Trade and Technology Transfer: The Case of Automobile, Electronic and Telecommunication Sectors in China

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Abstract

This paper gives a brief review on the recent progress under the WTO framework of the issues regarding technology transfer, and against this background, the evolution of China's technology transfer policy is outlined, as a country case study. It takes a closer look at China's strategy of "Technology Transfer in Exchange for Domestic Markets" (TTEDM), targeting on foreign direct investment (FDI). It analyses how TTEDM accommodates trade reform, identifies its mechanism and policy instruments, and assesses its effects, taking automobile, electronic and telecommunication sectors as examples. The impacts of WTO accession and the elimination of some trade- related investment measures are explored. The paper concludes that China's technology transfer policy has been effective in attracting FDI, building local technological capabilities to enhance absorptive capacity and technology diffusion, though more efforts should be directed to foster market competition, and strengthening R&D collaboration between "Transnational Corporations" (TNCs), and local institutes and

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stimulating indigenous technology development. The lessons other developing countries may learn from China's experience include first, some investment requirements are effective in building up domestic technological capabilities in the initial stages of development. Therefore, less developed countries should request for the extension of transition period of eliminating TRIMs. Second, moving into autonomous innovation is vital for developing countries that are climbing up towards higher levels of technology capability.

1. Introduction

In the knowledge-based global economy, technology plays an ever-important role in economic development. The concerns of the international community with respect to enhancing technology transfers to developing countries, as well as their technological capabilities, have increased. World Trade Organization (WTO) established the Working Group on Trade and Transfer of Technology (WGTTT) in 2001, in accordance with the mandate in paragraph 37 of the Doha Ministerial Declaration, to examine the relationship between trade and transfer of technology and any possible recommendations on steps that might be taken within the mandate of the WTO. The working group has carried out much work on the transfer of technology, including case studies and normative work, as well as analytical work on the interrelationship between trade, investment and technology transfer.

It has been observed that as a consequence of the importance of innovation for development, nearly all the governments in the world have adopted some types of

technology policy; i.e. a policy targeted to foster innovation, diffuse innovation within a country, or increase technology transfers from abroad (WTO, 2002a). It has also been generally agreed that transfer of technology is often most successful when accomplished by means of foreign direct investment. And active and dynamic national policies are among the most important elements for making the interaction between technology transfer and FDI a virtuous relationship (WTO, 2002b)

In economic theory, technology policy is only justified where market failures occur that call for remedial actions from government interventions to restore equilibrium, and when government is capable to undertake measures so that the benefits of intervention exceed their costs. However, governments in fact use technology policy to go beyond correcting market deficiencies to changing the basic parameters within which markets function: creating new factor endowments, industries, enterprises, capabilities, institutions and market structures (UNCTAD, 2003).

China is a country with long history of pursuing a technology policy. Before opening up in 1978, China carried out an externalization-oriented policy that aimed to build up domestic production capacity and procure technology transfers in externalized mode. Since the 1980s, China has shifted to an internalization-oriented strategy namely "Technology Transfer in Exchange for Domestic Markets" (TTEDM), which is accomplished by means of foreign direct investment and targets on attracting foreign funded enterprises (FFEs) to transfer advanced technology to China, and to reap the spillover benefits.

Both strategies have been successful in meeting their goals. The externalization-oriented policy had played an essential role in framing China's industrial structure and building up self-reliant domestic production capacity. The internalization-oriented strategy has been effective in bringing in advanced technologies from transnational corporations (TNCs) to upgrade traditional industries and set up newly emerging high-tech industries. However, with the progress of multilateral negotiations within WTO framework, the member governments of WTO are committed to accommodate relevant regulations such as TRIPS (Agreement on Trade-related Intellectual Property Rights), TRIMS (Agreement on Trade-related Investment Measures) and GATS (General Agreement on Trade in Service), and are required to depend on market force rather than on direct government interventions in promoting technology progress.

China is at the present stage transforming towards a mixed strategy that favors the flow of technology via both trade and FDI, and intends to build up local technological capabilities to enhance absorptive capacity and technology diffusion within the country.[i] The priorities of the strategy are on intensifying market competition, strengthening collaboration between TNCs and domestic institutes, and stimulating indigenous technology development.

Empirical evidence of China's experience in adjusting technology policy may provide lessons for other developing countries in mounting strategic interventions to enhance technology transfers and to build their technological capabilities.

Section 2 of this paper discusses major WTO issues regarding technology transfer in the context of Doha Development Agenda and China's active participation. Section 3 provides a review of China's technology transfer development and policy evolution. Section 4 takes a closer look at the TTEDM strategy taking automobile, electronic and telecommunication sectors as examples by examining the mechanism and policy instruments, assessing its impacts and discussing implications for further policy changes. Section 5 concludes.

2. Major WTO Issues Regarding Technology Transfer in the Context of Doha Development Agenda

Considering the growing importance of knowledge and technology as a production factor determining competitiveness and development, there is widespread acknowledgement that mastering technology is critical for developing countries. However, it requires, among others, a friendly international environment and international rules that facilitate transfer of technology from developed to developing countries.

2.1 Provisions Relating to Transfer of Technology in WTO Agreements

In view of the importance attached to transfer of technology, specific provisions on transfer of technology have been incorporated into WTO agreements, mainly TRIPS, TRIMS and GATS, which might have impacts on the transfer of technology from developed to developing members.

The TRIPS sets out its objective that the protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations (Article 7). TRIPS contains the statement of recognizing the special needs of the least-developed country members in respect of maximum flexibility in the domestic implementation of laws and regulations in order to enable them to create a sound and viable technological base (Preamble). What's more TRIPS also contains the "best endeavours" commitments that developed country members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed members in order to enable them to create a sound and viable technological base (Article 66).

The GATT stresses the process of liberalization shall take place with due respect for national policy objectives and the level of development of individual Members, both overall and in individual sectors. There shall be appropriate flexibility for individual developing country Members for opening fewer sectors, liberalizing fewer types of transactions, progressively extending market access in line with their development situation (Article XIX).

The trade-related investment measures have significant implications for technology transfer and capability building for developing countries. They have adopted the investment measures to accelerate industrialization and prevent the outflow of foreign

exchange. The TRIMS Agreement prohibits those that violate the GATT principles of "national treatment" (Article Ⅲ.4) and the elimination of "quantitative restrictions" (ArticleⅪ.1). The prohibited TRIMS include local content requirement, trade balancing requirement, foreign exchange restrictions, etc. It does not prohibit the use of other TRIMS, including export performance requirements, technology transfer and local equity requirements. The agreement also permits developing and least developed countries to request extension of transition periods if they face difficulty in eliminating prohibited TRIMS.

2.2 Issues Regarding Technology Transfer in the Context of Doha Development Agenda

Though there are provisions regarding technology transfer, it is not clear how technology transfer takes place in practice and if specific measures might be taken within the WTO to encourage such flows of technology. WTO ministers thus decided in Doha to establish a working group to examine the issue. The Working Group on Trade and Transfer of Technology (WGTTT) was established, in accordance with the mandate in paragraph 37 of the Doha Ministerial Declaration, to examine the relationship between trade and transfer of technology and of any possible recommendations on steps that might be taken within the mandate of the WTO to increase flows of technology to developing countries. The Working Group's work has covered wide range of issues related to trade and technology transfer, such as developing a common understanding of the definition of technology transfer; identifying the various channels of transfer of technology and studying the conditions under which those channels could be most

effective; examining the importance of FDI to technology transfer; host and home country measures to encourage the flow of technology; discussing possible negative impact of current WTO provisions on technology transfer; building of human resource/capacity etc.(WTO, 2002b, 2003a, 2003b). And plenty of country experiences were shared in communications and presentations contributed by members. Possible recommendations on steps that might be taken within the mandate of WTO to increase flows of technology to developing countries were also explored..

Since it has been observed that transfer of technology is often accomplished by means of FDI, the Doha Declaration paragraph 20-22 concerning relations between trade and investment also reflects principles on technology transfer. It spells out the need to balance the interests of foreign investment home countries and host countries, countries' right to regulate investment, development, public interest and individual countries' specific circumstances. The Working Group on the Relationship of Trade and Investment (WGTI) has since considered the question of the extent and nature of the contribution of FDI to the technological development of host countries, particularly developing countries, with focus on the channels through which FDI may have an impact on the technological development of host countries and the treatment of technology-related policies in current international investment agreements (WTO, 2002c) On the issue of whether the technology transfer measure[ii] has distorting effects on trade and should be prohibited, WGTI has conducted a series of study(WTO, 1998, 1999a, 1999b, 2002c) and the main findings are while foreign investment accompanying technology transfer is beneficial to host countries, restrictive technology

transfer requirement is not the effective measure in enhancing the technology transfer and thus not recommended. It has been noted that the content of the technology transferred through FDI depends basically on the local technology capability and the degree of competition a foreign affiliate faces, rather than whether the host country provides incentive to technology transfer or applies mandatory technology transfer requirement. Though it is widely recognized that the role of government policy is necessary since technology market is far from perfect and TNCs' strategic behavior could be out of line with fair market discipline, the priority of government policy should be placed on improving local conditions in host countries, such as a high level of local technical capability, infrastructure and a competitive market environment.

2.3 China's Participation in WGTTT and WGTI

Since China's accession to WTO in 2001, China has been participating actively, among others, in the work of both WGTTT and WGTI. A Chinese delegation shared country experiences of the critical issues relating to technology transfer, including in the context of FDI flows and intellectual property rights (IPRs) regimes.(WTO, 2003c)

China submitted, in cooperation with some other developing members, a communication to WGTI on Investors' and Home Governments' Obligations (WTO, 2002d), suggesting general principles to serve as the basis for drawing up investors' obligations as well as specific obligations of investors in the areas of restrictive business practices, technology transfer, balance-of-payments, ownership and control, consumer and environmental protection, disclosure and accounting. The communication noted that

the proponents of a multilateral framework on investment in the WTO have been seeking binding rights of foreign investors that the host member governments should agree to provide. However, not much discussion has taken place in the Working Group on what could be the obligations on the part of foreign investors or the home governments. The Doha Declaration indicates the need for balance between host and home member interests. Therefore, while recognizing the protection of legitimate rights and interest of the investing TNCs, the right of host members to regulate foreign investors and the need for foreign investors to undertake obligations in line with host members' interests, development policies and objectives, should be an indispensable part of the discussions in the Working Group. TNCs should strictly abide by all domestic laws and regulations in each and every aspect of the economic and social life of the host members in their investment and operational activities. Further, in order to ensure that the foreign investor meets its obligations to the host member, the cooperation of the home member's government is often necessary, as the latter can, and should, impose the necessary disciplines on the investors. The home member's government should therefore also undertake obligations, including ensuring that the investor's behavior and practices are in line with and contributing to the interests, development policies and objectives of the host member. It is important that the Working Group addresses the issue of investors' and home governments' obligations in a balanced manner.

In another communication, China submitted to WGTI concerning transparency, China expressed the view that while establishment of an open and transparent environment in

the host country will help reduce investment risks and enhance predictability and stability for investment and thereby build up and enhance confidence for the investor, account should be taken of the disparities of levels of development among different categories of members, particularly the special difficulties of the developing members in fulfilling their obligations on transparency. Taking into account this factor and in order to ensure effective implementation of the principle of transparency, China held that special and differential treatment should be accorded to the developing Members (WTO, 2003c).

According to a Decision Adopted by the General Council on 1 August 2004 (WTO, 2004), relationship between trade and investment will not form part of the Work Program set out in Doha Declaration and therefore no work towards negotiations on the issue will take place within the WTO during the Doha Round. However, technology transfer related issues remain sensitive and bear great potential for fulfilling the development dimension of the Doha Development Agenda, which places the needs and interests of developing and least-developed countries at the heart of the Doha Work Program. Pursuing the work of further discussions and clarifications of the technology transfer issue, in general and in country case study, would be necessary in order to work out the concrete and practical steps that might be taken to facilitate transfer of technology, which might be negotiated in future rounds.

3. Evolution of Technology Transfer Policy in China

Before 1978 when China adopted an 'open door' policy, China was basically closed to any FDI. Main channels served to transfer technology from abroad were limited to importing "turn-key" projects and assembly lines, accompanied by knowledge codified in blueprint[iii]. The technologies required for the ambitious industrialization campaign were mostly procured from the former Soviet Union in the 1950s', Western European countries and Japan in the 1960s'and 1970s'.

With the adoption of an opening up policy, FDI gradually gained significance as the dominant channel of technology transfer since 1978. Compared with technology transfer from an arm's length market, which is referred to as externalized technology transfer, the internalized technology transfer arrangements via FDI by TNCs bear several advantages[iv]. First, it could avoid the constraint of foreign exchange scarcity. Second, internalized technology transfer would do much better in providing matching tacit techniques. Third , certain technologies, especially new technologies, may be obtained only through an internalized arrangement, since technology owners were usually more willing to sell advanced technologies under arrangements they could have tight control over the technologies sold.

Being aware of the advantageous characters of FDI and facing the facts that China's foreign exchange remained scarce resource throughout 1980s, and given the fact that the majority of the technologies applied across industries in China were out-of–date and needed extensive upgrading, in late 1980s', the Chinese government adopted the strategy of "technology transfer in exchange for domestic market". It encourages

advanced technology transfers from TNCs, by offering attractive Chinese market in exchange. The launching of TTEDM was a turning point of China's technology transfer policy from externalization-oriented policy strategy that aims to build up domestic production capacity to an internalization-oriented strategy which favors technology transfers in internalized mode.

4. The Strategy of Technology Transfer in Exchange for Domestic Markets

The TTEDM strategy was designed with strong intention to attract technologically advanced FDI, and to exploit the spillover effects of FDI.

4.1. Trade Reform and FDI Strategy

FDI inflow to China could be classified into two categories: export-oriented and import-substitutive. Export-oriented FDI refers to those investments that are attracted primarily by China's abundant cheap labor and other inputs such as land, and to use China as an export platform with international market as their target market. This group of FDI ventures consists of numerous small firms from the newly industrializing economies (NIEs) of East Asia, Hong Kong in particular. They usually focus on labor-intensive industries. Since parent companies of this kind are usually not at the forefront of technology innovation, and the export-oriented production is, to a great extent, isolated from domestic production network, the export-oriented FDI is believed to have limited contribution to advanced technology transfer and to China's economic structural upgrading.

The import-substitutive FDI are mainly from large TNCs based in developed countries. The attractiveness of China for this kind of FDI mostly lies on China's huge potential market. The ventures are established with strategic perspective of producing proxy to the Chinese market and gaining competitiveness edge over rivals. This group of investment tends to target in technology and capital intensive manufacturing sectors and is often of tariff-jumping or import substitutive nature.

The two types of FDI have been both encouraged complementing the trade reform and opening up. Before 1978, following the self-sufficient principle, China's trade regime bore significant anti-export bias including overvaluation of currency, high barriers towards import. Export was assigned to finance the import of those that could not be domestically supplied and were of essential importance to the economic development.

Following the gradualist reform approach, China's trade liberalizing reform was divided into phases. The logic has been firstly, to remove the anti-export bias by providing export promotion incentives, while at the same time import protection has remained to ensure the continuous development of domestic industries. Secondly, with export competitiveness improved, and domestic the industries grew stronger to survive the import competition, export incentives and import protections were eliminated to result in a neutralized trade regime.

While export-oriented FDI serves as an effective approach to expand export, import-substitutive FDI was expected to accelerate industrialization by bringing in advanced technology either to establish new technology–intensive industries, or to

upgrade existing industries. The TTEDM strategy was designed to target on import-substitutive FDI from TNCs that have been the most important actors in generation, application and international transfer of technology.

The justification of TTEDM strategy could be examined from three aspects. First, by permitting access to otherwise protected local market, the strategy encourages foreign investors to deploy in China the productions that apply advanced technology. Internalized technology transfers enables faster introduction of technologies, especially new technologies, since innovators are unwilling to part with them to unrelated parties, transfer of such technology may be available only in internalized form. Moreover, internalization provided the direct access to parent firm's technology improvements where the technology is changing rapidly, and it also enables the access to parent firms' tacit knowledge, thus to reduce the learning costs of deploying a technology efficiently in a new environment (UNCTAD, 1999).

Second, the TTEDM strategy targets on exploiting the benefit of technological progress imposed by backward and forward linkages of FDI. Though internalized technology transfer may not result in the immediate technology upgrading of domestic firms, the linkage effects FDI bring upon domestic firms could be significant. By developing domestic suppliers and subcontractors around TNCs, or in other words, by integrating into TNCs' production network, it is possible to develop wide-ranging competencies and establish, build and deepen local industrial capabilities. As a consequence, the potential for technology spillovers into the local economy could be larger.

Third, the TTEDM strategy intends to take advantage of huge Chinese market by playing foreign investors against one another to reinforce technology transfer from TNCs, in the norm that the more advanced technology transferred, the wider access to Chinese domestic market is granted, TNCs would be directed to transfer more advanced technologies in order to win a larger slice of the Chinese market.

4.2 The Policy Instruments of TTEDM Strategy and Their Effects

4.2.1. Policy Instruments

The policy instruments of TTEDM strategy could be distinguished into three categories: incentive schemes, investment requirements and administrative approval scheme.

Incentives Schemes

Direct incentives towards high technology FDI include tax incentives and other privileges. Tax incentives are mostly in the form of reduced enterprises income tax and tax holidays, exemptions from customs duties, and value added tax (VAT) exemptions for imports.[v] In addition to tax reductions and tax holidays generally granted to FFEs, foreign firms introducing advanced technology are given further taxation concessions in terms of tax rate and length of tax holiday, are allowed to sell their products to local users through an import substitution scheme, and are promised better access to local bank loans and resources. Royalties received by FFEs in providing technology enjoy lower income tax rate. Equipments imported as an integral part of technology transfer deal are exempted from customs duties and VAT. In the various versions of Industrial

Guidelines towards Foreign Investment, in which three categories of FDI are explicit: encouraged, restricted or prohibited, with the first category focusing on advanced technologies, the above mentioned incentives are always provided to the encouraged category.

Besides the above direct incentive to encourage technology transfer by TNCs, China had put in great efforts to improve the intellectual property protection by strengthening legislation regarding IPR. China began establishing its legal system in terms of IPR in early 1980s, and expedited the pace in late 1980s and early 1990s when making preparations for joining WTO. Amendments and improvements regarding the legal system about IPR were made according to the requirements of TRIPS of WTO, though China was not a WTO member till 2001. The amended laws, regulations and rules provide a wider protection scope and stronger protection for the owner of IPR. These amendments have greatly improved the Chinese legal system in terms of IPR, thus ensuring its consistency with the TRIPs. China has also acceded one after the other to the major international conventions and agreements for the protection of IPR since the 1980s. Improving protection environment of intellectual property forms an important incentive for TNCs to transfer technologies to China[vi].

Investment Requirements

Investment requirements targeting on exploiting advanced technology and the spillover effects from TNCs include local equity requirement, local content requirement, and trade balancing requirement, foreign exchange restriction and technology transfer

requirement, etc.. It is generally believed that for fear of technology leakage, especially in host countries where intellectual right protection are limited, foreign firms with sophisticated technologies tend to avoid shared ownership and instead choose to invest only in fully-owned subsidiaries. In order to ensure participation of local capital in a foreign investment project and thus facilitates spillovers, requirement of local equity in some technology intensive sectors are introduced.

Requirements on local content, foreign exchange and trade balancing intend to induce foreign firms to procure locally. With these compulsory requirements, FFEs have to search part of their supply from local sources. In order to procure inputs of competent quality, FFEs are usually willing to provide technology assistance to local suppliers, in many occasions for free. Thus by encouraging linkages between FFEs and local production, advanced technologies, which otherwise are not to be provided or provided at higher cost by FFEs, could be transferred and their spillover effects are reaped.

The administrative Approval Scheme

Besides the incentive schemes and investment requirements, the approval administration system[vii] of foreign investment in China acted as one the most important policy instruments. It functioned in the process of decision-making regarding approvals of foreign investment contracts by being selective and restrictive. The FDI projects were examined among bids from TNCs, and the more technology-advanced projects were usually granted approval. The ambiguity of the scheme was that the approval was granted on a case-to-case bases, and there was not a clear-cut standard that was publicly

available. The Chinese authority had plenty of flexibility on picking specific investment projects.

The approval administrative body also held a principle of refining TNCs in each strategic industry to a limited few, such that plenty of market share could be left to domestic firms, once they catch up. The negative effect of the practice was realized by mid 1990s'. Though the initial motivation of the policy was to protect the domestic market of strategic industries from being dominated by foreign TNCs, the consequence has been quite the opposite. Since only few foreign invested projects were approved in each industry, while domestic firms were neither competent to compete nor sufficient in number to cover adequate market share, the early entrants of TNCs were naturally getting the market position of dominant firms, which reduced the urgency of transferring advanced technology to China by TNCs.

4.2.2 Effects of TTEDM Strategy

The effects of TTEDM strategy were generally reflected in continuous increase of technology import, linkage effects, the advancements of technology transferred by FFEs and building up of production capacity of high-tech products.

Technology Imports

From mid 1990s', with TTEDM strategy being reinforced in pillar industries including auto industry, electronics and telecommunications industry, and chemical industry etc., technology imports had experienced vigorous increase. The majority of the import was

directed into these pillar industries, which were also intensively invested by foreign capital. The annual technology import hopped from US$ 4.1 billion in 1994 to UD$ 13 billion in 1995. The share of technology import in total import jumped from 3.35% to 9.97% for respective years. Throughout the second half of 1990s, the technology import experienced continuous increase with the share of technology import remained higher than 10 percent of the country's total import (see table 1).

Table 1: Expenditures on Technology Import (1991 –2000) (Units: billion USD)

Year	Amount	Tech. Import/ Total Import (%)
1991	3.459	5.42
1992	6.590	8.18
1993	6.109	5.88
1994	4.106	3.35
1995	13.033	9.97
1996	15.257	10.99
1997	15.923	11.18
1998	16.375	11.68
1999	17.162	10.36
2000	18.176	8.07

Source: China Statistical Yearbook, various years, and data from Ministry of Commerce of China.

Local Content vs. Linkage Effects

Local content rate is an indicator contributes to measure the linkage effect of FDI. In order to meet local content requirement and reach the competent quality of local content, a foreign business has two options: to either encourage their suppliers to also come to China or to train local firms to produce quality products. Either way, technological know-how is transferred to China.

By the end of the 1990s', the local procurement ratio of many TNCs was raised substantially. Component suppliers in China, both FFEs and domestic firms, had been growing in number, density and capability. Clusters of suppliers working with TNCs in the coastal areas of China were growing particularly fast, implying significant linkage effects of FDI. A survey (Jiang, 2002) shows that among the 127 sample TNCs, 74 had local suppliers providing raw materials and parts, and 51 either set product standards or offered technological support to local suppliers (Jiang, 2002).

Though the establishment of local supply network formed the important channel of spillovers through backward linkages, the different status of foreign funded suppliers and domestic suppliers should be noted, which should have impacted on the evaluation of linkage effects of FDI. Foreign invested suppliers were generally at the more important position as core and high-tech parts suppliers, while domestic firms were usually low-tech and peripheral suppliers. Thus technology spillovers through linkage effect towards domestic firms could be limited.

Advances of Technology Transferred by TNCs

Technology transfer requirements and competitions among TNCs and between TNCs and the catching up of domestic firms have been a crucial impetus for accelerating technology upgrading. Technology transfer requirement have urged TNCs to provide technologies of international advanced level, and the policy shift by the Chinese government to inviting more TNCs to access the Chinese market have sharpened the competition among TNCs. This in turn has pressed TNCs to deploy more advanced

technology in China. What's more, the demonstration of advanced technology by TNCs and the pressure from losing market share has inspired domestic firms to increase investment in innovation and technology upgrading. As a result, domestic firms in some industries became more and more competitive. All of these factors have pushed TNCs to apply more advanced technologies in the Chinese market.

Throughout the 1980s' when market competition was seriously inadequate, advanced technology transfers to the Chinese market by foreign investors were very limited. There were only 2% of foreign invested projects with 5% of the total foreign investment that were recognized as technology-advanced projects[viii].

A survey (Jiang, 2002) showed that from 1997 to 2001, the advances of technology applied in affiliates of TNCs in China had improved in a large extent (see table 2).

In 1997, only 14 out of 96 (or 14.6%) FFEs surveyed were applying "advanced" level technology. By 2001, 42 out of 127 (or 33%) FFEs were applying "advanced" level technology. FFEs were applying "ordinary" level technology reduced from 34% in 1997 to 10% in 2001. And in 2001 survey, 83 out of 127 FFEs (65%) were found applying "filling the blank" technologies, which were defined as technologies that applied for the first time in China.

Table 2: Technologies Applied by TNCs in China (% of total)

Technology applied in TNCs	1997	2001
Comparing with parent's company		
Advanced	14	42
Relatively advanced	53	45

Ordinary	33	13
Comparing with domestic companies		
Never been applied before	-	83
Advanced	-	44

Note 1: 1997 and 2001 survey included 96 and 127 sample FFEs respectively, most of which are transnational corporations from developed countries.

2. Technology advances are defined as follows: when comparing with parent's company, "advanced" technology refers to those that are first introduced in the parent's firm in less than 3 years; "relatively advanced" refers to those that are first introduced in more than 3 years and are still in operation at the time of the survey; "ordinary" refers to those that are no longer in use in parent firms. Comparing with domestic companies, "never been applied before" refers to those technologies that is first applied in China; "advanced "refers to those that are already applied in China by other firms, but are still at the forefront of technology.

Source: Jiang 2002, P53.

Rapid Expansion of High-tech Product Export and the Contribution of FFEs

Encouraging technology transfers not only benefit China's import substitutive industries, but also export industry especially high-tech industry. China has achieved rapid expansion of high-tech manufacturing and export since the mid 1990s', which could be attributed, among other factors, to technology transfers from TNCs. In five years from 1996 to 2000, high-tech export more than tripled from US$ 12.6 billion to US$ 37 billion, and the share of high-tech product in total export increased steadily, from 8.3% in 1996 to 14.9% in 2000.. The trend has continued since 2001 with an even more rapid

annual growth rate. The share of high-tech product in total export has been raised to 28.6% in 2005. FFEs are major contributors of high-tech product export, whose share in high-tech product export was 58.6% in 1996, and the figure has increased all the way to 80.9% in 2000, and in 2005, FFEs contribution reached the new record of 88% (see table 3) .

The extraordinary contribution of FFEs in high-tech export also reflects the phenomena that while increasing high-tech production has been deployed in China by TNCs, domestic firms' participation has been limited. With advanced technologies having been mostly kept within the boundaries of TNCs, the benefit high-tech export brought upon technology progress and innovation capability building were only limitly extended to domestic firms.

Table 3: High-tech. Product Export Expansion (1996-2000)

Year	High-tech. Product Export (In billion US dollars)	Share in Total Export (Percent)	Share by FFEs (Percent)
1996	12.663	8.3	58.6
1997	16.310	8.9	66.9
1998	20.251	11.0	73.8-
1999	24.704	12.7	76.0
2000	37.043	14.9	80.9
2001	46.457	17.5	81,5
2002	67.707	20.9	82.2
2003	110.160	25.1	85.5
2004	165.540	27.9	87.3
2005	218.36	28.6	88.0

Source: 1996-1999 data are from the Ministry of Science and technology, adapted from Jiang 2002, p80. 2000-2005 data are from Statistical database of Ministry of Commerce, China,.

4.3 Industry Case: Automobile, Electronics and Telecommunications

Automobile, electronic and telecommunications are typical technology-intensive industries which Chinese government wishes to develop by carrying out TTEDM strategy. These industries are also of great interest to TNCs for China's potential market and are thus most densely invested by them in China.

4.3.1 Specific Policies towards Automobile, Electronics and Telecommunications Sector

Automobile

China proclaimed the auto industry as a "pillar industry" considering the strategic and economic importance this industry plays in supporting a range of other critical industries. In the 1994 officially published auto "industrial policy" designed to develop an indigenous auto industry, it is made clear that the development of China's auto industry will be largely dependent upon the acquisition of foreign technology. Strict requirements were set for establishing an auto manufacturing joint venture in China, which include

1) 40% local content at start up, 60% by the second year and 80% by the third year for passenger cars. Similar local content requirements exist for auto components, and the levels for trucks are even higher;

2) A department responsible for technological research and development must be set up within the enterprise. The department will have the capacity to update products;

3) The enterprise must have a capacity for manufacturing products that attain the international technological levels of the 1990s;

4) The enterprise will obtain the foreign exchange it needs mainly through exporting its products;

5) The joint venture must give priority to local-made spare or component parts when they need them.

Electronics and Telecommunications

Electronics and Telecommunications is the industry characterized by the fast pace at which advances are made and new technologies emerge. This nature allows less developed latecomers to this industry catch up rather quickly, , since latecomers could enjoy the advantage to "leapfrog" to the latest technologies. Like the auto industry, electronics and telecommunication were declared by the Chinese government to be a "pillar industry" in 1994, and an internal industrial policy designed to create an indigenous industry was developed and implemented but not published. The development of such high-tech industry will be largely dependent upon the access to foreign technology. Internal policy to encourage technology transfer typically reflects the theme of TTEDM strategy that market access is available in exchange for technology transfers. Measures include:

1) Provisions of advanced and continuous technology transfers as part of a joint venture agreements;

2) Requirement of 70 percent export of joint venture-manufactured products in order to enjoy preferential treatment;

3) Requirement of central government review and approval of certain electronics joint ventures to ensure the conformation to the state's industrial policies;

4) Restriction of labor-intensive joint ventures unless export of 100 percent of the products is guaranteed;

5) Restriction of wholly foreign-owned enterprises and requirement of no less than 50 percent of local equity in joint ventures.

4.3.2 Policy Effects

The huge potential market and TTEDM strategy had attracted increasing amounts of foreign capital to invest in China, and the automobile, electronic and telecom indutries were among sectors that were most targeted by FDI. Some features in the evolution of Chinese automobile and telecommunication equipment manufacturing reflected the positive and negative effects of TTEDM strategy.

Investment Requirements Have Strengthened the Linkage Effects

The strict local content requirement and foreign exchange balance requirement have stimulated foreign investors either to seek supplies from domestic producers or to persuade their suppliers also to invest in China. For instance, automakers around the world had been pressing their leading suppliers to open operations in China. Over 100 Volkswagen’s leading suppliers around the world have set up operations in China in

order to provide supplies to Shanghai Volkswagen. Ford Motor and General Motors have also considerably beefed up their supply lines in China. Telecommunication industry provide a similar case. Among hundreds of Motorola suppliers in China, about half were FFEs. In order to encourage more suppliers to invest in China, Nokia even invested to set up Nokia Starlight Industrial Zone, intending to form a cluster of suppliers for the telecommunication industry.

Inadequate Market Competition Has Negative Effects on the Advances of the Technologies Transferred

As part of the TTEDM, the Chinese government held a policy of "few firms, large scale" in key industries, refining TNCs in each industry to a limited few. Although there were regulations in place to ensure the advances of technology, it was difficult to implement since there was great flexibility in defining the technology level. As a consequence, the policy of restrictions on the number of TNCs has had a direct negative impact on the inadequate market competition, which has reduced the urgency for early entrant TNCs to transfer advanced technologies.

In the telecommunications industry, Shanghai Bell and Motorola were typical cases whose motivation of technology transfer was influenced by the policy. In the early stages of reform and opening up, the severe lack of telecommunication facilities were the bottleneck for China's ambitious reform and development program. The Chinese government started to negotiate with TNCs on the terms of setting up joint ventures, intending to establish China's own production capabilities with the help of technology

transferred from TNCs. Shanghai Bell became the first joint venture to produce program-controlled switching device in China in 1984. As the only joint venture in the industry, whose products were import substitutive, demand for Shanghai Bell's products was much greater than its supply capacity. Its annual supply was 300,000 lines in early 1990s. However, the orders for its products to be delivered in 1991 were 700,000 lines, 1,260,000 lines for 1992, and 2,700,000.lines for 1993. Buyers had to use all kinds of resource (guanxi) in order to be served at an early date. In the explosively expanding Chinese market, Shanghai Bell faced neither competition from other TNCs nor from domestic firms, which naturally resulted in its lack of pressure to upgrade its technology.

Another example is Motorola, which opened a representative office in Beijing in 1987, and set up Motorola (China) Electronics Ltd. in 1992. Its products were much less advanced while prices were much higher than in international market for a few years when it enjoyed monopolistic position in mobile telecommunication manufacturing.

As for auto industry, Shanghai Volkswagen was the first joint venture set up in 1984. In about 10 years after establishment, it held the dominant firm position in the passenger car sector. In late 1980s', Santana produced by Shanghai Volkswagen had about 90% of the market, and in mid 1990s', its market share remained as high as 60%. The first generation Santana it produced was the out-of-date car model, which its parent company had ceased producing in other markets back in mid 1980s'. However, the price had remained high in the Chinese market, almost twice as high as the price in the

international market when the same model was sold in mid 1980s'.

Being aware of the negative effects of the policy, the Chinese government started to make adjustment on foreign investment policy in the first half of 1990s, trying to foster competition by granting approvals of entrance to more TNCs's within an industry. By the end of 1990s, almost all major auto producers in the world had set up joint ventures in China. With increasing access of foreign auto producers, competitions between TNC rivals are enhanced, which has pressed them to introduce more advanced technologies in the Chinese market. Competition in the telecommunication sector has also been intensified by the policy shift, during 1992-1995, Bell's major competitor NEC, AT& T, Nortel all set up joint ventures in China. Domestic firms such as Huawei, ZTE also started to penetrate into the market previously dominated by foreign brand in mid 1990s. Tougher competition has accelerated the technology upgrading in the sector. Foreign companies were motivated to bring into China state-of-art technologies, and domestic firms were obliged to continuous technology innovations.

4.4 Impact of WTO Accession on China's Technology Transfer Policy

4.4.1 Removal of Trade-related Investment Measures

China had been preparing its WTO accession for 15 years before it eventually became a member of WTO in 2001. During the process, the Chinese government has used for reference the relevant international conventions, treaties including WTO provisions and has made necessary amendments and improvement to its legal system, Regarding investment and technology transfer, at the end of year 2000, prior to the accession to the

WTO, in the revision of legislation of foreign investment, China removed the technology transfer requirement together with content requirement, foreign exchange balance requirement and requirement upon FFEs to submit production plans to local authority.

The above amendments of foreign investment legislation are in accordance with "TRIMs Agreement" of the WTO that prohibits trade distorting investment measures. Though technology transfer requirement is not included in the prohibited list, host countries of foreign investment are still eligible to apply technology transfer requirements to support national development objectives, China has decided to remove the requirement from foreign investment legislation. The decision was based on the trend in international legislation of international investment, and lessons drawn from international and China's own experience.

4.4.2. Impacts of Policy Changes on Technology Transfer since China's Accession to WTO

Will the removal of trade-related investment measures and the compulsory technology transfer requirement from legislation of foreign investment reduce the quantity or quality of foreign technologies transferred to China? How FFEs have been reacting to the policy changes?

FFEs Remain as the Major Technology Importers

Technologies imported by FFEs continue to take large shares of national total technology imports, both in terms of contract numbers and money amount since

2001(see table 4).

From 2001 to 2005, FFEs accounted for 30%, 57%, 60.6%, 58.9% and 60.5% respectively of the total technology import contracts, and in money amount, FFEs took as high as 75% in 2002 due to a large licensing contract of over US$ 4 billion with Motorola, and in 2003, 2004 and 2005 , FFEs' share were 56.5%, 48.3% and 43.4%, Though FFEs' share are experiencing a slight decrease, which might indicate increasing enthusiasm of domestic firms to import technology, FFEs are still major conductors of technology import.

Table 4: Technology Imported by Foreign Funded Enterprises (2000-2005)

Year	Tech. Import Contracts (billion $)			Tech. Import Amount (billion $)		
	National	FFEs	FFEs/National %	National	FFEs	FFEs/National %
2000	n.a.	n.a.	n.a.	18..76	7.27	40.0
2001	3900	1170	30.0	9.091	n.a.	n.a.
2002	6072	3471	57.0	17.39	13.10	75.0
2003	7130	4313	60.6	13.51	7.61	56.5
2004	8605	5057	58.9	13.86	6.69	48.3
2005	9902	5992	60.5	19.05	8.26	43.4

Source: Statistical Database, Ministry of Commerce, China.

Technologies imported by FFEs were mostly transferred from their parents companies. By doing so, more advanced technologies were deployed in China, and technologies in industries densely invested by foreign capital were up-graded, and the gaps with world technology forefront were narrowed. Electronic, telecommunication and automobile industries were typical examples of the noticeable technology up-grade resulting from

technology imports by FFEs. These industries have stayed at the top among industries to which imported technologies have been destined (see table 5). From 2001 to 2005, the top 5 industries where imported technologies were most densely deployed remained fairly stable. China has emerged as one of the main markets where TNCs in these industries meet and compete, which in turn spurred the increase of import of advanced technologies by them.

Table 5: Top 5 Sectors Imported Technologies Destined (2001-2005)

(In money terms)

2001	2002
1. Electricity, steam and hot water supply	1. Electronic & telecommunication
2. Locomotives & vehicles	2. Ferrous metallurgy
3.Electronic & telecommunication	3. Locomotives & vehicles
4. Ferrous metallurgy	4. Chemical material & related products
5.Chemical material & related products	5. Computer applying service
2003	2004
1. Electronic & telecommunication	1. Electricity, steam and hot water supply
2. Electricity, steam and hot water supply	2. Electronic & telecommunication
3. Chemical material & related products	3. Ferrous metallurgy
4. Ferrous metallurgy	4. Locomotives & vehicles
5. Locomotives & vehicles	5.Other manufacturing
2005	
1. Railway transport	
2. Electronic & telecommunication	
3. Ferrous metallurgy	
4. Locomotives & vehicles	
5. Electricity, steam and hot water supply	

Source: Statistical database, Ministry of Commerce, China,.

Increase of “Software” Technology Import

One of the noticeable changes since 2001 regarding technology transfers to China was

the increase of “software” technology. The share of “software” import in forms of patents, industrial designs, technology consulting and service, computer software and trademarks, has increased remarkably recent years, while the share of “hardware” import in forms of key equipment and assembly lines has dropped (see table 6 and 7). Both FFEs and domestic importers of technology have shifted to focus more on software, which are essential for technology assimilation and diffusion, rather than on equipment import which are more associated with production expansion. From 1998 to 2000, the assembly line and key equipment accounted for high shares of 68.63%, 40.34% and 57.23% respectively in national total technology import. From 2001 to 2004, the shares were reduced to 36.94%, 10.66%, 22.05% and 27.31%. These changes might imply the strengthening role of import technology on technology progress and innovation capability building.

Table 6: Technology Import Sorted in Types 1998-2000

Year	1998	1999	2000
Types of tech. Import	% of total	% of total	% of total
Total	100.00	100.00	100.00
Tech. transfer	15.86	18.68	8.45
Tech, license	9.81	22.28	18.68
Tech. consult	0.47	3.46	2.38
Tech. service	4.95	14.05	11.6
Assembly line	33.16	15.47	19.17
Key equipments	35.47	24.87	38.06
Direct investment	0.28	1.19	1.66

Source: Ministry of Commerce, China, Statistical database.

Table 7: Technology Import Sorted in Types (2001-2004)

Year	2001	2002	2003	2004
Types	% of total	% of total	% of total	% of total
Total	100.00	100.00	100.00	100.00
Patents	63.06	33.54	9.85	7.41
Industrial Design	-	28.26	32.96	29.81
Consulting service	-	15.75	26.35	24.98
Computer software,	-	7.12	2.90	1.83
Trademarks	-	0.45	0.84	1.85
Investment related		2.96	0.95	0.83
Assembly line & key equipments	36.94	10.66	22.05	27.31
others	-	1.26	4.11	5.98

*Note: 2001 is a transitional year when Ministry of Foreign Trade and Corporation launched a new statistical system for technology import. No detailed breakdown by types of import is reported. The annual technology import is divided by "software" and "hardware", with the formal including patents, industrial designs, consulting and service, computer software, trademarks and direct investment, while the latter including assembly line and key equipments import.

Source: Ministry of Commerce, China, Statistical database.

Rapid Increase of R&D Facilities Set up by TNCs

One of the noticeable phenomena about FDI in China in recent years is that R&D centers set up by TNCs have been increasing rapidly. In 1994, Northern Telccom set up the first joint R&D center with Beijing University of Post and Telecommunication. By 2004, about 700 R&D centers have been set up in China, mostly locating in Beijing, Shanghai, and Guangdong.[ix] Establishment of research facility was one of the mandatory requirements the Chinese government set to obtain desired technology in targeted industrial sectors as part of TTEDM strategy. The mandatory requirement was

removed in 2000, and new preferential treatment[x] was adopted to encourage TNCs to set up more R&D centers in China. Foreign funded R&D centers have ever since developed at a faster rate voluntarily.

What have attracted R&D centers including the availability of a large pool of hard and soft R&D infrastructure (with complementary well qualified researchers) and the huge domestic market, where technologies innovated in developed countries need to be adapted to local demand. Though most of the joint R&D being conducted at these centers was "localization" of existing products and technologies rather than "innovation", however some R&D projects involve more advanced or basic research. In either case, a significant amount of technology know-how is being transferred. A survey by Beijing municipal shows that there were 18 R&D centers located in Beijing in 2000; most of the projects carried out by them were of adaptation nature. 63.6% of the total R&D expenditure was assigned to technology adaptation; 6.2% was to basic theory research; 24.8% was for experiment and improvement.[xi]

Another main drive inducing the rapid growth of R&D centers is the keen competition among TNCs and between FFEs and domestic firms. For instance, telecommunication equipment manufacturing is one of the areas R&D centers have been most densely distributed. As one of the largest and fastest growing markets for telecommunication manufacturing, China has attracted almost all the world brands to invest in China, thus the competition among them are tough. What's more, Chinese domestic firms such as Huawei, ZTE have been catching up very rapidly by taking the advantage of better

knowledge of China's telecommunication system, by means of purchasing technology from arm's length market and by vigorous innovation investment. Their products are not only competent to compete with foreign brands; they also command some forefront core technology of the industry. Facing fierce competition, almost all the TNCs in this sector who have investment in manufacturing in China have also set up R&D centers. And the R&D projects conducted in the centers are of more advanced nature, closer to the technology forefront of parents' company. These R&D centers have played a significant role in enhancing the innovative capability of foreign affiliates, and strengthening their competitive edges. And in some circumstances they are of strategic importance for TNCs. For instance, R&D center of Alcatel Shanghai Bell[xii] has become one of the three pillars of Alcatel's global R&D network.

Increase of Wholly Foreign Owned Enterprises (WFOE)

The share of WFOE in total FDI has increased dramatically since 2000. The gradual relaxation of restrictions on foreign ownership by the Chinese government and the increasing knowledge gained by FFEs about doing business in China has put impetus in the popularity of WFOE. Though based on accumulated amount of foreign investment, equity joint venture is still the top form of FDI. WFOE has taken over as the dominant form since year 2000 and its share went up to 62.39% in 2003, and further increased to 66.34% in 2004 and 71.21% in 2005 (see table 9). The shift towards WFOE should have an important impact on technology transfers by the TNCs. They tend to be more active in transferring advanced technologies to its wholly owned affiliate, while under

joint venture arrangement, especially in the situation of minority foreign ownership, foreign investors are more cautious about advanced technology transfers for fear of technology leakage.

Table 8: Distribution of FDI among Different Forms (Percent)

	Equity Joint Venture	Contractual Joint Venture	Wholly Foreign Owned Enterprise	Other Forms
1979~1985	34	62	4	
1986	60	49	1	
1991	53.1	21.1	23.8	
1995	4305	19.5	36.9	
1997	43.08	19.73	35.77	1.43
2000	35.23	16.2	47.41	1.26
2002	28.42	9.59	60.15	1.84
2003	28.77	7.16	62.39	0.63
2004	27	5.1	66.34	1.56
2005	24	0.3	71.21	1.78

Note: The distribution is based on amount of utilized foreign investment.

Source: China Statistical Yearbook, various years, China Yearbook Publishing House.

Collaboration between TNCs and domestic institutes is still weak

Successful technology transfers require not only that the host country be able to acquire the technology, but also that this technology is diffused internally and finally be used as a basis for creating new technologies by the host country. Technology diffuses in a country through backward and forward linkages, thus promoting technology links and collaboration between TNCs and domestic institutes is vital for foreign technology to take a deeper rooting in host country. Besides fostering domestic firms to cut into TNCs supply chain and form a local supply network with TNCs, as more complex technologies are imported and deployed, collaboration in R&D is crucial in order to

absorb their underlying principles.

However , R&D collaboration between FFEs and domestic institute are still very limited in China. A survey[xiii] (Wang, 2003) showed that 94% sample FFEs in China never participate in domestic technology market, none of the sample FFEs ever sold their technology in the market; 11.3% FFEs formed technology alliance with local firms; 1.5% FFEs co-apply patent with domestic institutes; 10.3% FFEs are involved with human resource movement with local institutes; 14% FFEs are involved with technology consultation with local institutes. The weak technology collaboration between FFEs and domestic firms, universities and other research institutes has slowed down the learning process and has reduced the spillover benefits from FDI.

FFE Patent Application and Granted Rate Remain Higher Than Domestic Counterpart

Though China has successfully attracted large amounts of FDI and technologies have been imported continuously both from internal markets of TNCs and from arm's length markets, the situation of China's domestic innovation is far from optimistic. An examination of China's patent applications, which is one of the outputs of innovation system, shows that domestic ownership of innovation and invention growth rates is much lower than foreign ownership, indicating domestic innovation and invention performance is lagging behind and the extent to which foreign firms control domestic inventions is high. The overall level of patenting activity has been increasing rapidly during the 1990s, which could be attributed, to a large extent, to the rapid increase of foreign patent applications. Between 1990 and 1999, foreign patent applications

increased by 26.9% a year, whereas domestic patent applications increased by only 11.9% a year (OECD, 2004). The three major kinds of patent (invention, utility model and design) granted to foreign applicants have been increasing much faster than that to domestic applicants (see table 10). This phenomenon might indicate that foreign firms are seeking stronger protection from IPR while transferring more R&D activities to China.

Table 9 Three Major Kinds of Patent (Invention, Utility Model and Design) Granted for Domestic and Foreign Applicants, 1997-2003

	Total	Domestic	Foreign
Average Increasing Rate(%)	23.6%	21.5%	38.6%
1997	16.5%	16.8%	13.5%
1998	33.1%	32.3%	41.5%
1999	47.5%	50.1%	23.7%
2000	5.2%	3.4%	25.5%
2001	8.5%	4.2%	48.1%
2002	15.9%	12.9%	35.6%
2003	37.6%	33.4%	60.8%

Source: State Intellectual Property Office of China (SIPO), http://www.sipo.gov.cn/sipo2006/

The above analysis shows that the removal of trade-related investment measures and the compulsory technology transfer requirement from legislation of foreign investment does not reduce the quantity or quality of foreign technologies transferred to China. The prospect that the fulfillment of the commitments China made upon accession of WTO

places China among one of the most open developing host countries. Furthermore, the fact that China's technology diffusion capability has improved greatly has boosted technology transfers since 2001. However, in order to reap to a greater extent the benefit spilled over from foreign technologies, policy instruments enhancing market competition and R&D collaboration between TNCs and local institutes are desirous.

5. Summary and Concluding Remarks

China's technology transfer policy went through a shift from the externalization-oriented policy to the internalization-oriented strategy. The internalization-oriented strategy, represented by TTEDM strategy, has been effective in bringing in advanced technologies from TNCs to upgrade traditional industries and set up newly emerged thigh-tech industries.

However, with the progress of multilateral negotiations within WTO framework, member governments are becoming less possible to apply compulsory investment requirements that have direct influence on technology transfers, though it doesn't prevent governments from acting actively in this aspect. Rather, given the increasingly important role of technology as a determinant on economic growth and development and on competitiveness in world market, and, the fact that technology transfer does not incur automatically with the arrival of foreign investment, government policy intervention remains highly necessary and could be effective if they are properly designed.

The key mechanism of TTEDM strategy, which lies on the administrative power of

granting approvals to TNCs is weakening out as China eliminated technology transfer as a compulsory requirement, and has quickened its pace in removing restrictions on market access for foreign investment. China is at the present stage transforming towards a mixed strategy that favors the flow of technology via both trade and FDI. The mechanism of the strategy has been experiencing dramatic shift from depending on direct government interventions to depending on market force. The priorities include enhancing market competition, strengthening collaboration between TNCs and domestic institutes, and stimulating indigenous technology development.

The enlightenment China's experience in technology transfer policy may provide for other developing countries includes:

Firstly, technology policy intervention by government is even more desirous when the market is open up. In order to balance the interest between TNCs and host countries, strong government institutions that are capable to bargain with TNCs are important.

Secondly, some investment requirements (such as local content requirement and technology transfer requirement) are effective in building up domestic technological capabilities in the initial stages of sectoral development. Therefore, less developed countries should be able to request extension of transition period of eliminating TRIMs, which shall permit these countries better position to benefit from FDI.

Thirdly, when moving up towards higher levels of technology capability, it is vital for developing host countries to encourage R&D collaborations between FFEs and domestic institute, which will help developing countries to move into autonomous

innovation and will eventually enable them to approach the frontier of technology.

End Notes

i Technology transfer strategies are divided into three categories: externalization-oriented, internalization-oriented and mixed strategy by WGTTT in WT/WGTTT/W/3.

ii TRIMs Agreement, one of WTO's Multilateral Agreements on Trade in Goods, prohibits trade-related investment measures, such as local content requirements, foreign exchange balance requirements, while technology transfer requirement is not included in the prohibited measure list. Thus, host countries of foreign investment are still eligible to apply technology transfer requirement to support national development objectives.

iii In the study by WGIT ' A Taxonomy on Country Experience on International Technology Transfer' WT/WGTTT/W/3, four main channels were defined to serve transfer technology across countries.: using technologically advanced intermediate products that have been invented abroad; accessing the knowledge codified in a blueprint; person-to-person communication or learning-by-doing; interaction between domestic and foreign firms.

iv.Technology transfer in internal market is transfers that occur between a parent of a multinational enterprise and a foreign affiliate under the ownership and control of that enterprise, transfer in external market is transfers from a multinational enterprise to an entity that is not controlled by that enterprise and can take the form of licensing, minority joint ventures, technical cooperation contracts, etc.

v Article 66 of Implementation Regulation on the Tax law of the People's Republic of China for Enterprises with Foreign Investment, 1991.

vi Recent study by OECD (2003) finds positive impact of intellectual property protection reform on FDI in developing countries, D/TC/WP(2002)42/FINAL.

vii Large foreign investment projects in strategic industries are subject to approval by the central government.

viii Foreign invested projects which apply technologies that were first applied by parent firms within the last 3 years. The figures are from Jiang, 2002, pp58.

ix News Release by Ministry of Commerce, China, December 24th, 2004.

x Ministry of Foreign Trade and Corporation, Notice of Issues Regarding Foreign Funded R&D Centers, April 2000.

xi http://www.bjstats.gov.cn/gcfx/tjbgjzl/kjfz/200207260262.html

xii Alcatel Shanghai Bell was born through the integration between the former Shanghai Bell and Alcatel's key business units in China.

xiii The survey was conducted in 2003, covering about 400 FFEs located in Beijing, Shanghai, Suzhao and Dongguang. These citie are among those most densely located by FFEs.

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