The Rise of China's Innovation Economy: "Opening Up" Policy to Manufacturing Maturity, and on to Innovation Based Economic Growth and Labor Market Dynamics?
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1.0 Introduction and Overview

China has for some time wanted its economy to become innovation based. This paper examines progress toward achieving this long term goal and related labor market adjustments that occurred in pursuit of this goal. The paper reviews China's economic development since the "Opening Up" policy was adopted in the late 1970s through the recent slowing of growth and a renewed commitment to transforming the economy once again to an innovation based model. The paper concludes that China is not only making measurable and significant progress but is also doing so in a way that raises the question of whether China has invented a new model? This conclusion is made with the caveat that China still faces a number of barriers for fully achieving self-innovation outcomes.

The first two decades of China's development plan focused primarily on de-collectivization of agriculture but by the late 1980s policy emphasis turned to privatization and contracting out some manufacturing functions from State Owned (SOCs) to private companies and thus transforming the economy from import to export oriented as it borrowed insight and guidance from the evolving experience of the export oriented growth model of the Four Little Dragons. The ensuing rise of China's manufacturing based economy depended on obtaining production and marketing technologies from the more developed countries of the world. To

the extent that innovation was involved in the rise of the manufacturing economy it was imitation based with Chinese companies inventing and implementing incremental changes on top of basic technologies and improvements acquired from others (Heilig, 2012; Zhang and Stough, 2012; Kerr 2013; and, Tse 2014).

From "Opening Up" and later as increased privatization unfolded, China's leadership understood that sustained growth would ultimately depend on its ability to innovate its own new technologies and methods (Economist, 2015). So it set about creating a technically skilled labor pool, and initiating a variety of experiments aimed at strengthening home grown innovation. From the early to mid- 1990s China implemented huge financial support programs and incentives aimed at promoting self-generated innovation. For example, national and sub-national programs providing support for technology incubation and government venture capital (e.g., the Torch Program) to support new technology companies were implemented and tested across the country (China.org.cn, 2004; and Blank, 2013) with nearly every medium to large sized city receiving central government support in combination with locally provided resources or match to create new technologies and processes. While these policies initiated many experiments, the immediate results were at best marginally successful and then mostly in a few places like Singapore and later Shenzhen.

There are many reasons for these seemingly failed policies and programs which are considered below in the next part of the paper. It is important to note that the early attempts to move China toward an innovative economy helped officials (national and local) learn that more than financial incentives and low cost labor would be required.

Until recently the slow to develop innovation skills resulted in a growing belief among foreign economic development and growth experts that China would experience great difficulty in creating an innovation economy and thus would be dependent for some time on acquisition of technical inputs from external providers via imitation and other methods (Abrami et al. 2014). Events in the past several years suggest that China might be altering this external perception as indigenous globally competitive technology and technology led companies have emerged. For example, a recent report lists four of China's internet and technology companies among the top ten in the world (Wired, 2014). Further, the U.S. National Science Board (the board of directors for the U.S. National Science Foundation) reports that China's share of high technology manufacturing rose from 8% in the early 2000s to 24% in 2013 and for a similar period China's global portion of technology manufacturing grew from approximately 2% to 14.5% . While the U.S. portion remains dominant, it fell from 37.5 % to 30% of global manufacturing (Abrami et al. 2014; and, Wertime 2014). These are only a few indicators or examples that China's economy is moving toward becoming a large and mature innovation based economy. This was not thought possible just a few years ago. This possibility is examined in detail below in Part 4.

Before turning to the analysis it is an instructive digression to consider Daniel Bell's (2015) thesis that China's society and thus its model of governance can be understood in terms of three layers. At the top is a decision and leadership structure that is based for the most part on meritorious principles. China has expended huge resources developing a leadership training, evaluation and testing program that aims to identify and select the "best and the brightest" for the top leadership positions in China. But this occurs only after candidates complete a long trek

that began with elections at the village and/or district level in urban areas, and only later progressed to more senior leadership roles (Bell, 2015). The more one rises to and seeks higher senior party level leadership positons, the more one must demonstrate (through interviews, and oral and written examinations) that he or she has sufficient broad and deep knowledge, and experience to successfully participate senior level decision making (Bell, 2015, 63-109).

Beneath this merit based decision framework is a middle layer of the structure that is experimental. Learning from experimentation has been a central element since "Opening Up" as demonstrated by the creation of the Special Economic Zones in the Coastal areas as early on economic development experiments for testing and evaluating market principles. This early experience provided "lessons learned" and subsequently to dissemination of "best practices" in support of subsequent formation of next generation development zones. The Shenzhen special economic experiment is an intermediate case of a special economic zone being erected upon best practices learned from earlier experiments and experience. The modern history of China's attempts to create an innovation economy may be viewed as a series of learning experiments that revealed workable practices and constraints that needed to be more carefully managed.

Finally, Bell (2015) argues that democracy operates at the local level as described briefly above about how local and regional candidates for leadership positions must compete for those positions through elections. This practice began in the early 1980s in Guangxi province and the new constitution adopted in 1982 included a clause defining the village committee and residents' committee as self-governing organizations of the masses in rural and urban areas, respectively, including the provision that officeholders should be selected by election." (Bell, 2015, p. 181).

The importance of China's recent seemingly increased indigenous innovation did not happen because the Chinese Communist Party (CCP) just ordered it, but rather, it is the result of more than 2 decades of experimental efforts to create an innovation economy. The lessons learned from failed and sometimes successful attempts have produced innovation approaches that are indigenous in nature and seem to be coming increasingly more successful especially in the past few years.

The paper is organized in several parts following this Introduction. The concept of an innovation economy is examined and described in terms of associated input and output factors, not the least of which is the labor market, in part 2.0. Next, the rise of the Chinese economy from "opening up" until signs that the manufacturing based economy was beginning to decline in the 2nd decade of the 2000s is examined in part 3 along with the barriers to innovation. Following this, in Part 4, the rise of the Chinese innovation economy is presented. In part 5 the vision of China's innovation based economy is examined in terms of recent experience and on the basis of change in both input and output indicators. Also, barriers that are still begging attention are considered. Conclusions and discussion of the implications of the rise of China's innovation economy for the rest of the world and future Chinese economic development are presented at the end.

The Chinese labor force has experienced several transformations from the beginning of opening up through the manufacturing dominated economy to the present time when its innovation economy is evolving (Kerr 2013). China's quest and rise to the status of an innovation economy is marked by many changes and transformations of its economy not the least of which is the continued adjustment of its labor force skill base to support a more self-

innovation economy. This paper, in addition to its basic purpose to examine the development of an innovation economy in China, also demonstrates how the Chinese labor force has evolved and transformed as new economic realities arose.

2.0 The Innovation Economy

The history of economic development reveals the focus of economic activity of nations and regions arising from initial dominance of agriculture, livestock herding and hunting being replaced by manufacturing and eventually to a predominance of services (Binns, 2008, Rostow 1960). These evolutionary steps of the development process are arguably driven in part by new technologies that transform the previous economy into a new one (Smith, 1776, Holcomb 1998) that enjoys a significant increase in total factor productivity (Baumol, 1986). The sequential development of transformations has been experienced by nearly all developed nations and their regions, and to date at least, China has followed this pattern but at a more rapid pace than in the past.

Today advanced economies are molting or adjusting once again to a new era of technology, the knowledge and information age, where the amount of new as well as archived knowledge is growing exponentially (Toffler 1962, Drucker 1991, Castells 1994, Krugman 1995). In this context as in earlier economic structures the end outcome of knowledge is increased productivity per unit of capital and labor inputs, i.e., total factor productivity. This is achieved via increased efficiency in the transformation of knowledge into ideas and concepts, prototypes and testing leading to new products and services. The recent increased growth of knowledge as a function of rapidly evolving information technology and its integration with

telecommunications is producing a rapidly growing interest in and ability to manage this resource as it becomes a dominant factor contributing to increased productivity.

In the knowledge age and the age of globalization of nearly everything, innovation has become significantly more important for maintaining sustained economic growth in the developed countries and those aspiring to developed status (Antonelli 2003; Romer 1986 and 1990; Lucas 1988).

Innovation has for a long time been viewed as one of the factors that produced economic growth (Smith 1776, and Schumpeter 1943). “Where did the Model T, the Internet, laser technology, space exploration and the innovations that led to these products and the attendant job growth come from?” They came from innovation and were achieved in part through ideation, prototyping, trial and error testing, and market planning and selling. Thus, while innovation may be viewed as one of the elements that always contributed to economic growth its role in the past was viewed as only one of several inputs that drove growth, wealth creation and improved life quality. In this context it is important to recognize that it is the entrepreneur who is the agent that manages and guides the process of innovation (Stough et al. 2013). Today, in the knowledge age, capital and human capital are still important inputs to the development process but rapidly expanding new and archived information/knowledge are taking a leading role in driving innovation and economic growth (Romer 1986, 1990; and, Lucas, 1988; and, Arrow 1962).

It is not clear if nations and/or regions can leapfrog in some way the historical sequence of national economic structural change and growth: agriculture to manufacturing, manufacturing to services and now services to knowledge. It may be possible now that there is

understanding of this sequence of development events or stages to shorten if not leap frog one or more sequences or stages of the development process? This is the question that economic planning in China faces today. Can China make a very rapid transition from an economic structure focused on manufacturing and service sector growth driven mostly in the recent past by traditional labor and capital inputs to a knowledge and innovation driven economy? The answer may be yes.

There are signs that China is beginning to achieve self-innovation and technological driven economic growth at a high level which is attention grabbing given it has been less than a decade since China became the dominant manufacturing economy in the world. Are we seeing *déjà vu* or are we witnessing a shortening of stages or just a leapfrogging of even the historical development sequence?

In the following parts of the paper we examine China's economic growth and related policies that have for some time included a desire to create self-innovated new technologies and products. We begin this discussion in Part 3.0 with a review of the rapid rise of the modern Chinese economy.

3.0 The Rise of the Modern Chinese Economy: From "Opening Up" through Imitation Based Manufacturing and on to the Innovation Economy

In 1978 the People's Republic of China announced an "Opening Up" economic policy designed to engage the markets of the world through inviting in foreign investment, decollectivizing its huge and bulging agricultural sector where most of its population lived and worked (Kerr 2013). At that time China could not grow enough food to feed its population, poverty was wide spread, education and especially higher education was limited to the few, and foreign involvement and presence in China was limited. This policy permitted some

entrepreneurs to start their own companies with the hope of stimulating the rise of an entrepreneurial class. So “Opening Up” was a monumental policy of economic and social reform aimed at improving the economy and the lives of its citizen’s.

It is important to recognize that import to export oriented growth was also part of “Opening Up” vision. In this way China opened its market and exposed itself to the process of global innovation. Imitation based manufacturing was achieved through importing and learning from other countries. By adopting and incrementally transforming the innovation China was able to build a huge manufacturing driven economy that not only served the local but also the export market. In this way the opening up of its economy resulted in new foreign led or financed manufacturing that relied upon foreign production technology. This process of adopting and becoming exposed to foreign technology is called imitation innovation, i.e., acquiring technology by observing how it works and then adapting it to local conditions. Yet, as noted, China always envisioned building an economy that was erected on the ability to self-innovate. The reality was a manufacturing economy that relied on imitation of other’s innovations.

3.1 The Rise and Expansion of the Manufacturing Sector

For the two decades following “Opening Up”, despite some modest support for the development of entrepreneurs and small businesses, China’s manufacturing sector was dominated by State Owned Enterprises (SOEs) that were charged with producing durable and infrastructural goods and services. Foreign direct investment was secured to help modernize the physical infrastructure of the country including surface transportation, power production,

water supply, sewerage and treatment, telecommunications, airports and ports. However, SOE dominated manufacturing was slow to improve efficiency and output quality (Kerr 2013).

While SOEs have been viewed as a barrier to innovation by many observers, SOE reform measures are considered by the Chinese leadership as potential sources for innovation in China. Because the SOEs are closely controlled and monitored by the central Chinese government it can and has promoted innovation in the SOEs. While many external observers see the SOEs as a hindrance to innovation from the Chinese perspective, SOE reform may potentially trigger innovative behavior not only in market driven enterprise development but also in these more tightly State controlled organizations. The results of reform and its influence on innovation in the SOEs is a topic of considerable interest as discussed further below.

From 1990 increased attraction of FDI to support further infrastructure development, Chinese spinoffs from the SOEs, and subsidiary plants of foreign companies occurred in an effort to achieve greater output efficiency and quality. The quality and quantity of manufacturing output expanded rapidly and China became arguably the largest provider of manufactured products globally by 2010 in terms manufacturing as a source of GDP and in manufacturing employment (Woetzel and Seong 2015).

How did China accomplish this? Certainly foreign investment was an important ingredient. First to finance physical infrastructure modernization that improved productivity through improved supply and demand logistics and general mobility and second by injecting external exposure and competition into a production system that was largely operated by SOEs and fall farmers. Third, the presence of large and accessible pools of low cost labor where in some cases marginal cost was nearly “0”, until recently, was a highly significant factor as well.

Innovation in this period was mostly of the imitation variety where existing production technology was acquired via FDI and other methods that enabled Chinese companies to adopt or "imitate" technological knowhow – thus the reason why this form of innovation is called imitative (Levitt 1966,Tse 2014, Shewe 1966 and Zhou 2006). China was able to gradually and incrementally add to known technical knowhow on a trial and error learning basis as best or near best-practice technologies became available. While this approach led to the development of a few large and globally competitive companies, these were exceptions to the general rule of economic growth depending on imitated technology.

Imitation is not the type of innovation that generally transforms economies or even industries as it mostly helps fine tune known methods and incrementally adds to productivity gains and growth, *ceteris paribus*. As long as factor costs of production are favorably priced imitation is a viable economic growth strategy. Until recently there was relatively little short term concern in China with reliance on imitation as the labor cost differential was so great that China continued to enjoy a significant cost gap compared to other producers globally.

While China continued to enjoy global labor cost advantages it still maintained its desire to become a truly self-innovating economy but its early efforts (experiments) had limited success with the huge innovation stimulation policies and programs (e.g., the era of the Torch programs). There were many reasons for this which are discussed in more detail in the next part of the paper but the urgency or necessity that comes from an economy driven by strong competitive forces was not yet one of these given China's huge labor cost advantage over most emerging and developed countries of the world.

By the second decade of the 21st Century the huge success of China's manufacturing based economy and subsequent adoption of new and emerging technologies was experiencing an increasing demand for higher skilled labor. This development in turn began to bid up labor cost despite expansion of technical and engineering graduates entering the workforce due to increased investments in higher education (see below) and the production of more college graduates in technical areas such as engineering, science and management, etc. With rising labor cost contributing to the increased total cost of manufactured products and rising costs of managing environmental pollution, and when coupled with a major global recession starting in 2008, new pressure was added to accelerate China's self-innovation capability (Roth et al 2015 and financial Bitcoin & Cryptocurrency News 2015).

It is important to stress again that one of the factors that had constrained the growth and development of innovation capacity was, ironically, the huge success of China's manufacturing. Rising labor costs after 2010 along with the slow recovery from the 2008 recession served as strong motivators to accelerate self-innovation capacity. We now turn to factors other than labor cost advantage that China enjoyed that have constrained or slowed the development of innovation capacity.

3.2 Constraints to the Development of an Innovation Economy in China

China has, since the early days of "Opening Up", wanted to transform its economy into a sustaining and self-innovating economy (Veldhoen et al. 2013). While early national policy attempts to stimulate indigenous innovation provided considerable investment to induce innovative behavior and create new technologies, the results produced only modest innovation outcomes. Why did most of these investments fail? Several reasons have been offered in the

literature including but not limited to a lack of high quality human capital, limiting government institutions, and existing and sustained strong manufacturing driven economic growth. We now examine these and other limiting factors.

3.2.1 Success of imitation innovation in the manufacturing sector helped produce sustained economic growth (Fu, 2015). So there was little urgency to make changes due to competitive cost competition until after 2010. While manufacturing supported by imitation innovation dominated, it is important to note that the whole Chinese economic experiment was just that and included such trail-and-error and learning from experience programs as the Special Economic Zones (SEZs), government sponsored technology incubation programs and other programs designed to produce technology and innovation outcomes like the Torch and government sponsored venture capital initiatives. Some of the successes included a few break out innovation (R&D) centers/parks like in Shanghai and Suzhou (for example, China, Singapore, Suzhou Industrial Park, 2016; and SIPAC, 2016) where a few local/regional businesses grew from small ventures into emerging global reach firms by the early 2000s like, for example, the Haier Corporation in Qingdao. These few successes survived because they were highly entrepreneurial in transforming from imitative to self-innovation. Nonetheless, despite these limited success cases most of the growth of the Chinese economy from the early 1990s until recently was erected upon and depended on imitation innovation based manufacturing.

3.2.2 Some argue that imitation innovation breeds follow the leader type behavior which easily accommodates and contributes to the development of a **lack of an innovative spirit** (Tse 2014, Wertime 2014, and Chow 2015). This belief was supported in part through a perception

that Chinese university graduates while becoming quite able managers were not very innovative (Wertime 2014). At the same time one may argue that a rote and imitative learning system of higher education coupled with the need on the part of those wishing to attend the university to pass the national examination [see below in section 3.2.4) with high scores helped contribute to risk adverse graduates (Wertime 2014).

3.2.3 Many have argued that **government institutions** in China themselves limited innovative behavior and outcomes. For example, the strong central control of the government would not be expected to create an atmosphere supporting diverse behavior and trial and error learning both of which are required inputs for successful innovation. The inefficiencies of the State Owned Enterprises (SOEs) serve as a standing example of "regression to the mean" type of behavior that arises when such organizations operate as arms of a strong central government (Tse 2014).

Central control has been exhibited through censorship, restricted freedom of speech, strong oversight of education and especially higher education where universities operate with guidance from a strong CCP dominated board (Chen 2015, Sheng and Xiao 2015). Further, there are rule of law issues that would not seem fair to many western societies. Finally, mobility constraining rules such as those that define one's Hukous (i.e., official residence that is for life and determines where and how one obtains government benefits such as health care, education, voting in local elections, and so on) are also important constraining factors (Chen 2015).

3.2.4 Advancement in China's **higher education** system has historically been based on high

quality performance primarily on the national entrance exam. Grading has tended to be in terms of the ability of a student to recite or feed the professor's view back to him or her, verbatim. This system has not been tolerant of error behavior and does not create an environment that encourages learning by doing and learning from one's mistakes which are at the foundation of successful innovative behavior (Wertime 2014).

Some Chinese people and leaders would claim that the national entrance examination is the only fair and effective way to ensure equality of college/university admission. Recently changes have been made in the nature and governance of higher education (discussed below; and, see Tong 2012) to make learning by doing and learning from one's mistakes more important attributes for gaining university admission. But the national examination score is still the primary factor for gaining entry into the higher education system.

3.2.5 Intellectual property issues in China are well known throughout the world (Chow, 2015, Shao and Feng 2015).Given that students are taught to internalize and echo the teacher's (professor's) views and are graded accordingly it would be surprising if they would come to see such views as property of the professor or for that matter for the professor to consider his views and knowledge as his property. Until recently, Chinese students have not understood that such ideas and knowledge are the property of others and thus objects that require protection. Basically, such property in China has been treated as societal knowledge, i.e., a totally open system of knowledge.

3.2.6 There are **other issues** in addition to these more commonly referenced concerns. One is corruption that has existed as a given in Chinese society throughout most of its history (Sheng and Xiao 2015). While merit may be helpful in moving up in leadership roles in society, bribery

has also generally been a strong attribute of Chinese society. Environmental pollution as in many countries moving into and through the transition to development has and is at a high level in China and especially in its cities. While this does not contribute directly to a lack of innovative behavior it detracts from the quality of the environment (Chen 2015, Sheng and Xiao 2015). As personal income grows and citizens begin to enjoy discretionary earnings they voice concern to improve environmental quality and thus the quality and expectation of better living conditions. As such, environment becomes a competitor along with economic growth for resources as well as more recently with innovation and also as an ally with most innovating given that much of technology driven development is in the IT sector which relies heavily on a clean environment. Finally, local leadership has been variable and often lax resulting in unsustainable local debt, ghost towns, shadow banks, inefficiency (Sheng and Xiao 2015).

While these factors have been considered to limit innovative behavior and innovation as drivers of economic growth, significant changes are underway as China moves to become an innovation driven economy. In the next part of the paper these developments are discussed along with the evolving innovation driven economic growth that China is beginning to experience. In part 5.0 discussions regarding how China is dealing with the factors that are viewed as barriers to evolving an innovation based economy.

4.0 China's Innovation Economy?

Many changes have occurred in China over the past 10 years and especially the last 3 with respect to altering the innovation barriers discussed above. These changes are examined in this part of the paper (and in Part 5.0) along with the presentation of evidence that an innovation economy is emerging in China.

China has long used its wealth and political will to propel economic innovation from the top down to local and regional governments with a long term goal of transforming China into an innovation economy and society (Abrami, et al., 2014). In 2006 China, with the release of its medium to long term development plan, announced the goal of transforming China into an "innovative society" by 2020. More recently President Xi, Jinping in presenting China's 13th 5-year development plan (2016-2020) re-emphasized the importance of this goal (Financial Bitcoin & Cryptocurrency News, 2015). China is now spending more than $200 billion each year on R&D which is many times more than in the early 2000s (Economist September 2015). This level of investment represents about 2 percent of GDP, exceeds that of the EU and could match the current U.S. level of about 2.8 percent of GDP (Economist, September 2015) by 2020 in the near future. Thus in terms of national inputs and commitments the last decade and especially the last few years have witnessed significant investments and major strides in upping the inputs for an innovation economy in China. Now for the discussion of the outputs.

China now has a major presence in such technologically intense sectors as wind turbines, high speed rail, aircraft engines and space related equipment which are mostly technological products developed by SOEs. Highs speed rail is an example of how some SOEs have used self-innovation on top of imitation innovation to export newly enhanced and developed products. High speed rail was initially imported from Germany, after self-innovation on top of this China has exported it to Russia and Indonesia.

On the private and/or blended side of business development China has achieved a major presence in such technological intense sectors as telecommunications and information technology, Internet and social media with 4 of the global top ten internet technology and

social media companies (Alibaba, Baidu, Tencent and Xiaomi) of which 3 joined the top 10 since 2013 (Wired July 2014). Others have achieved a major global market presence; for example, Haier Corporation (consumer durables) and Huawei (mobile phones hardware and networking) (Financial Bitcoin & Cryptocurrency News, 2015). So, there are some very innovative examples of major technology business development on the part of both government and (the SOEs) private sector organizations.

Many of these businesses began with higher education investment as a primary input for innovation and China has recently been invested increasingly high levels of resources to expand the skill level of its labor force. For example, university enrollment in 1978 was less than 1 million; by 1998 3.4 million. In 2012 enrollment reached 23.9 million or 4 million more than in the U.S. China today produces more Ph.Ds (30,000 in science and engineering) than any country in the U.S. (Wertime, 2014; Roth, et al. 2015). China was ranked 29th among innovation economies by the Global Innovation Index[1] overall. In this it leads the other middle-income nations; at the same time it performed at the level of developed nations in human capital enhancement and R&D funding (De Vido, 2015).

In 2006 China's Education Ministry created the Chinese Academy of Science modeled largely after the U.S. National Science Foundation which adopted peer review for the allocating its research funds. More recently China has become a global leader in patents with nearly 1 million in 2014 which was more than the 578,800 in the U.S. Sixteen percent of Chinese patents came from universities in 2010 which is up from 10% in 2010 (De Vido, 2015; Roth, et al. 2015; Economist, 2015).

[1] The Global Innovation Index 2015 is a joint project of Cornell University, INSEAD and the World Intellectual Property Organization (WIPO). Find the 2015 Index Report at [https://www.globalinnovationindex.org/content/page/GII-Home].

For more than two decades China has invested heavily in experiments for converting knowledge into better if not new products and services through various intermediary facilities as Industrial parks, and then later as technology incubators, and science and technology and R&D centers. Many of these today are called innovation centers. The goal of all of these was and is to develop an ability to convert new and existing knowledge into new products and services. From the beginning these initial and former efforts were seen as experiments in critical innovative infrastructure. But most of the early efforts were little more than real estate ventures whereby firms mostly offered a semblance of technical oriented products and services based on technical input from other places. The early centers provided little more than space for housing these ventures. Most offered little or no services such as how to start and grow a business, how to create a business plan, technical education and training, and networking these fledgling companies into existing supply chains and markets and so on. In short, very few produced new companies that grew. In general these efforts were largely failures. There were of course a few exceptions, for example, a few centers in Shanghai, Suzhou and Guangzhou (OECD 2008, and, Chow 2015).

Gradually these technology or innovation experiments acquired knowledge from the few more successful Centers and abroad, and thus began to learn that more inputs than just space, utilities and engineering talent was required for growing innovative new companies and technologies. The centers needed to provide training, networking or linkages to new knowledge, to markets, to specialized talent, to capital, and research support services for not only technical development but also for legal, and marketing, management and sales services.

Yet even as recent as the early 2000s many of the innovation centers offered at best a mixed bag of support of useful services and lacked sophisticated networking capabilities.

Signs today are that the innovation centers in China are or have become more sophisticated than observed in the recent past (Stough and Yu, 2015). For example, several fully integrated innovation centers exist in Guangdong Province including in Guangzhou, Shenzhen, Dongguan, Foshan and Zhongshan and new innovation centers are being planned in Zhuhai and Zhaoqing. One now finds a broad set of services to support new startups, and existing companies ready for embarking on a growth trajectory. These also include spinoffs of existing companies that have farmed these new ventures out to these Centers knowing that a wide range of needed services exist to optimize their development potential. These services go far beyond just the provision of space and utilities. Each that Stough and Yu (2015) have visited is managed and led by a person who has considerable experience not just in China but also in the "perfumed parlors" of the world's most recognized innovation areas, e.g., Silicon Valley, Cambridge (U.K.), Austin Texas, and so on. Further, each provides, at the most elementary level, "maker's spaces" for young entrepreneurs to explore ideas. When ideas begin to coalesce assistance is available for prototyping, customer/market development and financing (largely via crowd funding methods at the earliest stages but from more robust forms). At the highest levels Centers now help link emerging growth companies develop global market plans, network with potential local and international partners and their supply chains, and even assist where mergers or acquisitions may be required. In short, today's innovation centers have learned from earlier experiments in China as well as from global experience and have incorporated that learning into design, management and operations best practice facilities (see Jain et al., 2010).

The current successful innovation centers in China are large, integrated and multi-level centers of technical and creative activities ranging from support for ideation leading to start ups to high level technical growth companies. The experience and learning from some 25 years of experimentation with R&D and innovation centers has produced what may be a model for world class self-innovation. As such, environments have been created that are successfully helping firms innovate on top of technologies that may have originally arisen via imitation or acquisition from more developed countries but are now both incrementally and self-innovated.

5.0 Recent Changes in Barriers to Creating China's Innovation Economy

Reducing the many barriers to innovation in China poses considerable stress, conflict and motivation to the senior leadership of China in its goal to both maintain growth and transform the economy and society. Below we examine recent changes in China that have or are occurring to help manage the effects of the barriers to innovation examined earlier in the paper.

With the seating of China's President Xi, Jinping in 2015 he was immediately confronted with slowing growth and the need for a response to lift China's lagging economy (Xinhuanet, 2015; and Zinhuanet 2016). One of the primary visions on how to do this was to accelerate the development of China's innovation economy. Immediately upon his inauguration President Xi announced a number of reforms. Among these was a goal to significantly reduce corruption (Guo, 2014; and, Riley 2015). Soon several senior political leaders were unseated on corruption

charges and new regulations were adopted that resulted in improved recording and tracking of financial resource allocations[2].

Today in China like in most developed countries payments for services, e.g., in the university stipends for lectures, travel and visitor support payments and in the SOEs payments for services and assistance from contractors are carefully documented and audited. This is not business as usual in China where stipends for lectures and other forms of assistance were paid directly in cash in the past. While today cash payments are still made in some cases there are paper trails that evidence where such funds come from and what they were used for. In short, there are many visible signs that corrupt behavior and bribery are being curbed. These signs are powerful symbols and indicators that this kind of behavior is not acceptable and if it occurs there will be sanctions.

Another barrier to innovation lies in the area of intellectual property. Increasingly leaders are recognizing that self-innovation on the part of Chinese companies (SOEs as well as private Chinese companies) is constrained when these companies cannot protect their intellectual property (Economist 2015; and, Shao and Feng 2014). Thus, patents are not only tolerated but now China's SOEs, private companies, universities and even foreign companies are increasingly encouraged to file patents so as to protect their unique product and service supporting technologies, processes and services (Chow 2015). As noted above the patent output of China based organizations has surpassed that of any other country in the world (Economist 2015)! While there are some who claim that many of these patents are not high

[2] Another side of anti-corruption can also be mentioned. Anti-corruption can bring many positive outcomes such as fair competition, effective resource and asset management etc., However, many people claim that to some extent, anti-corruption discourages leaders and people from implementing new polices, and under this atmosphere, people become risk adverse and conservative. So anti-corruption may also have an adverse effect regarding moving the China economy more forcefully toward self-innovation.

quality and intellectual property of others is still appropriated and misused, significant attention is being paid to this issue and conditions are improving (Economist 2015) as China learns how to adapt to intellectual property norms. It is understood that transforming the economy from predominately manufacturing to knowledge and innovation driven growth requires protecting intellectual property.

Since the "Opening Up" policy was adopted in the late 1970s education has been a Chinese priority. As noted above the China higher education system today boasts the largest university enrollments of any country in the world and in the past year has surpassed enrollments in the U.S. At the same time the education approach in China which has been dominated by content learning and rote learning, and to feedback learned content verbatim. Further, access to higher education has been dominated almost totally on a student's ability to pass the national admissions examination. Passing the exam required students and their families to make great resource sacrifices and of their time in order to prepare them to perform at the exceptional levels needed to pass the examination. Most students (and families) have employed tutors and commit as much time to learning from the tutors as in school. In sum, the culture of higher education has been that of "getting it right" at almost all costs and at the same time, very few if any mistakes.

In such an education system learning by doing (and from making mistakes) has not tended historically to be an element of the curriculum but it is this type of learning that is central to inventing and innovating. Innovation involves stepping off into the unknown with a concept or idea of how to improve or enhance the way things have been done and requires challenging known and accepted things and processes. In an education system that tends to

focus on getting it correct at all costs, it is not surprising that entrepreneurial and innovative behavior was limited in China's early efforts to produce innovative outcomes.

Education in China has been changing over the past several years (Tong, 2012). For example, the role of the national admissions test has been modified and a student's experience (internships, sports, practical training, etc.) is now considered as a meaningful component of university admission. It is believed that such experience helps students acquire learning by doing skills and thus learning from making mistakes; in turn it will help them become more at ease with innovative thinking and doing. Further, universities now provide entrepreneurship/innovation courses as electives for students, and offer special funds for student innovation/entrepreneurship competitions and related activities.

It has been argued that the role of the Central China Party (CCP) in higher education via its heavy representation on the Boards of universities contributes to constraining academic freedom and thus limits innovative thinking and behavior (Chen 2015; and, Manning, 2015). While this remains a concern, de-administrativization actions of universities (Tong, 2012) have been and continue to be adopted to address this concern. For example, more Chinese with foreign doctorate degrees are being hired as faculty members; university boards in some cases hold meetings to hear opinions of all members of the university community; and university faculties and staff are encouraged and welcomed to offer suggestions on university management (see Tsinghua, Peking and Renmin university web sites regarding governance).

Tong (2012) provides a framework for understanding the pressures facing reform and transition in the higher education system of China. He notes that three power systems are involved (political, administrative and academic). There is a continuing struggle among these

three forces about what the nature of higher education should be in China and its administration and academic freedom. Tong (2012) and others observe that reform and liberalization in education are unfolding and will continue to do so given the “backwash” force of the demands of the evolving innovation economy.

All of this suggests that change is coming and will continue to the higher education system in China and that a passing score on the national entrance examination is not the only criterion for admission. These changes are being driven by the needs for supporting a self-innovation economy. That said there is still opportunity and pressure for more change.

As noted above, a lack of innovative spirit has been attributed to the China workforce and thus a reason why it may be difficult for China to create an innovation economy. The basis for this argument comes from the observation that China’s rise to a leading manufacturing role in the world economy has not been erected on self-innovation but rather on an imitation of technologies and methods derived from other more developed countries. This observation is certainly supported by experience at least in terms of the role imitation innovation has played in China’s economic growth. But the evidence as reflected in the development and growth of large scale global companies such as Huawei, Haier, Alibaba, Sany, Baidu, Tencent and Xiaomi is convincing proof that China can build growth companies that are competitive and sustainable in the world marketplace. Further evidence of an innovative spirit in China can be found in the wide and deep willingness to experiment with new methods and approaches as illustrated by the success of the special economic zones like Shenzhen and in Shanghai and now others across China. These experiments provide test beds for not only more of these projects but also help guide the testing and development of a broad and deep cadre of R&D and Innovation

Centers/Parks across China that are now spearheading the applied research and prototyping needed to transform ideas and theoretical and technical knowledge into viable innovative and useful outcomes (products and services). Today the many innovation centers across China are integrated centers for innovation and development of new companies and the growth of initial stage and emerging companies and growth companies. Given these developments it would seem that China is becoming one of the more innovative economies of the world and if not yet it is moving measurably toward becoming a truly innovative economy. It seems that the innovative spirit has been awakened in China.

But not only has China acquired an innovative spirit, it seems that it probably had a great deal of innovative and entrepreneurial energy in the past but that it was suppressed by various government controls and norms that constrained its expression. It also was probably constrained because China was already experiencing exceptional economic growth and growth of a meaningful middle class that had discretionary income both of which emerged under the manufacturing economy. Success at manufacturing which relied on imitation innovation did not create urgency to move more rapidly toward innovation. But as the economy slowed in the last few years it became clear that China needed to accelerate its goal of becoming an innovation economy. As a consequence, changes to make innovation and entrepreneurship more attractive and acceptable have been made and with it the latent innovative nature of Chinese culture has been more fully released. The assumption of what fundamentally drives economic growth is erected on the Adam Smith and Schumpeter arguments that innovation is the driver. For a more detailed discussion of the Smith and Schumpeter vs Ricardian (1821: 1912) theories of economic growth see Holcomb (1998)

6.0 Conclusions and Discussion

The paper began with the question of whether China's imitation manufacturing based economy was molting into an innovation driven economy or not. Analysis of the evolution of the China economy found that there are a number of indicators that support a conclusion that the China economy has been and is transforming into a more balanced economy that is motivated by increasing self-innovation driven growth and development. While China, over the last 20 years or so became the largest manufacturing based economy in the world, it was also learning about its strengths and weaknesses to indigenously innovate new products and services through a variety of experiments that began with robust policy experiments like the Torch Program and technology, R&D and Innovation centers and transformation of higher education all of which were expected to build innovation capacity.

At the same time, China's experience has unfolded consistently with the history of economic development of the developed countries but it has done so not only in the span of slightly more than one generation (1979-2015) and it has tightly and compactly overlapped the stages of development so that learning what is needed to reach the next stage is acquired while consolidating the current stage. For example, the manufacturing stage was being developed while the initial stage of de-collectivization and modernization of the agricultural sector was being achieved; and, the innovation stage was in the making while consolidation of the manufacturing economy was occurring. In short, it appears that China has become essentially a developed country faster than any country in history. Given that it is one of the two largest countries in the world, we ask "how is this possible?"

This is a question that the authors and other development specialists have been asking. It is a big and complicated question and thus one that cannot be answered in depth in this paper. Given this caveat we take this opportunity to offer a tentative and partial answer more as a working hypothesis or thesis than a definitive one.

First Bell (2015) has offered a coherent and defensible theoretical framework as discussed in the Introduction. In brief, Bell views the Chinese development experience as organized around three action layers. At the top meritocracy principles have guided strategic decision making; at the bottom democratic principles tend to govern who initially rises to leadership positions; and, those who rise to top leadership positions do so through a combination of success via elections, and nearer the top, merit determined by extensive leadership examinations. Finally, in between the top and bottom of this Chinese governance model is experimentation. With Bell's framework China's development success can be understood to have arisen in part from well informed and tested leaders, and strategic decision makers who have been examined not only in written and oral interviews and examinations but also by fire in local level elections.

The history of national economic development all over the world and across centuries stands as a testament that even the most well informed leaders have difficulty in implementing and maintaining strategies leading to the status of developed country. The experimental middle part of the Bell framework stands as an monument to the insight of China's strategic development leaders in that large scale experiments have been used to inform decision making about how to successfully adjust and integrate development objectives and implementation and their dissemination to other parts of the country.

The Bell framework serves as an interesting working hypothesis or thesis about how China as one of the two largest countries in the world has essentially achieved developed country status in about one generation. This is a feat that was considered impossible among development specialists as late as the 1980s.

There is another concept that has been followed and is consistent with Bell's view. China's quest to achieve developed status which is called Advantage Integration (Yu, 2006). This approach argues that implementation of development strategies should be guided not only by integrating one's strengths but also transforming one's weaknesses into strengths as part of the integration process. China's attention to the barriers to becoming a self-innovation driven economy is a clear demonstration of how China has incorporated the integration concept in guiding its transformation of an imitation manufacturing based economy into an emerging self-innovation driven economy.

The development of the Chinese labor market was noted in the Introduction as a secondary goal of the paper. While not examined in detail here the analysis as well as the Bell (2015) and Yu (2006) conceptions provide some insight into the transformation of the labor market that has occurred since the adoption of the "Opening Up" policy in 1979.

With decollectivization massive unskilled labor became available over a short period of time in China. This served as a low cost input to fuel manufacturing but limited early manufacturing ventures (SOEs and private) to producing relatively low skill products. As manufacturing evolved the Chinese economy demand for higher skilled labor arose which has been in part served by growing investments in education that is now producing university graduates in general and more specifically engineering and technical graduates at rates that are

the highest in the world. But as skill requirements became greater the sophistication of manufactured goods also increased and so did labor cost. As labor costs increased, China increasingly faced competition from countries with lower labor costs, e.g., Viet Nam, Laos, Philippines, and Myanmar etc. Thus its ability to compete in the production of low skill manufactured products grew more difficult forcing it to move up to a more sophisticated level of manufacturing.

Today, China is producing some of the most sophisticated products and services in the world but it is also self-innovating some new products and services that are requiring ever more high skilled labor. So China's labor market is evolving toward one of the most skilled in the world and with wages that continue to increase as a consequence. The Bell (2015) trifecta conceptual framework coupled with advantage integration (Yu 2016) help to explain how China's labor market evolved and adjusted to changed internal and global competitive factors.

It is important to not over interpret the exceptional advances China has been making to establish a self-innovation capacity. While the evidence shows that very significant progress has been made, there are still barriers facing self-innovation driven economic growth in the large. These include altering the education (K-12, higher education) to become more supportive of innovative ways of thinking and solving problems; adjusting to rising labor cost; further overcoming institutional bias against self-innovation; continuing to reduce corruption; improving environmental conditions; and, continuing to relax private property constraints. Yet, it appears that over time the Bell trifecta concept of governance in China offers a pathway to closing the gap between imitation and self/indigenous innovation.

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