paying jobs.

The growth tendency in high-tech production in the world total can also be well explained with the theory of development stages described in The Global Competitiveness Report (2011). According to this theory, factor driven, efficiency driven and innovation-driven economies distinctly stand out:

- Factor-driven profile economies compete based on their factor endowments - mainly unskilled labor and natural resources.
- Efficiency-driven profile economies compete with efficiency and quality. These economic features can be reached by better education and training, efficient goods markets, well-functioning labor and developed financial markets, the ability to harness the benefits of existing technologies, and large domestic or foreign markets.
- Innovation-driven profile economies can compete only by producing new and different goods using the most sophisticated production processes and by innovating new ones.

Industrialization being a bridge to transform a country from factor-driven to efficiency-driven, then to innovation-driven, high-tech industry is specially addressed because of its innovation-inherent, high value-added and spillover features.

Supposition – III. High-tech industry plays an important role in attaining stable growth and sustainable economy.

1.4. Industrial Structure

Realizing indispensible power of innovations in growth and competitiveness, almost all leading countries started investing heavily in research and development (R&D). However, observations reveal that still a small number of geographic locations mostly dominate the global innovation process in specific sectors and technological areas (Porter, 1990). This further encouraged scholars to find out the underlying reason of these particular locations being more competitive than the others. Thus, “cluster” effect is brought up; geographical proximity creates faster interaction between in-cluster companies and more efficient flows of goods, services, ideas, and skills follow thereby yielding high levels of productivity growth and rapid rates of innovation in both processes and products (Idea, 2008).

Although interpretations of driving forces behind emergence and development of early clusters markedly diverge among researchers, the sheer volume of productivity and innovativeness of in-cluster companies is generally agreed. Agglomeration advantages such as networks, knowledge spillovers, and human capital mobility make clustered firms more productive than other outside firms (Erik, n.d.). Therefore, when it is considered to increase innovative capacity of the nation in terms of new-to-the-world innovations, these three important factors; (i) innovation infrastructure (ii) the industrial cluster environment (iii) the linkage between these previous two are highly necessary (Furman, 2002). Industrial clusters are not only viewed from the angle of high innovativeness (clusters belong to both high and low-value added industries), but also their contribution to the development, the detraction of poverty through impacts on the local economy in which they function. (UNIDO, 2004).

Supposition – IV. Cluster effects can bring difficult-to-imitate capabilities to the firms operating inside.

2. INDUSTRIALIZATION AND TECHNOLOGY MANAGEMENT IN CHINA

Upon the introduction of its open market policy in 1978, China started to integrate into the world economy with astonishingly high speeds. From the very beginning of its opening to the world, China represented a high pace of increase in its GDP growth, an average of 10.1 percent growth throughout the last 30 years (the World Bank), and by the end of 2010 China overtook Japan (Japan used to hold the title of being the second largest economy since 1968) in terms of its GDP and turned out to be the second largest economy second to USA in the world (Tomoko, 2010). Can these indicators represent that China is the world leader in Science and Technology and hosts the manufacturing hub for the world and its biggest multinational corporations? The more probable answer by many might be "not". More precisely, not all the inference can be drawn using simply some general statistical numbers. This can be seen in another example; between 2001 and 2007 high-tech goods exports from USA to China more than doubled and at the same time this indicator more than quadrupled from China to USA (AeA). Yet, we should not oversee the fact that 86 % (2006) of high-tech goods are being produced by partially or wholly foreign-invested firms, mostly by American originated ones (Xing, 2010). However, at the same time, China has devised a plan to be "an innovation-oriented country" by 2020, a "world's leading science power" by 2050 which requires solid industrial base and science-technological capacity (Cong, 2006).

2.1.China - on the way to innovation-driven economy

Since embracing open economy policy, China has taken and led numerous measures to boost its capacity to create "indigenous innovations" by lending more weight to the development of Science and Technology potential of the nation. Establishment of Ministry of Science and Technology (MOST), Chinese Academy of Science (CAS) and National Natural Science Foundation of China and launch of different national programs in different periods including The Key Technologies R&D Program, 863 Program, 973 Program, The Spark Program and Torch Program and many other S&T oriented programs indicate how China is desiring its Science and Technology capacity to grow (China in brief). China's science and technology power is underpinned by the network of 5400 national governmental institutions, 3400 university-affiliated research institutions, 13000 research institutions under large state enterprises, and 41000 non-governmental research-oriented enterprises (Jiang Yu, 2010). Analyzing the early results of subsequent Science and Technology policies over the last 30 years we can see noticeable increase in scientific power of the nation: 293066 pieces of Chinese resident patent applications submitted to the World Intellectual Property offices around the world (fewer than 5% is submitted abroad) placed China in the top position in the world in 2010 (WIPO, 2010). Formulated with the aim of further developing its science and technology base to foster innovation-based development, China's 15- year Plan of being innovation-oriented country until 2020 outlines several related policies including increasing GDP share up to 2.5 % into R&D sphere by 2020, raising the contribution of technological advance in economic growth to more than 60 %, limiting reliance on imported technology to no more than 30 percent of value added, becoming a leading country in terms of invention patents and scientific papers citation gained by Chinese citizens (Denis, 2007).

2.2.Economic and Technological Development Zones of China

China's strong industrial base has been created mainly on the face of its several state-level Economic and Technological Development Zones (ETDZ). China is home to seven Special Economic Zones (administrative divisions), 131 state-level ETDZs and over 1,500 industrial parks (Wanda, 2007). Reasonably, the meaning of forming special zones has also changed. Whereas it was just involving

foreign funds as a crucial target in the beginning stage of this policy, now the focus has largely shifted to technology innovation (Zhang, 2012). After the implementation of the national “Torch Program” in 1988, China has enjoyed an outstanding performance in high-tech industrialization as well; 56 High-tech Industrial Development Zones with great high-tech achievements (CADZ, 2009) were established to date. Some of the best ETDZs of China are described below:

2.2.1. Beijing Zhongguancun Science Park

Beijing Zhongguancun Science Park is based in the capital of China and is regarded the premier science and technology development “incubator” of the country. Its history dates back to the “Zhongguancun Electronics Street” in the early 1980s, which later was officially recognized in 1988 as “High-tech Development Experimental Zone” and was formally approved as China’s first state-level high-tech development zone in 1999. The zone is comprised of several clusters including aerospace industry cluster, electronic information industry cluster, new material industry cluster, new energy vehicle industry cluster, new energy, energy conservation and environmental protection industry cluster, equipment industry cluster, emerging cultural and creative industry cluster and biological industry clusters. The area is surrounded by a 32 higher educational institutions, 206 national and provincial research institutions such as The Chinese Academy of Sciences, Beijing and Qinghua Universities and so on. The park’s total revenue in the late 2009 was 1.3 trillion Yuan and the number of patent applications submitted was 16547 in 2008 (SIPO, 2009). The area attracts more than one third of the nation's entrepreneurial investments. Until now more than 15,000 overseas returnees have established more than 6,000 enterprises in the park. Almost 200 branches and R&D centers of the world's Top 500 companies have set their offices in the Zhongguancun Science Park. A number of companies registered in the Zhongguancun Science Park have been listed on NASDAQ, New York Stock Exchange and Hong Kong Exchanges and Clearing Ltd (ZGC, 2012).

2.2.2.Shenzhen Special Economic Zone

Shenzhen Special Economic Zone was founded in 1980 as the first special economic zone in China. Shenzhen Special Economic Zone covers four of the six districts of Shenzhen City in Guangdong Province with a total area of 493 km². Once a small fishing village, the Zone enjoyed an annual economic growth rate of 25.8 percent compared with 9.8 percent for the whole China within last 30 years claiming country’s highest GDP per capita of about 14615 $ in 2010, which made Shenzhen one of the most prosperous of all the Chinese cities. Shenzhen Special Economic Zone accommodates Shenzhen Hi-Tech Industrial Park and Shenzhen software Park, whose industrial range covers many of high-tech industries like biotechnology and pharmaceuticals, building and construction materials, chemicals production and processing, computer software, electronics assembly, industrial equipment production, medical equipment and telecommunications equipment. In the year of 2010, Shenzhen Hi-Tech Industrial Park achieved a gross industrial output of 301.42 billion Yuan, of which export value accounts for 15.468 billion US dollars (Wikipedia, 2010) Shenzhen is considered as one of the fastest-growing cities in the world (USCS, 2008).

2.2.3.Xi'an High-Tech Industries Development Zone

This Industrial Development Zone opened was conceived in 1991. The main goal of this Development Zone is to spur the development of predominantly high-tech industry; communication industry, photovoltaic industry, power equipments, electronic components, automotive manufacturing, industry of advanced materials, bio-medicine and software industry in central and north-west China. So far, the Zone

has added 997 foreign-funded enterprises, of which 609 high-tech ones, to its already existing 7619 local companies list. Its companies employ a total number of 287,140.employees (2011). In the year of 2011, the Zone gained about 19,716 transformed scientific and technical achievements with 90 percent of registered intellectual property rights and it is highly recognized with its outstanding share in developing Chinese independent innovations. In 2010, the total industrial output hit the point of 263.4 billion with 31 percent increase compared to previous year. As of 2006, XHTZ was chosen by the Chinese Government as one of the six high-tech zones to be further transformed into "First-class High-tech Development Zones" in the country (XDZ, 2011).

3. CHALLENGES TO CHINA'S STRATEGY IN MANAGING TECHNOLOGICAL INNOVATIONS

China is taking all the measures to capitalize on its innovation-driven economy, yet there are still many obstacles to be dealt with properly.

3.1.Industrial Pollution

Chinese miracle of economic growth has been highly debated over the past years. In the meantime, side effects of massive industrialization have started taking its toll; pollution-related disease burden, pollution-exacerbated water scarcity, waste-water irrigation and concerned loss of fishery, crops and excessive degradation of natural resources have surfaced to be a real concern. China hit the highest record number of deaths attributed to air pollution in the world with 700,000 person in a year and this number is expected to rise to additional 550,000 in 2020 (Jeffrey, 2008); around 190 million people are believed to be sick from drinking contaminated water (Elizabeth, 2007). The aforesaid numbers partly represent the effects of industrialization on human health but some other sides of the environmental issues are also equally severe.

Generally, there might be two side effects of this situation to China's strategy of building innovation-oriented society: (a) A healthy workforce being vital to a country's competitiveness and productivity (GCR, 2011) and main base in generation of innovations in the country, it is hard to bring up "innovative talents" of the future in a highly unhealthy environment. (b) Worsening environmental degradation may force the government to divert the attention and investment from its 15 -Year Plan related projects (AeA, 2007).

3.2.Unquestioned Deference to Authority

Although many of the scholars acknowledge driving power of Chinese government's "visible hand" in attaining such a great development in a relatively short period of time, many others question motivational power of authoritarian government system to further support "innovators" economy. Highlighting underpinning role of horizontal networking within different actors of innovation (research institutions, financiers, partners, suppliers and customers) in favoring knowledge, capital, product and talent exchange to make innovations happen, Gilboy (2004) questions the vertically structured Chinese political system in encouraging innovativeness. Rodney (2008) also states this problem as, "Openness matters – in innovation, in education, in all realms of scholarships and the arts, and in debates about progress within politics" and accentuates freedoms which remain constrained in China.

3.3.Unsupportive Education System

Education is an important base in forming future innovators. Through our exploration of several articles, we have found a number of authors doubting the quality of Chinese education in this respect. Many tend

to criticize Chinese education system in raising future talents for its favor of rote teaching. Sargent (2006) asserts the current system is not good enough to foster problem-solving, innovation and creativity skills in students. Additionally, the overly strict rules followed by boredom which can lead to rote memorization for examination are deemed to be one of the main reasons why dropout rates are high in China (Hongmei et.al, 2011).

3.4.Lack of managerial skills

Experienced managers are the key vessels watering innovation to grow. However, Shui (2009) mentions a low rank of China in terms of process and management skills and highlights the lack of managerial experience as one of China's major weaknesses in IT industry.

3.5.Customer's Quality Appreciation

Readiness of customers to pay for a better quality product is the main incentive for the producers to conduct research on further betterment of their products, thus to be more innovative. Since China is still a middle income country, there are not many wealthy local customers who appreciate high-end brand products and are willing to pay for it. Emphasizing the importance of domestic user-producer linkages in fosterage of innovations, Tilman (2007) points out underdeveloped loops of this interaction in the case of China. Thus, the purpose of technology development in enterprises is being limited to merely meeting present market demand rather than developing potential markets.

3.6.Loose Protection of Intellectual Property Rights

According to the results of CEA survey (2007), most new products are generally imitated within a year. Apparently, this period is even shorter in China. Hout (2006) specifies that due to weak intellectual property rights in China, many producers are losing their incentive to innovate. Based on his review of selected articles from leading journals on intellectual property rights, Hanni (2012) finds that almost all the articles on China scope pertain to the protection of intellectual property.

3.7.Loose intensity of relationship among actors of innovation

Density and quality of collaborations among main actors (industry, academia and public or government research institutes) of innovation can be a determinant of innovations in terms of quality and quantity. However, these linkages are still relatively weak in China (Mu, 2008). Motohashi (2007) also confirms that the degree and quality of research-oriented cooperation between university (research institutes) and industry are lower as opposed to developed countries.

4. CONCLUSION

China has showed a tremendous development pace throughout these last 30 years. Its "open doors" policy has proved to be efficient and contributed a lot to the prosperity of the country. Thirty years of open policy has helped China build its strong manufacturing based economy and this economy demonstrates its strength to the world within many different aspects. At the same time, China's recent plan on building its innovation based economy has raised even more discussions among its partners and competitors. However, this plan cannot be easily realized in the face of many different obstacles. If problems concerning industrial pollution, autocratic control, quality of education, intellectual property rights and loose relationship among actors of innovation will timely be recognized by the government and attentively dealt with, then, China has a solid base to reach its target.

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