Analysis on the Impact of International Technology Transfer on China's Industrial Restructuring and Upgrading

Xie Shuyuan and Ma Huijun

***Abstract*—Under China's New Normal, international technology transfer put forward new requirements for China's industrial development. Based on the meaning of international technology transfer, this paper analyzed the effects of technology transfer and TFP from the perspectives of technical input and technical output, and discussed theoretically the internal mechanism that international technology transfer effected the transformation and upgrading of industrial structure. In the end, the paper proposed some policy recommendations about China's industrial restructuring and upgrading including establishment of a virtuous cycle mechanism on technology introduction, adjustment about industrial organizations and industrial technology policy, improvements on the legal and market environment of international technology transfer.**

***Index Terms*—International technology transfer, industrial structure, restructuring and upgrading.**

I. Introduction

With the advent of the era of New Normal, China's economy has entered a reform period with steady growth, structural adjustments and transfer from factor-driven, investment-driven to innovation-driven. China has entered a new stage that the industry must rely on the transformation and upgrading to promote its development. In the process, the international technology transfer made a great contribution on China's scientific and technological progress and stimulated the creativity of China's industry.

II. The Implications of International Technology Transfer

Technology transfer was originally put forward at the first session of the United Nations Conference on Trade and Development in 1964, and the Conference collectively called the input and output of technologies between countries Technology Transfer. [1] Fransman has the definition of "international technology transfer" that one country got an outside technical knowledge from another country and used it to form the state-owned beneficial knowledge [2]. As informative, professional and timeliness useful resources and commodities, the technology diffusion from its original body is driven by benefit mechanism, and the occurrence of cross-border movement finally evolved into international technology transfer. International technology transfer generally includes the transfer body, the transfer object and the transfer behavior. The behavior takes place in the process that technology supply side transfers the technology and demand side absorbs the technology. Factors affecting the international technology transfer focused on technology supply and demand sides, technology selection, the mode of technology transfer and external environment of technology transfer, shown in Fig. 1 as follows:

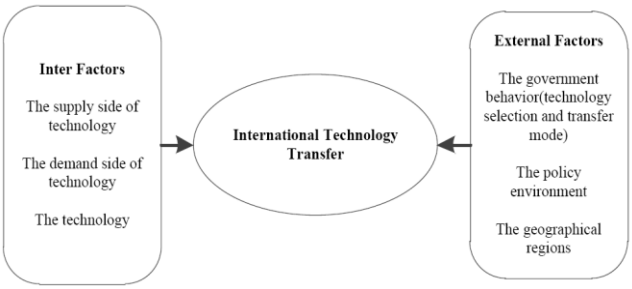

Fig. 1. The factors that affect international technology transfer.

Due to conflicts of interests and differences of objectives, international technology transfer is essentially a process that technology supply side and demand side make a game each other around the technology object. And the willingness of cooperation and the ability of both sides directly influence the effect of technology transfer and the levels of absorption. Meanwhile, to some extent, the government's intervention effectively protects selective mode and content of technology transfer, policy environment supports and encourages the main decision-making behavior of technology transfer, and geographic regions also affect the actual results of international technology transfer.

III. The Internal Mechanism that International Technology Transfer Effects China's Industrial Restructuring and Upgrading

China's industrial restructuring and upgrading means that the upgrading of China's traditional industries and the development of high-tech industry. Its main obstacle lies in the lack of high-level technology and innovation ability. The scientific and technological progress and innovation ability cross-border international technology transfer brought about are the main force and ultimate target of driving China's industrial transformation and upgrading.

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A. Technical Input

For an example, FDI international technology transfer, this section constructed the theoretical model of technology transfer effects. According to Cobb-Douglas production function $Y_t=AL_t^{\alpha}K_t^{\beta}$ .Wherein, Y_t is domestic industrial output, A is endogenous technological progress, L_t and K_t are respectively labor and capital factor inputs of the department, α and β represent the output elasticity of labor and capital output. Assume there's constant returns to scale in this industry, then $\alpha + \beta = 1$. And it shows that the production efficiency is not improved with the expansion of production scale. Only the technical level improved, can the economic benefits increase. After calculating, the logarithmic equation is as follows:

$$ln(Y_t/L_t)=\beta ln(K_t/L_t) + ln\, A \quad (1)$$

$ln\, A = ln(Y_t/L_t)-\beta ln(K_t/L_t)$ is Total Factor Productivity (TFP), also known as "Solow Residuals [3]". Solow believes that all factors affecting the production function move (change) is technological progress, which is mainly reflected in the new technological achievements such as the capital stock, the improvements of labor force the quality of education and so on [4]. Assume that TFP of the department is determined by department's own domestic technological advances factors and the effects of FDI international technology transfer, then set $A=f(R_t,FDI)=R_t^{\gamma}FDI^{\delta}ge^{\varepsilon}$ [5], the result is:

$$ln\, A=\gamma\, ln\, R_t + \delta\, ln\, FDI + \varepsilon + u \quad (2)$$

Associate (1) with (2), the result is:

$$ln(Y_t/L_t)=\beta ln(K_t/L_t)) + \gamma\, ln\, R_t + \delta\, ln\, FDI + \varepsilon + u \quad (3)$$

Among them, R is technological progress factor of owned sector, FDI is foreign variables, ε (constant) indicates other factors affecting TFP, u is a random disturbance term, δ is the influence coefficient of China's new industrial structure technology spillover. If δ is positive, the international technology transfer has a positive spillover effect on required technological progress for industrial development. If δ is negative, the international technology transfer has negative effect on technological progress. Due to the limitations of money and technology, one country can import foreign high-tech, save the costs of one country's research and development, shorten the development cycle and the technology gap by the introduction of new technologies, equipment and products. In the open economy, technical input is a more direct channel of technology diffusion, and can directly share the results of investments in R & D from technology exporters.

Generally, there are market-driven and government-driven modes of the transformation and upgrading of China's industrial structure. The former is mainly the natural process that technological progress promotes industrial restructuring and upgrading. The latter refers to the achievement of organizational changes and transaction cost reducing through government's purposeful behavior. To some extent, China's industrial restructuring and upgrading depends on technology transfer effects brought by technical input. It means that technology imported countries will take full advantage of technology to improve the development leapfrog of technology structure by the introduction of technology, including the development of related technology, technological localization and innovation, etc. In the situation of economic globalization, the number of advanced technologies China introduced through international trade, FDI and multinational companies is increasing. China has been gradually shifted from "world factory" in the period of reform and opening to the "R&D Center", promoting technology upgrading and provide context-developed high technology platform through the introduction of technology.

B. Technical Output

This section constructed a theoretical model based Feder model. For example, China's manufacturing industry, assume that there're export manufactured goods or intermediate goods, and non-export sector in China's manufacturing sector. The traditional Cobb-Douglas production function is extended to output expansion function $Y_t=F(L_t, K_t, X)$ applied to technical development under the open economy. Wherein, Y_t represents the total output of the manufacturing sector, L_t represents labor input, K_t represents capital investment, X represents exports (technical output). After the "t" derivation of both sides of this equation, then the equation is divided by the Y both sides, the regression model can be obtained as follows:

$$GY_t = C_0 + C_1GL_t + C_2GK_t + C_3GX + u \quad (4)$$

GY_t, GL_t, GK_t and GX are respectively gross output, labor, capital and the growth rate of exports , C_1, C_2 and C_3 respectively are output elasticity of labor, capital and exports (regression coefficient), C_0 is a constant term, u is random disturbance term[6].

Now, with the N and X representing the output of China's manufacturing non-export sector and export sector, total output is $Y = N + X$, then

$$N = F(K_n, L_n, \mathrm{X}) \quad (5)$$

$$X = G(K_x, L_x) \quad (6)$$

wherein, X is the element determining N and reflects the manufacturing export sector promoted non-export sector. [7] It is assumed that the marginal productivity of manufacturing export sector is δ higher than the marginal productivity of non-export sector. The ratio is the same as different elements, then

$$\frac{FK}{Gk} = \frac{FL}{Gl} = \frac{1}{1+\delta} \quad (7)$$

Derivation of the equation $Y=N+X$, the result is:

$$dY = dN + dX = F_K dK_n + F_L dL_n + F_x dX +$$

$$(1+\delta)F_K dK_x + (1+\delta)F_L dL_x \quad (8)$$

Total manufacturing investment, $I= I_n+I_x= dK_n+ dK_x$.
Total labor increment, $dL= dL_n+ dL_x$.
Associate these equations above with (8), the result is:

$$dY = F_K I + F_L dL + (F_X + \frac{\delta}{1+\delta})dX \quad (9)$$

With divided by Y both sides of (9), assume $C_1=F_K$, $C_2=\frac{LF_L}{Y}$, $C_3= F_X+\frac{\delta}{1+\delta}$, the regression model is:

$$GY = C_0 + F_K \frac{I}{Y} + \frac{LF_L}{Y} GL + (F_X + \frac{\delta}{1+\delta})GX(\frac{X}{Y}) + \varepsilon \quad (10)$$

"$\frac{X}{Y}$" is the export dependence of manufactured goods or intermediate goods and "$\frac{I}{Y}$" is investment-output ratio. When efficient productivity in the export sector playing an important role in the non-export sector, there's external economic effects, then $C_1=F_x$. When the export sector doesn't have economic or any external impact on the non-export sector, then F_x=0.

Technology exporters can promote national technological progress and improve TFP through technology spillover effects, further promote the industrial structure optimization. Industrial structure rationalization is the essence of industrial structure upgrading, but also the power of industrial restructuring and upgrading [8]. It provides intermediate inputs and goods among industries, matches industrial technology base and labor factors with industry, promotes related technological achievements commercialization and drives national technological development by importing technology. To some extent, the technical output is beneficial to the formation of the related industrial chain and synchronously upgrading of industry-related technology, management and business models. China's industrial transformation and upgrading must rely on the endogenous variables of technological progress in the process of industrial structure adjustment and optimization. First, from a technical motivation, technological change, technological innovation and technological progress directly achieve change to the transformation of the existing industrial sectors and the establishment of emerging sectors. It led to changes of supply structure or industrial structure [9]. Second, from the social cause, social development and technological progress affect changes in human social hierarchy of needs and demand structure, leading to changes in the industrial structure, thereby the industrial transformation and upgrading.

IV. Suggestions on China's Industrial Transformation and Upgrading under the New Trend of International Technology Transfer

With the continuous deepening of economic globalization and the vigorous development of new technological revolution, the scale of international technology transfer is larger, the structure is more rational, the market is centralized and the sources are multipolar,. In order to achieve China's long-term sustainable industrial development, some strategic thinking and suggestion are as follows:

A. Establishment of a Virtuous Cycle Mechanism on Technology Introduction

At the macroscopic level, first, make national technology strategic planning about introducing technology, ensure the quality of investment from the source of system, split or break impede of local fragmentation. Second, establish incentive and restraint system of technology import, motivate business decision makers of technology introduction reasonably and avoid moral hazard of business decision makers. Third, the government should give companies some financial and tax policies to support technology transfer and ease the financial pressure on the introduction of technology. Fourth, ensure the strict implementation of the intellectual property system and the increase of international technology transfer bilateral economic interests. At the microscopic level, strengthen R&D organization and management strategies to ensure that technical and strategic objectives are consistent with the objectives of business strategy. Second, enterprises can establish cooperative R&D institutions and research institutes to jointly improve the efficiency and level of technological innovation.

B. Adjustment about Industrial Organizations and Industrial Technology Policy

On the industrial organization policy, first, strengthen and perfect the competition and exit mechanism of enterprises, encourage economy of scale and eliminate enterprises with poor economic performance through fair competition and reasonable mergers between companies. Second, break down and eliminate boundaries among regions, sectors, ownerships and administrative monopoly, promote industrial structure optimized and industrial restructured. Third, support the development of small and medium-sized enterprises, definite an important role in promoting industrial restructuring and upgrading and create a good competitive and financial environment for them. On the industrial and technological policies, first, try to achieve deep development of technology through external sources such as international trade, FDI and transnational corporations, and improve technology lever by international technology spillover effects. Second, focus on domestic technology innovation, imitation innovation or di-second innovation, reduce market risk and investment cost.

C. Improvements on the Legal and Market Environment of International Technology Transfer

On the legal environment, first, enhance awareness of IPR protection, give full play to the economic utility of intellectual property rights and improve their market competitiveness. Second, establish a sound legal environment which regards intellectual property legal system as its core, and provide incentives and legal basis for international technology transfer. Third, increase punishing cost of intellectual property violations and resolutely combat violations. From the view of market, first, improve the human resources market and promote cooperation among the government, enterprises, research institutes, universities and TNCs, and develop domestic high-tech co-cultivation of innovative talents. Second, it's important to develop a sound and comprehensive informational market operation mechanism, improve the information and transparency of international technology transfer, intensify the function of the supply and demand mechanism on international technology transfer. If so, these measures can truly promote China's industrial restructuring and upgrading more advantageously.

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