IMPACT OF INWARD FDI, IMPORT ON DOMESTIC INNOVATION: EVIDENCE FROM CHINA

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ABSTRACT

Hastened by triangle trade patterns, exchange of immediate goods and inward foreign direct investment have become the main channels to achieve technical spillover. Based on regional inward capital data and classified traded goods, we examine causes of innovation in the context of inward foreign direct investment. We find that local absorptive capacity critically affects creative power. Economies transfer techniques using various approaches, impacting local innovation in diversity. A low degree of industrial-correlation hampers knowledge spillage through foreign direct investment in high-tech industries. Existing technology stocks satisfy technical wants for imported parts rather than imported capital goods. This makes it difficult to digest or absorb spillovers from the latter. China benefits substantially from technical spillovers of imported parts mostly from Asian economies. Governments should support research and develop machinery and equipment industries to accumulate know-how. China should proportionately import parts from European countries and USA to realize trade balance and reduce trade conflicts.

JEL: D24, F14, F23, O33

KEY WORDS: New Triangle Trade Pattern, Knowledge Spillover, Absorptive Capacity

INTRODUCTION

Technological progress drives economies. In the early 1900s, ninety percent of the doubled efficiency in the USA come from technology progress and 10% from capital increment (Solow,1957). Three technology progressive patterns receive the most academic attention. Anglo-Americans fundamentally rely on basic research and independent innovation. South Korea focuses on introducing, digesting and absorbing overseas advanced technology and innovating afresh. Asians attract foreign direct investment (FDI) to narrow the technical gap with developed countries. Developing countries try to absorb technical spillover through trade and inward FDI with the aim to quickly cultivate and create need for independent research and development.

Since 1990s, China adopted a cascading-tariff policy by exerting low or exempted tariffs for imported parts to stimulate processing and promote export-oriented industries. Fostered by new-triangle trade, resulting from division of production and processing, inward FDI and intra industrial trade developed quickly in China. Newly industrialized Asian economies such as Japan, South Korea, Taiwan, Singapore, and Hong Kong transplanted their labor-intensive industry to less-developed Asian economies. They export capital goods and intermediate products to those zones having a comparable advantage and re export final products to European countries and the United States. By 2008, from the core position of "triangle trade", China became the world's top exporter of mechanical and electronic products.

High technical industries have three characteristics. First, mainly importing high-tech products from newly industrialized Asian economies and exporting to European countries and the United States. In 2008, over sixty percent of hi-tech products were traded by Asian economies, especially with Taiwan (17.14%), South Korea (15.3%) and Japan (13.56%). Of the export products, 42.32 percent are exported to Europe and America and nearly 23.45 percent transit at Hong Kong. Second, large contributions come from immediate-products trade. Of the traded high-tech commodities, parts represent 52 percent for imports and 48% for exports, whereas 68 percent of imported immediate goods are for processing rather than for domestic sale（Gaulier et.al.,2007）.

Properties of New triangle trade suggest we should distinguish sources of investment and trade type to analyze their effect on indigenous innovation. Because different investment bodies have different roles in trade, a single study of the impact of export or FDI on indigenous innovation and technical progress might lead to incorrect conclusions. Based on the New Triangle Trade Mode, this study explores two paths of technology spillover on innovation in the context of technical trade and FDI. Two questions will be discussed: (1) Is export growth and export commodity structure improvement derived from the progress of technology, or does an FDI strategy reduce New Triangle Trade? We investigate trade routes and investment paths to absorb external knowledge spillover. (2) Absorptive capacity, investment and trade are important paths to introduce external technology. Is current technical progress derived from trade spillover or investment spillover? What degree of impact does each overflow path exert on innovation performance?

The rest of the paper is organized as follows: In section two the theoretical underpinnings of our research are elucidated. Section three provides an in depth analysis of trade flows and investment sources in China and ASEANs. ASEANs refer to member states of the Association of South-East Asian Nation, including Indonesia, Singapore, Malaysia, Philippines, Thailand, Laos, Vietnam, Brunei, Cambodia and Myanmar. In the fourth section we propose some hypothesis and use data from 1998- 2008 to examine the role of local absorptive capacity and paths of spillover on creation. The results are discussed in Section five and some concluding comments are presented in the last section.

LITRERATURE REVIEW

Spillover spurs technical transfer across boundaries. Endogenous Growth Theory predicts positive externalities and spill-over effects from trade and inward FDI in favor of host countries when know-how act as public good or noncompetitive asset (Acs et. Al., 1994).

Technical import is the best way to acquire advanced knowledge in the absence of local technology stock. Trade becomes a vital channel to get knowledge and to stimulate total factor productivity (TFP) growth in industrial nations (Crespo et al., 2004; Frantzen, 2000). Blalock and Veloso (2007), Qu (2009) discuss a process of knowledge exchange between local producers and foreign suppliers. By using an error correction and co-integration model, Madsen (2005) verifies that inward know-how drive TFP increased by 200% in machinery equipment and medicine, the top three high technical industries.

After World War Ⅱ, international economic cooperation and division of labor occurred on a larger scale and in greater depth. Multinational investment became the chief path to transfer technology and spread knowledge. Caves (1974) first examined spillover effects in Australian manufacturing, finding foreign equity favors technique transfer, increases of local labor productivity and distributional or technical efficiency. The research of Harris and Robinson (2004) on Greece and Britain support this conclusion. Barrel and Pain (1997) highlighted the propensity to absorb inward FDI spillover, which contributed to a 30 percent productivity increase in the British manufacturing industry. FDI spills over knowledge and managerial experience for technical transfer, industrial links, imitation or indirect labor flows. Blomstrom (1986) and Kokko and Zejan (1996) find support for the FDI spillover Hypothesis in their study of Mexico and Uruguay. Haddad and Harrison (1993), Aitken and Harrison (1999), Kathuria (2000) found no or negative effect of spillover in their research on Morocco, Venezuela and India, which indicates positive FDI spillovers exist in certain premises.

Kiyoshi Kojima schools regard FDI as an essential way to transfer capital, know-how and techniques across countries with productive disparity. Advanced productivity carried by inward FDI diffuse through training and imitation in the host country. Comparative advantages gained stimulate industrial productivity and create commercial opportunities. Aitken et.al (1997) indicates exports of foreign enterprises intensify of local enterprises. However, if FDI enterprises over depend on imported parts, domestic suppliers can hardly benefit from economies of scale, which may lead to a negative backward FDI spillover effect. Barrios and Strobl (2004) found positive spillover effects exists in export-oriented enterprises supported by more R&D capital against intense overseas competition in Spanish manufacturing. Kokko (1994) and Greenaway et.al (2004) argue commerce impacts FDI spillover ambiguously. FDI exports weakly affect export intensity of local enterprises.

Recent concerns focus on impacts of invested strategy and property on spillover effects. Positive effects are verified in joint-venture projects, with close upper-and-lower industrial links that depend on local sources. This leads to a learning-by-doing effect, demonstrative and cultivate effect and labor turnover effect which benefit local enterprises. Conversely, exclusively foreign-owned projects mainly displayed in horizontal industrial links aim to export and occupy foreign markets. This leads to a weak or insignificant spillover effect. Mattoo et.al (2004) verified a backward link which absorbs FDI spillover. Sole ownership enforces rigorous technical security with little regional reliance. Zhang (2006) pointed out that overseas corporations with controlling stakes sternly prevent key technical spillover, displaying competitive over collaborative relations.

Strategies also influence the entry of invested corporations. Multinational enterprises with superior technical, managerial and marketing skills monopolize the host country market. Gatignon and Erin (1988) and Asiedu and Hadi (2001) verified R&D intensity is significantly and negatively correlated with foreign equity. Wholly-owned FDI enterprises dominate in hi-tech industries. Neven and Siotis (1996) argue informative facilities also affect investment location. If a host country owns sound facilities in informative transfer and R&D, transnational companies with superior technology may have less invested motive to invest.

The idea of absorption capacity first proposed by Cohen and Levinthal (1989) refers to the ability to study and apply advanced technology from developed countries. Borensztein et.al (1998) noted that only nations having certain profiles of technology and facilities can benefit from FDI. Yu (2004), Xu and Jiangyu (2006) confirmed technique spills over well, only when a foreign entity owns superior technology and when the host nation has enough absorption and communication skills. FDI spillover does not occur as result of inward FDI. Learning techniques through immediate overseas purchase or indirectly through inward FDI is the premise of spillover. Proper reactive action by local entities is a necessary condition.

Enterprises expand their research and development (R&D) expenditures to heighten their creative ability. Basant and Fikkert (1996) studied over 900 manufacturing enterprise in India and found R&D expenses of local enterprises are significantly and positively correlated with FDI spillover. Kathuria (2000) confirmed knowledge spillover and R&D expenses complementarily correlate. Pearce (1999) argues a large technology gap reflects poor technical build-up and mimic capacity. As a result local enterprises cannot gain demonstrative-and-imitative effect from inward and eventually "enslaved" FDI . FDI does not significantly spill over in backward industries or enterprises with large technological gaps. Huang (2006) found that Existing technological gaps between foreign and domestic enterprises in China are not reasonable which significantly and negatively impacts knowledge spillovers. Backward technology suggests local enterprises absorb transferred techniques from multinational enterprises weakly and have little creative incentive. Multinational enterprises in business processed with imported raw materials. Spare parts hinder their upward-and-downward business links with local enterprises. This environment provides few chances to learn, digest and absorb introduced advanced technology and unflavored technical diffusion.

Impact of FDI Spillover Path on Creation

Two contrary views exist on links of FDI and endogenous creation. Wang et.al (2005), Xian and Yan(2005) found competition intensified by FDI result in local research and development. FDI spillover contributes to innovative performance. But if domestic enterprises excessively rely on exotic skills and abandon existing supporting technology, they may reduce their production scale and R&D expenses. Thus, local creativity depend more on foreign R&D, with an obvious market-stealing effect. Veugelers and Vanden (1990) found foreign capital negatively affects local R&D expenses in Belgium. Fan and Hu (2007) verified company's R&D expenses lessened when augmented foreign capital entered. Wang (2003) and Hu (2006) found FDI does not affect local technical progress. In high-tech industries, foreign enterprises chiefly receive capital goods from their home country. Domestic enterprises integrate into global processing of low value chain items. Chen (2007) found a "stealing effect" exists in his study on local innovative impact of foreign R&D institutions in the Pearl River Delta of China. Zhang and Feng (2007) found that external FDI spillovers drive indigenous technical creation and offset local R&D. Buying techniques both from home and abroad do not speed up local creation unless local industries have intense absorptive capacity. Zhang (2008) regarded the importance of capital and intermediate products as main channels to absorb external techniques and realize self-renovation.

Existing research shows trade and investment are the main channels to absorb external knowledge spillovers. The present researches focus more on productive spillovers among developed nations than spillover channel for developing countries. So far, we have found little research on links between spillover channels and local creation in Asian economies. Most researchers concentrate on a single spillover path, ignoring links of trade, investment strategy and local absorption, which plays key role in new triangle trade.

Descriptive Research: Evidence from China and ASEANS

Impact of Trade on Technical Progress: To further analyze spillover from traded goods, we use the Trade Balanced Contributed index (CTB index) proposed by Lemoine and Deniz (2004). We calculate the data from the COMTRADE database using a processing stage. CTB index can remove cyclic effects thereby more accurately reflecting comparative advantages of traded goods and their contribution to traded balance from a processing profile. The CTB formula is given by:

$$CTB = (\frac{x_k - m_k}{x+m} - \frac{x-m}{x+m} \times \frac{x_k + m_k}{x+m}) \times 100$$

Wherein x_k represents export value and m_k represents import value of product k, $\frac{x_k - m_k}{x+m}$ shows true trade balance of a specific product measured by national total trade balance. To remove micro-economic impact on short-time variation, we apply $\frac{x-m}{x+m} \times \frac{x_k + m_k}{x+m}$ to reflect expected trade balanced value of specific product k, using $\frac{x_k + m_k}{x+m}$ as a trade weight. The margin between true and expected trade balanced value measures the contribution of specific product k to total trade balance. If true surplus is greater than expected surplus or true shortfall is less than expected, the positive devotion suggests a comparative advantage. Conversely, negative devotion suggests comparative disadvantages. The greater the values is, the larger the contribution of the specific product and the more obvious the implied comparative.

Final products have comparative advantage and contribute 55.96 percent to exports. Consumer goods and capital goods proportioned by 27.14 percent and 28.82 percent respectively, dropped or rose from 47.5 and 15.62 percent in 1998. Parts represent 52.4 percent of overall exports in 2008. Semi manufactured and pare goods are 26.35 and 26.05 percent respectively, changing from 46.21 and 21.76 percent in 1998. These results show a convergence tendency. This is consistent with the foregoing analysis. New triangle trade drives global exchange of parts and components and deepens the international division of labor. The import ratio of capital goods is smaller than that of components and parts, remaining at 19 percent. Local enterprises in China are concerned with introducing equipment rather than to digest or absorb external skills through direct or indirect import of technology. Cost of technical imports against digestion rises from 1:1 in 1995 to 1:1.8 in 2005, still below EU-15 nation (1:3) and Japan (1:5) ratios. Facilities import expenses represent 73.87 percent of the overall outlay for technical introduction (including visual plant and beltlines) during the plan and afterwards decline yearly. This implies China has higher absorptive and creative capability and depends less on imported capital for technical upgrades. Imports of spare parts are a more important channel to absorb external knowledge relative to capital goods.

The CTB index shows that China has a comparative advantage in producing consumer goods relative to parts. This leads to surplus in traded consumer goods and deficit in traded parts components. This tendency further expands for the new triangle trade mode. In 2008, hastened by processing trade undertaken by Asia-funded enterprise, 48.15 percent of parts and components came from and 47.61 percent transported to East Asian economies. Trade surplus of final products with European economies and U.S.A and trade deficit of intermediate and capital goods with Japan, South Korea and newly industrialized economies in East Asia indicated China mainly absorbs external techniques through imports of intermediate and capital goods from East Asian Economies. The export-oriented industry is most active but does not represent industries with the best technology. It reflects a transfer process from trade deficit with parts with East Asian Economies to trade surplus of capital and consumer products with European and American economies. This implies research solely on the creative impact of exports may exaggerate the effect of trade on technical upgrades.

To investigate the role of trade on technique upgrades, we analyze the prime mover for high-tech product exchange. CTB indexes of hi-technical products are negative but declined in absolute value, indicating that incremental exports are not a reflection of an industrial comparative advantage, but rather lessen industrial comparative disadvantages. In 2008, the trade deficit of the main hi-tech industries, with some exceptions, fits the phenomenon determined by comparative advantage and invested strategy. Commercial parts and components make up more than half of tradable hi-tech products, implying FDI characterized by processing trade drives incremental commercial hi-tech products. Imports of intermediate and capital goods are the main channel to absorb spilled technology.

Economies transfer technology in different ways. Newly industrial Asians mainly transfer through processing the import of parts and components. European economies and the U.S.A mainly transfer through general import of capital goods. Studying developing economies in Southeast Asia at the hub of new triangle trade, we found the import of intermediate products is significant, implying an important channel to absorb external techniques. Countries in various stages of economic development spill over technology in various channels. In Indonesia, imports of parts and capital goods converge, while in Malaysia, Philippines, Cambodia and Thailand, exchange of parts and components are still important channel for spill over. Less developed economies in Southeast Asia proportionately import parts from newly industrial economies in East Asia and export final goods to European economies and U.S. An increased ratio of exportable capital goods reports incremental technology-intensity. The CTB index shows comparative disadvantages in production except for consumer goods as a result of new triangle trade. This suggests ASEAN may use similar channels to absorb extraneous spillover.

Impact of FDI on Technical Progress: Evidence shows that investment purpose, varying with capital sources, determines the disparity in devoted industries as well as its spillover effects. East Asia transferred their matured industries to China to search for cheap raw materials and workforce. Conversely, European economies and America invest in China with the aim to occupy the Mainland market. This was done mainly by transferring know-how through general exports of capital goods, displaying market-driven and capital-intensive or technology-intensive features. Sole ownership dominates the inflow pattern in hi-tech industries showing intense technical monopoly and limited outward spillover. In 2006-2008, foreign capital invested by multinational companies in China came from Asian economies at 36.23 percent and European economies and USA contribute at 8.63 percent. Japanese enterprise accounts for 4.48 percent and half of products produced for export.

Inward FDI in China, dominated by cost-driven and export-oriented strategies, promote commercial and technical growth. Lacking local supply, FDI enterprises process most products for export with imported parts and semi-manufactured products. In 1992-2004, imports by FDI enterprises increased radically, of which just a quarter are for local sale. For export of made products hi-tech products rose from 6.8 percent in 1995 to 28.6 percent in 2007. In 2008, foreign enterprises contribute 79.99 percent of imports and 85.16 percent of exports in hi-tech industries. Exclusively foreign owned enterprises were responsible for 62.57 percent of imports and 67.59 percent of exports. Some 80 percent of overall trades result from foreign enterprises from East Asian economies. Based on volume of exports and import hi-tech products in proportion to overall products, we found foreign-funded enterprises have much higher technology intensity.

Research on new triangle trade indicates inward FDI and trade jointly drive the growth of Investments. An important question arises: Is technical progress driven by FDI spillover or trade spillover? Capital, mainly invested in labor-intensive industries by East Asian newly industrial economies, display competitive, substitute and market-stealing effects. In recent years China exports of East Asian invested enterprises account for over 50 percent of national exports, suggesting the existence of a market-stealing effect. In ASEANs, Indonesia, Malaysia and Thailand rank highest for capital intake (Singapore excluded). In 2006-2008, capitals in-flowed from EU-15 and USA reach $54.987 billion and $29.433 billion, accounting for 29.78 percent and 15.95 percent of overall inward FDI in ASEAN. In 1995-2005, in-house capital in ASEANs reaches $32.5 billion, accounting for 11 percent of overall inward FDI, two thirds of which is from Singapore. These figures suggest that, ASEAN less-developed economies have become a base-place to carry out industrial transfer from Asian developed economies and provide a gateway for European and American markets. According to World Investment Report (2008), service (54.26%), trade (16.94%), finance (15.80%) and manufacture (33.92%) are the top four industries to attract FDI. Investment in financial services and the manufactured industry are mainly from European economies. Half of funds originating from Japan and Singapore centralize in manufactured industries (Plummer, 2009).

DATA AND METHODOLOGY

Hypothesis

Imports of parts and capital goods are a key channel to absorb external techniques. Different origins transfer technology in different ways. European enterprises prefer to invest in those technology-intensive industries, aviation, life science and integrated computer (Lemoine and Deniz, 2004), and transfer technology through arm's length trade and general trade of capital goods. Asian invested enterprises prefer to transfer technology through immediate-goods trade among entities. In 2008, the top three export industries in China, electronic techniques, computer and telecom are heavily dependent on processing trade, with parts and materials supplied by (40%), Japan (20%), and European countries and U.S. (less than 10%). In the processing industries spread skills are less advanced but benefit technical progress through close industrial links. Local suppliers or subcontractors gain technical support from their foreign cooperators, which means they can acquire marketing or production skills to upgrade their techniques and gain opportunities to explore new products by imitation and through their own R&D.

H1: Gained spillover through processing imports of parts from newly industrial economies in East Asia and general imports of capital goods from US and EU-15 economies positively associate with creative results.

In less developed economies of East Asia, foreign entities display a cost-effective nature with aim to acquire cheap resources, including raw materials or labor. The objective is to maximize interest in globalization, or display a market-snatched nature to monopolize facilities including water, electricity, energy or technology and capture local markets. Foreign entities mainly occupy processing business which provide or import materials for manufacturing industries and are mass in and mass out in nature. This prevents technical spillover and industrial correlation with local supply that is crucial to develop import-competitive or processing business. High Tech foreign entities highlight patent protection against technical spillover. Motorola and Siemens set up intellectual property protection (IPR) departments to handle patent affairs in China. They designate executives from the parent company to manage technical or human resource departments avoiding key know-how spillover. Increasingly, foreign entities prefer sole ownership, breaking communicative links with local organizations, to reduce spillover likelihood.

H2: Foreign entities funded by East-Asian economies have insignificant or negative impact on local creation. They target cost-effective labor and raw sources, are export oriented and competitive against collaborative relations with local enterprises. Foreign entities funded by EU-15 and US target local markets or crucial sources and have little spillover and local creation. They are natured by sole ownership and have few links with local industries.

Both investment and trade change local R&D intensity and creative achievements. R&D expenses determined by local enterprises correlate with expected external technical spillover. If local entities expect to gain spillover from foreign enterprises, they may reduce R&D expenses and depend more on blindly introducing, mimicking and utilizing inward technology rather than self-innovation. This possibly leads to a poverty trap. Conversely, if local entities expect to absorb less spillover, they may strengthen R&D to upgrade their capable digestion in favor of renovation. In addition, local R&D can counter the effect of foreign entity entrance. When transplants expect to absorb more reversed spillovers from host nations, they may relax equity limits and create more opportunities to vertically spill over knowledge.

To measure the likelihood to absorb technology spillover through each channel, we use education expenses (EDU) as a proxy for local absorptive capacity, and consider interactive terms of financial educative expenses (EDU) with each spillover channel. A positive coefficient implies local know-how stock in favor of technical absorption and re-innovative achievement. A negative coefficient suggests weak local absorptive capacity might lead to a poverty trap.

H3: Financial education expenses (EDU) positively affect local creation (IP). The coefficient of interactive terms of financial educative expenses (EDU) and each spillover channel is uncertain. If local absorptive capacity fit spilled know-how needs, interactive terms will positively affect local creative results (IP), showing the spillover channel is effective. Conversely, a negative or insignificant coefficient indicates market-stealing or crowding-out effects against innovative achievement.

We consider spillover is a process to transfer know-how and skills from developed economies to less developed economies. We treat creation as a procedure to create new technology, products or production process with acquired know-how and critical through imports of parts and capital goods and inward FDI from developed economies. In this section we examine the impact of inward capital and commercial goods from Asian developed economies (Japan, South Korea, Hong Kong, China, Singapore), EU-15 countries and USA respectively on local technical progress based on data from China, Indonesia, Malaysia, the Philippines and Thailand at the hub of New Triangle Trade. We choose domestic patent authorities (IP) as the dependent variable and employ imports of capital goods (CI), spare parts (PI) and actual foreign direct investment (FDI) as independent variables to measure received spillover through commercial channel and inward capital respectively. In order to eliminate the effects of inflation, all interval variables are converted to 1990 constant value in logarithm form. Data description and economic significance are shown in Table 1.

Table 1: Definition and Sources of Variables in Research

Variables	Definition	Description of Economic implications	Data Sources
1、IP	Domestic patens authorities	To measure innovative results including utility model and appearance design of domestic enterprise or residents of host countries.	The European Patent Office (EPO)
2、EDU	Financial educative expenses	A proxy for absorptive capacity. The more spending on education, the higher the national quality, the higher the absorptive capability, and the more conducive to independent innovation.	OECD education database, Global education database China statistical yearbook
3、FDI	Actual foreign direct investment value	Reflects the impact of FDI spillover on innovative performance	OECD database
4、FDI-A	FDI value originated from Asian developed economies	Reflects FDI spillover originated from Asian developed economies on innovative performance.	OECD database
5、FDI-B	FDI value originated from European developed economies and USA	Reflects FDI spillover originated from European developed economies and USA on innovative performance.	OECD database
6、IM	Imports value	Reflects the impact of trade spillover on innovative performance.	COMTRADE database
7、CI-A	value of parts and components imported from East Asian developed economies	Reflects spillover impact of imports of parts and components from East Asian developed economies on innovative performance	COMTRADE database
8、CI-B	value of parts and components imported from European developed economies and USA	Reflects spillover impact of imports of parts and components from European developed economies and USA on innovative performance	COMTRADE database
9、PI-A	value of capital goods imported from East Asian developed economies	To reflect spillover impacts of capital goods imports from East Asian developed economies on innovative performance	COMTRADE database
10、PI-B	value of capital goods imported from European developed economies and USA	Reflects spillover impact of imports of capital goods from European developed economies and USA on innovative performance	COMTRADE database

This table shows the definition, economic implication and data sources of dependant and independent variables in our research.

Methodology

The following general model is used to analyze the panel data:

$$Y_{it} = a_i + \sum_{K=1}^{K} X_{itk}\beta_{ik} + v_{it}\,,\quad t = 1,2,\cdots,T\,,\quad i = 1,2,\cdots,N \qquad (1)$$

Where α_i is an intercept term; X_{itk} represents the k[th] explanatory variable of the t[th] year in country i ; υ_{it} is the error term. K is number of explanatory variables excluding the constant term，N represent the number of cross-sectional individuals, T is time periods. K is the number of explained variables.

Three types of models are distinguished according to various limits on coefficient of explained variables and intercept term. The heterogeneous coefficient model occurs if *all individuals* have same regressive intercept and different slope, that is the same α_i and different coefficient $\beta_{k1},...,\beta_{kN}$ ($k = 1,2,\cdots,K$) for explained variables.

$$Y_{it} = \alpha + \sum_{k=1}^{K} X_{itk}\beta_{ki} + \upsilon_{it}\,,\quad t = 1,2,\cdots,T\quad,\quad i = 1,2,\cdots,N \qquad (2)$$

The heterogeneous intercept model occurs if all individuals have different regressive intercepts and the same slope, namely, of different α_i but the same coefficient $\beta_{k1},...,\beta_{kN}$ ($k = 1,2,\cdots,K$) for explanatory variables:

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} X_{itk}\beta_{k} + \upsilon_{it}\,,\quad t = 1,2,\cdots,T\quad,\quad i = 1,2,\cdots,N \qquad (3)$$

The homogenous coefficient model occurs if the regressive Intercept and slope, α_i *and* coefficients $\beta_{k1},...,\beta_{kN}$ ($k = 1,2,\cdots,K$)of explained variables the same for all individuals:

$$Y_{it} = \alpha + \sum_{k=1}^{K} X_{itk}\beta_{k} + \upsilon_{it}\,,\quad t = 1,2,\cdots,T\quad,\quad i = 1,2,\cdots,N \qquad (4)$$

We use a Redundant Fixed Effects-Likelihood Ratio to test if the null hypothesis are rejected and individual effects and time effects exist. On the assumption of same slope, we construct F statistics:

$$F = \frac{(S_4 - S_3)/(N-1)}{S_3/(NT-k-N)} \sim F[(N-1),(NT-k-N)] \qquad (5)$$

Or chi-square statistics:

$$\chi^2 = (S_4 - S_3)/\sigma^2 \sim \chi^2(N-1) \qquad (6)$$

If the null hypothesis is rejected, the intercepts are homogenous for individuals, indicating the presence of an individual effect. Similarly, we use F statistics and chi-square statistics to test for the presence of a time effect if the null hypothesis is rejected. If an individual effect exists, we further test the existence of an innovative impact of explained variables for individuals, namely, whether each model follows a homogenous coefficient model. We construct F statistics:

$$F = \frac{(S_3 - S_1)/[(N-1)k]}{S_1/[N(T-k-1)]} \sim F[(N-1)k, N(T-k-1)] \qquad (7)$$

RESULTS AND DISCUSSION

Table 2 show the domestic patent license number (IP) is positive skewed, platy kurtosis and normally distributed under a 5 percent significant level, which means the required normal distributed dependent variable or error terms can be satisfied for subsequent regressive analysis.

Table 2: Simple Description of Main Variables (1998-2008)

	Mean	Med.	Max.	Min.	Std.	Skew.	Kur.	J-B	Prob.
IP	6.354	5.861	12.773	1.609	3.125	0.7785	2.593	5.935	0.0514
EDU	22.780	22.614	25.738	20.957	1.152	0.7818	2.903	5.624	0.0601
FDI	7.220	8.439	11.593	-8.423	4.884	-2.406	7.746	104.67	0.0000
FDI-A	5.728	7.277	9.120	-7.729	4.689	-2.057	5.738	55.967	0.0000
FDI-B	5.886	7.087	10.814	-7.489	4.859	-1.869	5.583	47.298	0.0000
IM	25.401	25.181	27.994	24.341	0.9043	1.119	3.668	12.494	0.0019
CI-A	23.099	23.122	25.354	20.863	1.006	0.1604	3.176	0.307	0.8576
CI-B	22.656	22.914	24.646	20.671	1.005	-0.2769	2.447	1.405	0.4955
PI-A	22.402	22.445	24.928	20.741	1.079	0.7054	2.797	4.655	0.0975
PI-B	26.189	25.801	29.096	24.900	1.146	1.121	3.049	11.518	0.0032

This table shows descriptive statistics of each variable. Mean, Med, Max, Min, Std, Skew, Kur., J-B, Prob are abbreviations of mean value, median, maximum, minimum, sample standard deviation, skewness coefficients, kurtosis coefficients, Jarque-Bera statistics and corresponding probability value Respectively.

Table 3 shows the related coefficients of variables are obvious, indicating an inseparable relationship and links between trade and investment. Commerce of parts and capital goods accelerated by foreign invested activities jointly drive local technical progress. This means we should distinguish channels of trade and FDI to study spillover impact on local innovative performance and fully consider individual effects and Heteroskedasticity. Specifically we should consider disparity of the dependent variable and variance resulting from historical, economic and cultural distinctions among nations.

Table 4 shows the results of the unit root tests. Results of IPS, ADF and PP test show test statistics pass the significant inspection at 5% level, unit root does not exist for dependant variable IP, which signs a stationary process and indicate no false regressive phenomenon exists in subsequent model analysis.

Based on the supposed constant coefficient model, which implies variables have a consistent impact on the dependent variable, we control for 1 year lagged domestic patent authorities (IP_{-1}) and local knowledge stock (EDU) and test whether individual effects and time effects exist by utilizing the following models:

$$IP_{it} = \alpha_i + \beta_1 IP_{it-1} + \beta_2 EDU_{it} + v_{it}, \quad t = 1,2,\cdots,T, \quad i = 1,2,\cdots,N$$

H_0: $\alpha_1 = \alpha_2 = \cdots = \alpha_N$

Table 3: Analysis of Related Coefficient

variable	IP	EDU	FDI	FDI-A	FDI-B	IM	CI-A	CI-B	PI-A	PI-B
IP	1.000									
EDU	0.7857**	1.000								
FDI	0.5667**	0.6255**	1.000							
FDI-A	0.4115**	0.5832**	0.7887**	1.000						
FDI-B	0.6231**	0.6425**	0.9346**	0.7052**	1.000					
IM	0.7773**	0.9446**	0.5286**	0.4796**	0.5685**	1.000				
CI-A	0.7473**	0.7969**	0.6969**	0.6031**	0.6654**	0.8319**	1.000			
CI-B	0.6076**	0.6778**	0.6400**	0.6032**	0.5791**	0.6736**	0.9297**	1.000		
PI-A	0.7201**	0.9177**	0.5702**	0.5346**	0.5873**	0.9619**	0.8695**	0.7244**	1.000	
PI-B	0.8409**	0.8813**	0.3602**	0.3108*	0.4465**	0.8994**	0.6159**	0.4321**	0.8025**	1.000

*This table shows correlative between variables. **represent significant at 5%, *represent significant at 10% (double tailed test).*

Table 4: Result of Unit Root Test of IP

Test	IPS	ADF	PP
t-statistic	-1.670	21.233	22.527
P	0.0475	0.0195	0.0126

This table shows t-statistic and p-value of IPS, ADF AND PP tests.

The results, presented in Table 5, show the existence of only individual effects. Based on this result, we include only individual effects in future modeling.

Table 5: Result of Individual Effect and Time Effect Inspection

Test	result of individual test		result of time effect test	
	Cross-section F	Cross-section Chi-square	Period F	Period Chi-square
Statistic	6.290	23.033	0.3362	3.830
d.f.	(4,43)	4	(9,38)	9
Prob.	0.0004	0.0001	0.9571	0.9222

This table shows results of individual effect and time effect tests. D.f, Prob are abbreviations of degree of freedom and corresponding probability value Respectively.

Considering the existence of heterogeneous effects with intercept, we test whether the slopes are equal by testing H_0: $\beta_{k1} = \beta_{k2} = \cdots = \beta_{kN}$ ($k = 1,2,\cdots,K$)。F statistics constructed from model 1 to 9 presented below are shown in Table 6.

Model 1： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_{2i} EDU + v$, $i = 1,2,\cdots,N$

Model 2： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_{2i} EDU + \beta_{3i} FDI + v$, $i = 1,2,\cdots,N$

Model 3： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_{2i} EDU + \beta_{3i}(FDI - A) + \beta_{4i}(FDI - B) + v$, $i = 1,2,\cdots,N$

Model 4： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_{2i} EDU + \beta_{3i}(FDI - A) * EDU + \beta_{4i}(FDI - B) * EDU + v$, $i = 1,2,\cdots,N$

Model 5： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_{2i} IM + v$, $i = 1,2,\cdots,N$

Model 6： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_{2i}(CI - A) + \beta_{3i}(CI - B) + v$, $i = 1,2,\cdots,N$

Model 7： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_{2i}(CI - A) * EDU + \beta_{3i}(CI - B) * EDU + v$, $i = 1,2,\cdots,N$

Model 8： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_2(PI - A) + \beta_3(PI - B) + v$, $i = 1,2,\cdots,N$

Model 9： $IP = \alpha_i + \beta_{1i} IP(-1) + \beta_{2i}(PI - A) * EDU + \beta_{3i}(PI - B) * EDU + v, i = 1,2,\cdots, N$

Table 6 shows the F tests are indistinctive, which implies constant coefficient models exist and impacts of explained variables on innovative performance in each nation are consistent.

Table 6: F-Test Results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
S_3	14.156	13.467	12.408	12.401	12.941	13.357	12.746	12.066	12.901
S_1	10.480	9.079	7.535	7.539	9.887	9.084	8.148	7.524	7.594
S	3.676	4.388	4.874	4.862	3.054	4.273	4.598	4.542	5.308
df1	8	12	16	16	8	12	12	12	12
df2	35	30	25	25	35	30	30	30	30
f	1.534	1.208	1.011	1.008	1.352	1.176	1.411	1.509	1.747
prob	0.1812	0.3220	0.4769	0.4801	0.2521	0.3433	0.2146	0.1748	0.1059

This table shows F-statistics of model 1-9. Wherein: $S = S_3 - S_1$ *; df1=(N-1)k; df2=N（T-k-1）; prob represents the unilateral probability value of corresponding F value.*

<u>Estimation of Models</u>

We select estimated models considering the existence of individual effects. Considering heteroscedasticity and cross-sectional correlation may exist among individuals, we adopt a cross–sectional SUR (Seemingly Uncorrelated of Regression) estimation method to eliminate the impact of individual micro-conditional disparity of market size, economic scale, dimensions of investment in fixed assets, inflation and change of interest and exchange rate on estimated results. Current innovative activities are closely related with national knowledge stock and can be seen as a continuation of previous creation. Thus, we control innovative performance of the previous term (IP-1) and local knowledge stock(EDU), then join variables that measure various spillover channels through trade and investment, to test their innovative impact. We further use the interaction term of absorptive capacity (EDU) and channel to examine the fits of local absorptive capacity and know-how spilled channel. Relative regressive results are presented in Table 7 and 8, which indicate no self-correlation exists with DW statistics close to 2.

Model 1-4 display, previous creation (IP-1) and indigenous knowledge stock or absorptive capacity (EDU) have a significantly positive effect on innovation performance (IP), implying innovation is a continuous output of the process. Inward capital (FDI) positively but insignificantly influences innovation performance (IP), implying the stated investment activities deficiently stimulate local creation. Different sources of FDI have different spillover effects. FDI value originated from Asian developed economies (FDI-A) and local innovation (IP) correlate significantly and positively, while FDI value originated from European economies and USA (FDI-B) obviously and negatively impact local innovation (IP). This conflicts with the previous hypothesis, indicating inward FDI originated from Japan, South Korea, Taiwan, Hong Kong and Singapore are still the main channels for absorbing exterior knowledge. In 1998-2006, we find total national patent authorities, utility model, design and invention patents account for 49.99%, 41.57% and 8.44% respectively of the Chinese patent distribution. This indicates the importance of imitation in developing countries. EU-15 and USA invest in fields of low technology to acquire natural resources, or in fields of high technology to obtain cost-effective technical sources. The former has a low technical level. The latter has a high technical level but monopolized technology to crow out indigenous creation.

In China, inward FDI originated from European economies and USA are demonstrated by market-driven or technology-sourcing approaches, with aim to capture inland markets and gain low-cost technical resources. They operate in full foreign equity in hi-tech industries with limit technical outflow. Meanwhile the absorb anti-spillover from local entities. Consequently, this type of FDI shows more crowed effect than resource complementary effect on local creative achievements.

To further study the absorptive capacity and spilled know-how through various channels, we examine the interaction term of current absorptive capacity and FDI originated from Asian economies (FDI-A*EDU) . The results sow significant and positively impact of local creative performance (IP). the interaction term of current absorptive capacity. FDI originated from European economies and USA (FDI-B*EDU) are negatively related with innovative performance (IP), which implies inward FDI originated from Asian newly-industrialized economies are still main channels to acquire external knowledge spillover. From the above results we conclude FDI cannot spill over technology by itself. Re-innovation occurs only through learning and R&D activities. Limited by poor absorptive capacity, investors from East Asian newly-industrialized economies are main actual spillover sources. Investors from European economies and the USA are potential spillover sources. Only when know-how and location advantage accumulate to a certain degree, can the equity restriction of foreign entities in hi-tech industries can be broken.

Table 7: Estimated Results of Regressive Models 1-4

	Model 1	Model 2	Model 3	Model 4
Constant	-6.309**	-4.177**	-6.274**	-5.775**
	(-6.790)	(-1.873)	(-5.890)	(-5.621)
IP-1	0.4780**	0.4636**	0.4379**	0.4377**
	(9.629)	(8.444)	(11.490)	(11.485)
EDU	0.4306**	0.3335**	0.4233**	0.4118**
	(8.971)	(6.078)	(8.718)	(8.414)
FDI		0.0238		
		(1.466)		
FDI-A			0.0611**	
			(3.598)	
FDI-B			-0.0412**	
			(-3.211)	
FDI-A*EDU				0.0028**
				(3.553)
FDI-B*EDU				-0.0018**
				(-3.139)
R2	0.9981	0.9985	0.9990	0.9990
Adjusted R2	0.9979	0.9983	0.9988	0.9988
Durbin-Watson stat	2.016	1.876	2.009	2.020

*This table shows the regressive results of mode 1-4. Figures in brackets under estimated parameter is corresponding t value; * shows significant level at 10%; ** shows significant level at 5% (double-tailed inspection).*

Model 5-9 shows imports (IM) significantly and positively correlate with innovation performance (IP). Considering the influence of imports, the relationship between local knowledge stock (EDU) and innovative performance (IP) become insignificant. This finding suggests that local enterprises excessively relay on imports for knowledge spillovers. Imports of parts and components from Asian developed economies (CI-A) and imports of capital goods from America and European developed economies (PI-B) are the most effective commercial channels to absorb external acknowledge and manifest significant and positive correlation with innovative performance (IP). This is consistent with previous analysis that FDI enterprises originated from Asian developed economies focus on parts processing trade and have intense business links with local entities. FDI enterprises originated from European economies and USA mainly introduce advanced technology by general imports of capital goods from parent states and spill over techniques through industrial links, technician turnover, demonstration and imitation. Imports of parts from European economies and USA positively impact creative performance (CI-B), implying this type of import is a potential channel to absorb external know-how.

When taking interaction between absorptive capacity and various commercial channel into account, we find the correlation coefficient of different sources of capital goods imports (PI-A * EDU and PI-B * EDU) become insignificant. This implies that local absorptive capacity matches the technical requirement of imported parts more than that of imported capital goods. Restrained by existing know-how stock, introducing foreign capital goods slavishly might sink into a poverty trap and over-relying on external technology against self-innovation.

Table 8: Estimated Result of Regressive Model 5-9

	Model 5	Model 6	Model 7	Model 8	Model 9
Constant	-10.304**	-8.421**	-2.608*	-17.154**	-3.074*
	(-4.375)	(-3.194)	(-2.154)	(-4.753)	(-2.535)
IP (-1)	0.4489**	0.5086**	0.4665**	0.3807**	0.4334**
	(9.986)	(10.509)	(9.250)	(7.071)	(7.934)
IM	0.5503**				
	(5.6799)				
CI-A		0.3595***			
		(1.966)			
CI-B		0.1511			
		(0.6143)			
CI-A*EDU			0.0175*		
			(2.241)		
CI-B*EDU			0.0059		
			(0.6656)		
PI-A				0.0921	
				(0.6025)	
PI-B				0.7323**	
				(3.339)	
PI-A*EDU					0.0075
					(1.377)
PI-B*EDU					0.0050
					(0.8697)
R2	0.9937	0.9953	0.9943	0.9914	0.9935
Adjusted R2	0.9928	0.9945	0.9934	0.9900	0.9924
Durbin-Watson stat	2.008	1.983	1.977	1.982	1.935

*This table shows regressive results of model 5-9. Figures in brackets under estimated parameter is corresponding t value; * shows significant level at 10%; ** shows significant level at 5%; *** shows significant level at 1% (double-tailed inspection).*

CONCLUDING COMMENTS

This paper uses a cross sectional likelihood non-relative estimation method to test the technology spillover on indigenous innovation activities in the context of Inward FDI and imports of immediate products in sample countries, China, Indonesia, Malaysia, Philippines and Thailand located in the hub of new triangle trade. Evidence shows absorptive capacity crucially determines national innovative performance. To foster potential competitive power, governments should input more R&D capital and promote commercialization of creative results. We find that restrained by existing know-how stock, importing parts is an effective approach to promote national innovation. Local absorption ability matches spilled technique desires through parts import. By expanding imports more innovation is expected. But at present primary parts are imported from East Asian economies rather than Europe and the USA. China should expand imports of parts from Europe and the USA, in order to reduce trade surplus, absorb technology spillover from various sources and alleviate trade friction. We also find that low industrial association crucially restricts FDI spillovers in hi-tech fields. Foreign enterprises supported by East Asian economies focus on labor-intensive products. The technical level is low, but because of the existence of vertical industry associations, these economies still pass forward or backward spillovers to domestic enterprises. In the hi-tech sector, FDI with sole proprietorship and technology monopoly shows less industrial links with local entities. To breakthrough equity restriction and strengthen industrial associations, the state should focus on construction of innovative supply chain clusters, perfect assorted service systems, implement quality supervision or technical support and help more enterprises involve global supply networks. Finally, we find existing technical capacity doesn't match the technical requirements of importable capital goods. The government should enhance research and development in the machinery and equipment industry to accumulate acknowledge.

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