

Background, Mechanism and Approaches of China's Innovation-Driven Economic Transformation

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Abstract—The promotion of the Chinese economic transformation driven by the technological innovation is the major innovation China adapts to and takes a lead in the new normal of the economic development, the initiative choice to adapt to the new situation of the comprehensive national strength competition after the international financial crisis as well as the inevitable requirement of the “updated version” of China’s economy, thus having the very great realistic significance and far-reaching historical significance for China’s economic development. It requires the good command of the inherent correlation and the operational mechanism between technological innovation and industrial development, demand structure and elements component. In the future, the technological motivation for China’s economic transformation requires the great efforts made in developing the strategic emerging industries, enhancing the independent innovation ability, deepening the reform of scientific and technological system, promoting the economy towards a more advanced stage of development with more sophisticated division of labor and more optimized structure.

Index Terms—Technological innovation, China, economic transformation, mechanism.

I. INTRODUCTION

After conducting some research, Robert Solow, founder of the Neoclassical Growth Theory, found out that capital and labor force can only explain for part of the economic output. He then discovered the contribution of technological progress to economy. But in his theory, technological progress is only regarded as an exogenous variable. In 1980s, representatives of the New growth theory, such as Paul M. Romer and Robert Lucas, found out that technological progress is actually, to a large extent, an endogenous variable, because technological innovation behaviors depend largely on the rules and regime of the economy. After conducting research on East Asia’s economy in 1990s, Paul R. Krugman then held the view that sustainable growth could be impossible if not taking technological progress as an endogenous power. According to the Chinese economist Wu Jinglian, China’s slow development of technology is due to the flaws of its systems, as is shown in the economic development process over the past several decades. In the 21st century, the Chinese government has laid special emphasis on technology’s role in economic development, pointing out that the integration of technology with economy is not only a technological issue, but more importantly, an

economic issue. Lin Yifu, chief economist and former senior vice president of the World Bank, argues that technological innovation is the most fundamental power for economic development, and China’s reform and opening-up has led us to the path of a market-oriented system, which has created a very favorable environment for company innovation and entrepreneurship. In May 2016, China issued “the Outline of the National Innovation-driven Development Strategy” as the basic principle and action guidance to accelerate the development of an innovation-oriented country. The main content of the document lies in taking technology as a core and priority for innovation; promoting the transformation in development modes by relying on continuous knowledge accumulation, progressive technology and high-quality labor force; pushing the economy to a more advanced stage of development with a more sophisticated labor division and a reasonable structure [1]. This thesis will mainly focus on the three questions: why technological innovation is pivotal in economic transformation when China’s economy settles into a “new normal” state; what is the internal working mechanism of technology in supporting China’s economic transformation; what are the suggestions for China to realize the innovation-driven development. In a final analysis, economic transformation itself is a diachronic, dynamic and developing concept. Different countries have different development models because of their different historical stages and technology levels. Therefore, the research techniques adopted in this thesis are the historical analysis method, the normative analysis method and the empirical analysis method. In addition, some appropriate quantitative and qualitative analysis are also made in this thesis.

II. STRATEGIC BACKGROUND

A. International Perspective: An Irresistible Trend of the Superpower Competition under the Background of the New Scientific and Technological Revolution

The development process of human society shows that the area with more vitality for the technological innovation will be more easily become the wider stage of industrial revolution to promote the nation towards the prosperity; once this vitality is lost, the area will be confronted with the danger of being edged out of the competition.

Historically speaking, the major technological revolution tends to give rise to an industrial change of real significance. As long as a country seizes this opportunity, it can turn itself into a powerful country. Nearly 300 years as from the 18th Century witnessed the three major technological revolutions with the far-reaching impact, followed by the three corresponding industrial revolutions and a lot of world powerful countries. Britain grabbed the first revolution of

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science and technology marked by the steam engine technology, thus taking a lead in completing the industrial revolution in such sectors as textiles, chemicals, metallurgy, machinery, etc., and having built a dominating empire “on which the sun never sets”; Germany brilliantly stood out in the second revolution of science and technology marked by the electric power technology and Internal Combustion Engine. Around the 1940s, the United States dominated the 3rd Technological Revolution and Industrial Revolution marked by the electronic computers and information technology (IT), thus has occupied a long-term position as the hegemony in the world. It follows that the transfer of the world's technological and economic center of gravity from the United Kingdom to Germany, and then to the US represented a change of the geographical location on the surface, but to a larger extent, it reflects the transformation of innovation capacity [2].

From the point of view of the current world situation, the technological revolution represented by the new generation of information technology, new energy technology and biotechnology, etc., is being incubated and rising to drive a new round of industrial transformation. To take the initiative, get the upper hand and control the commanding heights, the major developed countries in the world have successively formulated the corresponding strategic programs. Say, the US government formulated its strategic programs and action plans, such as, “Strategy for America Innovation” and “A Framework for Revitalizing American Manufacturing”, etc., in the hope that the US could maintain its position as the world's engine of scientific discovery and technological innovation; the European Union has formulated its programs, such as, “Horizon 2020”, “For Sustainable Growth and Innovation”, etc., focusing on the development in such industries as the new energy and biology, etc.; also, Japan has formulated its programs, say, “Brilliant Japan's New Growth-oriented Strategy (2020)” and “Comprehensive Innovation Strategy”, etc., all of which shows that it is the current irresistible trend to seek the innovation-driven development and enhance the international competitiveness.

China failed to catch the great waves of the previous technological revolutions due to various reasons. However, it is lucky that in face of the latest round of technological revolution and industrial revolution, only by strongly seizing and utilizing the opportunity and adhering to the innovation-driven economic transformation can China transform from a big country into a powerful country.

B. Realistic Perspective: The Pressing Situation for Overcoming the Development Difficulties in Transforming the Economic Development Model

Over the past 30 years and more since reform and opening-up, China has leapt to the second in the world in terms of the economic aggregate and has forged toward a new big height in respect of the social productive force, comprehensive national strength and scientific and technological strength. However, China's economic development model has entered into a major transition period and the essential conditions supporting China's economic development is having a qualitative change with an obvious increase in the cost of the labor force, resources and

environment, as well as a narrower space for the original development model highly featuring the investment-driven growth, scale expansion and export orientation, thus leaving behind various problems, say, imbalanced, uncoordinated and unsustainable development with poor technological innovation capacity and irrational industrial structure, etc.

Actually, these problems are not unique in China. From the point of view of the development of all other countries in the world, the countries entering the moderate income level are often faced with similar problems, which is the “Middle Income Trap” prescribed in Economics. In view of these problems, many economists have conducted a lot of research from different angles. However, there is one thing in common, namely the emphasis on the technological innovation, which can be penetrated, merged and internalized into the traditional elements including capital and labor, etc., to effectively improve the efficiency in using other elements, break through the resources bottleneck, reduce the environment pollution, accelerate the fundamental transformation from element-driven to innovation-driving to provide a powerful driving force for the sustainable and sound economic development [3].

For instance, Finland has got rid of the plight of excessive reliance on resource consumption by flexibly using the innovation-driven model. After World War II, Finland achieved the fast economic recovery and growth through the development of its forest and mineral resources, thus having ranked the 3rd in terms of the per capita income in the world in the 1970s. Yet, the two economic crises have plunged Finland into the bitter development trap of the excessive reliance on the single resources advantage, so its economic development remains stagnant. After that, Finland took a lead in designing its policy by initiating the national innovation system framework and finally formed its economic development model with “Innovation-driven” as the main feature [4]. Even in face of the financial crisis in 2008, Finland, as one of the countries in EU with the highest renewable energy utilization ratio, remained fully confident in its national economy relying on the advantages of the new energy and the Internet technology. The lesson and experience drawn from Finland offers China much food for thought in seeking the transformation of the innovation-driven economic development.

C. Theoretical Perspective: The Inevitable Requirement for Scientifically Grasping the Development Law in the Economic Cycle

The economic cycle means an alternate and circulating phenomenon of the periodic economic expansion and economic austerity, which, to be specific, can be classified into four phases, respectively prosperity, recession, depression and recovery. Either a small product of an enterprise or the economy of a country, has the same development cycle. According to the research conducted by Austrian economist J.A. Schumpeter, the fundamental reason of the economic periodic change lies in technological innovation. The application and expansion of new tools and new methods can stimulate the investment on a large scale and lead to an upsurge in the economic prosperity. However, the lack of innovation and the loss of investment

opportunities can cause economic recession, which can slowly fall into the low ebb, followed by the depression. So the major technological breakthrough and innovation can extend the period of prosperity, or accelerate the recovery from the low ebb for the prosperity at a higher level. In a broader sense, it is evident that the economic cycle is a continuously growing and upgrading process because of scientific and technological innovation.

Take Japan for example, it underwent a 10-year postwar recovery and then entered a fast growth period of nearly 2 decades, followed by a major turning point in 1974 when Japan began to entered a low-growth period for 15 years. In the 1990s, Japan plunged into the economic stagnation period until now when Japan remains in the low-growth phase. The key reason for the economic fluctuation in Japan is due to the technological innovation. Japan achieved the fast growth for nearly 2 decades due to its technical introduction, absorption and re-innovation in the 1950s, so it surpassed Germany, England and France in 1968 in terms of the economic aggregate; Later, Japan advanced “Technology Revitalization Strategy” and it fully exceeded all countries in West Europe in terms of the per capita GDP in the mid-1980s. However, when the information wave swept the world, Japan had the slow action and lacked the driving power in the new round of industrial structure adjustment and the transformation of the economic development model, which has led to the long-term development downturn since 1990s[5].

The Chinese economy has achieved a rapid growth for more than 30 years, having surpassed that of Japan in economic aggregate. It has entered a state of new normal with a medium-to-high-speed development. We must scientifically grasp the transformation law of the economic cycle in a bid to achieve the development for a longer period, at a higher level with higher quality particularly by using the dominating advantages of technological innovation and taking the initiative in specific actions.

III. MOTIVATION MECHANISM

A. Technological Motivation of the Industrial Transformation

At present, China has solved the problems related to the irrational proportion of its industrial structure and the incongruous growth, and the tertiary industry has increased significantly its proportion, which has made a breakthrough in 2015 at 50%. However, the US has gradually stepped on the development road by pulling the optimization and upgrading of the industrial structure by formulating a series of mid-long-term development programs as early as in 1990s. Network and information industry has gradually become a new growth point and the pillar industry of the US economy and the output directly or indirectly related to information industry has accounted for 75% in the total US GDP. Its original industrial structure has changed greatly and the tertiary industry mainly focusing on the information service sector has increased its proportion in the industrial structure at 75.8% and it remains at about 80% thus far, so the US economy maintained the fast growth for 10 consecutive years

in the 1990s.

China's direction for the industrial structure optimization and upgrading is to ensure the foundational position of agriculture and optimize the inner structure of industry to greatly develop the tertiary industry, particularly the producer service industry. Cloud computing technology, for example, can change the supply of information technology service just like the supply of water and electricity as a basic public resources service, which is readily available to enterprises and individuals at any time and place. The optimization and upgrading of industrial structure due to the cloud computing technology can be achieved mainly in three aspects: Firstly, it is penetrated and merged in the traditional information industrial fields to create a brand-new industrial value chain (say internet industry). Secondly, it can intensify the competition among traditional industries through the technical transformation, thus forcing the traditional industries to be integrated with more technological elements to promote the traditional information industry for structural upgrading. Thirdly, the technical upgrading based on the penetration and transformation can promote the optimization and upgrading of the entire industrial structure with its strong support to ensure that the manufacturing industry, agriculture, service industry have more technology contents and higher economic value.

B. Technological Motivation of the Demand-Oriented Transformation

The contribution rate of consumption, investment and net export to China's economic growth are clearly shown (in Figure 1) from the GDP data released by National Bureau of Statistics of China: the contribution made by the ultimate consumption to its GDP in 2015 is 60.9%; the contribution generated from the capital formation is 41.7% and the contribution made by net exports of goods and service is -2.6%. All in all, the demand structure of the Chinese economic development shows the pattern of “a decline in investment proportion, a slow trade surplus and a rising consumption proportion”. Currently, China is making greater efforts in strengthening “the structural reform of the supply side” in a bid to raise the supply system quality and efficiency. However, it does not mean that we can ignore the role played by the demand. The key to optimize the demand structure is to expand the domestic demand and adjust the proportion of consumption demand and investment demand. For example, it's been more than twenty years since we had mobile phones in our life during which it was the symbol of the luxury consumption and now it is the mass consumption, witnessing transformation from the most difficult situation to get access to a mobile phone at the start to the current No. 1 mobile phone producer in the world with the largest output, which no doubt represents the change brought by the technological innovation one after another. Therefore, the technological innovation can change the way of consumption, increase the consumers' choice, thus lowering the product price but increasing the efficient consumer demand. Affected by the increase of the consumer demand, it must stimulate the increase of production means for manufacturing this consumer product and the increase of the investment demand.

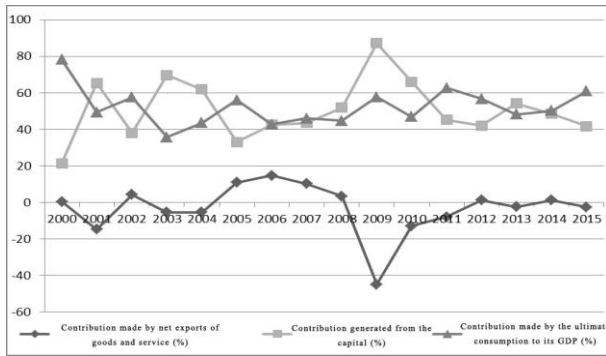


Fig. 1. Change of the contribution rate made by three major demands to the GDP growth during 2000-2015

C. Technological Motivation of the Element-Oriented Transformation

Production factors are generally composed of two categories: firstly, the traditional elements, mainly meaning the natural resources, capital and labor force, etc.; secondly, the knowledge elements, mainly including technology, management and information, etc. If we want to promote the economic growth, we should continue to input the traditional elements, say, the capital and labor force, etc., into the traditional model. However, in case of other conditions unchanged and the continuous increase of the equal increment, the increased quantity of the products thus provided will drop after it is increased to a certain output. In other words, the continuous increase of the input of capital and labor and other relevant traditional elements can initially increase the output, but the output increasing rate will not go up, and it may even drop on the contrary after the increased quantity reaches a certain level. To overcome the progressive marginal benefit decrease and achieve the increasing returns of elements, quite a few economists conducted a lot of research as to this problem from different angles. Among them stand out Paul M. Romer's knowledge spillover model, Kenneth J. Arrow's "learning by doing" model and the HR model of Robert Lucas, etc., all of which emphasizes the knowledge elements, particularly "the internalization" of the technological elements to have the organic integration of both by internalizing the knowledge elements into the traditional elements to form the technical talent flow and technology diffusion to promote the technological talent flow and the economic development by ultimately extending the product life cycle and increasing the output.

China's economic growth mainly depends on high consumption of natural resources and high investment input, thus imposing an unbearably heavy burden on resources, energy and environment. Therefore, the transformation of the element structure epitomizes the fundamental change mainly from the traditional elements to the knowledge elements. To be more specific, it is required to promote the elements for "implementing the new combination" [6] to strengthen the replacement of the technological elements of capital and labor force to promote the talent flow and technology diffusion through the flow of the relevant elements, thus changing the element structure. The essence of implementing the new combination is to continuously optimize and integrate all innovation elements for the resources allocation. The element replacement means the replacement of

traditional elements with knowledge elements. The flow of elements mainly means the transfer and change of all innovative resource elements [7].

IV. PATH SELECTION

A. Promoting a Closer Combination of Technological Innovation with the Socioeconomic Development

As early as in 1912, J.A. Schumpeter, an Austrian economist, put forward the word "innovation" in his book entitled "Introduction to Economics of Development". He thought that innovation was the application of new tools or new methods to create the new value [8]. It is easy to see that the word "innovation" was not merely a pure concept in science or technology, but an economic concept. Since the 20th century, the importance of the science and technology to the economic development has been universally accepted by all countries, but it is not easy to build a system highly combining science and technology with economy. In the process of the competition between the former Soviet Union with western countries in the 1960s to 1970s, although the former Soviet Union has realized the importance of science and technology by increasing the technological input on a large scale so that its research and development expenses accounted for 4% of the total national incomes, 2%-3% far more than the level of the western developed countries, it didn't build the institutional system effectively integrating the science and technology with economy without identifying the technical progress as the endogenous force to fuel the economic development. Although it achieved outstanding results in many scientific and technological fields, its economic competitiveness didn't get the obvious improvement. The promotion of the combination of science and technology with economy remains an old topic in Chinese economic development. In 1985, Deng Xiaoping pointed out, "Now we should further solve the problems by combining the science and technology with the economy." Since China's reform and opening-up, China has made tremendous progress in promoting the combination of the two aspects. But on the whole, the problem related to the failure to closely combine science and technology with economy remains not fundamentally solved with the technology transfer rate less than 25% and the industrialization rate less than 5%, thus there being a far cry from the developed countries at 80%. Particularly now in the new phase when China is accelerating the transformation of its economic development model, it must promote the closer combination of science and technology with the economy from the beginning to the end.

Currently, the key for promoting the combination of technological innovation with the socioeconomic development lies in effectively dealing with the relation between the government and the market to further open up the channels between the science and technology and socioeconomic development to ensure that the market can play a decisive role in distributing the innovation resources so that enterprises can truly become the major players in allocating the technological innovation resources and that the

enterprises can truly become the main players of the technological innovation. The government should respect the innovation law and play an active role in the fields concerning the people's livelihood and the industrial lifeline, conduct the scientific behaviors in a bid to create the excellent policy environment. For example, China decides to vigorously foster and develop the strategic emerging industries to adapt to the development requirements of the times as the major strategic deployment in promoting a closer combination of technological innovation with the socio-economic development.

B. Promoting the Synergic Development of Industrial Chain, Fund Chain and Innovation Chain

In view of the great improvement of the independent innovation capacity, the top priority is to be given to the adherence to the orientation of science and technology for the socioeconomic development, to deploy the innovation chain based on the industrial chain, upgrade the fund chain based on the innovation chain to eliminate "Islanding Phenomenon" in the technological innovation and break barriers restricting scientific and technological results transfer diffusion and enhance the whole efficiency of the national innovation system.

In particular, the synergetic development of the industrial chain, fund chain and innovation chain ("three chains") related to the R&D and manufacturing of "large aircrafts" will be of great significance in greatly enhancing the independent innovation capacity. "Chain" represents the relations among the main players in the innovation activities in the process of all relevant activities for connection, cooperation and value dissemination. The industrial chain of "Large Aircrafts" is mainly composed of the raw materials suppliers, component and part manufacturing enterprises, whole machine assembly manufacturer and after-sale service companies, etc. Its innovation chain includes the initiation, scientific research demonstration, master design, test evaluation and the chain structure in the whole industrialized production and sales process. "Deploying the innovation chain based on the industrial chain" is to meet the market demand of large aircraft as the orientation, fully use and depend on the aerospace manufacturing base as its industrial chain is closely combined with such main bodies as the government, enterprises, colleges, research institutes, etc., through the innovation activities to achieve the excellent interaction of R&D and the industrial sectors to ultimately strengthen the core competitiveness. "Deploying the innovation chain based on the industrial chain" is to build the fund chain tallying with the large aircraft innovation chain. On the one hand, it can lead and guide the funds of the state-owned enterprises, private enterprises, foreign investors and the government departments involved with the innovation chain and the industrial chain for concentrated flow to all necessary links of the R&D of the large aircrafts. On the other hand, a lot of new technologies will inevitably crop up in the development process of the innovation chain, and some technologies may not be suitable for the large aircraft projects, but the secondary development of these technologies will contribute to the development of the new product market, thus improving the fund chain^[9]. It is

obvious that the industrial chain is the base while the innovation chain is the core and the fund chain is the guarantee in the innovation-driven economic transformation. Only with "Three-chain synergy" can we improve the overall efficiency of the innovation system.

C. Deepening of the Reform of Science and Technology System

Firstly, build the market-oriented mechanism for the technological innovation. The key lies in achieving the excellent interaction among enterprises, colleges and scientific research institutes. The main reason for the fast development of "Huawei" Company lies in that Huawei pays closer attention to the clients' demand in the world Telecom market and has gradually formed its scientific and rational "production-education-research" synergetic innovation mechanism [10] by setting up R&D foundation and building research centers in colleges and universities, say, Shanghai Jiaotong University (SJTU) and University of Electronic Science and Technology of China (UESTC), etc.

Secondly, build the intellectual property utilization and protection mechanism. Strengthening the protection of intellectual property rights is an important link in the implementation of innovation-driven development strategy. The essence of the protection of intellectual property rights lies in the protection of the rights and benefits of the original inventors, stimulate the innovation driving force to ensure that the innovation vitality can brilliantly burst and the innovative thoughts can be brought into full play and that the technological innovation can become the robust locomotive to strongly promote the socioeconomic development. The US President Lincoln once said, "The patent system has added the fuel of interest to the fire of genius." The establishment of the intellectual property right use and protection mechanism to improve the incentive policy for the transfer of scientific and technological achievements is conducive to creating an environment and atmosphere for stimulating the innovation.

Thirdly, strengthen the macro planning and infrastructure construction to mainly break the departmental segmentation to form the excellent situation for the synergetic innovation; accelerate the infrastructure construction and build the open, transparent and high-efficient resources-sharing platform. Say, China is implementing "2011 Program" as a typical case, aiming at promoting the resources integration among higher education institutions and scientific research institutes and between scientific research institutes and higher education institutions in a bid to build a number of high-level and resource-sharing basic science and cutting-edge technology research bases.

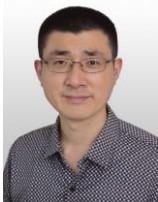
V. CONCLUSION-RECOMMENDATIONS FOR CHINA INNOVATION-DRIVEN DEVELOPMENT STRATEGY

The coming five years will witness a decisive period of building a moderately prosperous society in an all-round way in China. The key as to whether we can successfully transform the mode of development, promote industrial upgrading and stride over the "Middle Income Trap" lies in creating a new longer growing period by relying on innovation to foster new development engine and to cultivate

new growth driving force. The innovation-driven transformation represents the inevitable requirement to effectively solve the in-depth problems hindering the current economic development in China as well as the fundamental way to create the new driving force for the long-term sustainable development. Only by strongly promoting the close integration of scientific and technological innovation with economic and social development, greatly enhancing synergy innovation competence and deepening science and technology system reform, can we achieve more enduring development at higher level with better quality.

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