

China's International Competitiveness: Evidence from Bilateral Trade Patterns

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Abstract

China has drastically increased its international trade flows in the last decade and now it is a major trade partner for OECD countries. The phenomenal export performance of China raises worldwide issues – ‘How competitive is China?’ and ‘Why is China so competitive?’ For instance, the US trade deficit has become a political issue. In this paper, we analyze China’s absolute advantage, its comparative advantage, and its geographical barriers, using a bilateral international trade matrix ($N \times N$ data) in manufactures for China and major Asian and OECD countries in 1999–2003. We estimate the Ricardian theory based on the gravity model modified from Eaton and Kortum [2002]. The model captures the competing forces of comparative advantage that promote trade, and both artificial and natural geographic barriers that inhibit trade. The model has simple expressions relating bilateral trade volumes to technologies and geographical barriers.

Our finding suggests that China is as competitive as Germany, following Japan and the United States, among our 18 sample countries. The analysis of the source of the competitiveness implies that lower wages, higher R&D expenditures and human capital (higher per capita GDP) are significant, but the impact of lower wages on competitiveness declined over the sample period. Thus, it suggests that China’s low wages contribute to its competitiveness, but a recent wage rise, which may have been caused by the appreciation of the RMB, will not substantially change China’s advantage. Inward foreign direct investment may play an important role in China’s competitiveness through the inflows of technology and management skills. In addition, we explain why China is more competitive than India.

Keywords: Bilateral trade, gravity model, China’s competitiveness, foreign direct investment, wages, technology

JEL Classification: F11, F13, O24, O33

1. Introduction

In the past three decades, China has drastically increased its international trade flows, to the extent that it is now one of the major trade partners for OECD countries. In Asia, the most important manufacturing center in the world, in 2006, China–Japan trade volume exceeded US–Japan trade volume and China became the largest trade partner for Japan. The phenomenal export performance of China raises worldwide issues – ‘How competitive is China?’ and ‘Why is China so competitive?’ For instance, the US trade deficit has become a political issue. In addition, EU countries are now devising policies to protect domestic shoe manufacturers against imports from China. On the other hand, Chinese manufacturing industries have played a key role in the economic growth of China. China provides a new model for developing countries. Furthermore, in recent economic development literature, the comparative economic analysis between China and India has become a hot topic.

How competitive is China? The answer depends on the cost of producing a unit of a manufacturing good as well as the cost of delivering a unit of the good in China and its trade partners. Wages represent a key cost in manufacturing industries. Regardless of rapid economic growth in the past three decades, Chinese wages are still extremely low in comparison with OECD countries, as well as in comparison with most East Asian countries (Adams, Ganges and Shachmurove [2006]). The low wages may reflect the access to technology of China, because countries are working with different technologies. Meanwhile, the openness of China’s economy to foreign direct investment has dramatically improved the efficiency of China’s manufacturing technology. China has been the dominant destination for foreign direct investment in East Asia. Foreign direct investment often combines cheap labor costs and foreign technologies and makes a key contribution to China’s competitiveness. In sum, foreign direct investment is an important factor, not only for capital flows, but also for flows of technology and management skills (Adams *et al.* [2006]). Moreover, foreign invested firms play a great role in interindustry spillovers to China’s manufacturing sector (Wei and Liu [2006]). Also, the openness to foreign direct investment has made a critical difference in the economic growth between China and India in the past decade.

Quite a few previous papers have discussed a variety of measures and linked them with

China's competitiveness. Most of them have documented China's export performance, attributing it to foreign direct investment and low wages. In this paper, we explore China's absolute advantage, its comparative advantage, and its geographical barriers, using a bilateral international trade matrix ($N \times N$ data) for China and major Asian and OECD countries in 1999–2003. Here, comparative advantage and competitiveness are interchangeable terms. We estimate the Ricardian model developed in Eaton and Kortum [2002]. The model captures the competing forces of comparative advantage that promote trade, and both artificial and natural geographic barriers that inhibit trade. The model has simple expressions relating bilateral trade volumes to technologies and geographical barriers. Based on Eaton and Kortum [2002], we estimate the parameters needed to examine the absolute advantage and the comparative advantage of China and its trade partners.

Our parameter estimates allow us to explore a number of issues. First, we provide an answer to the question 'How competitive is China?' Also, we explain 'Why is China competitive?' in comparison with India, the second most populous country in the world. Finally, we analyze the consequences of a wage rise in China, which may be caused by appreciation of the RMB. The rest of the paper proceeds as follows. Section 2 describes our empirical model and the dataset. Section 3 explore the issues listed above, using the parameter estimates. Section 4 concludes.

2. The Model and the Data Set

2.1 The Ricardian Theory-based Gravity Model

Our empirical model is the Ricardian theory-based gravity model, which is modified from Eaton and Kortum [2002].¹ With constant returns to scale, the cost of production in country i in good j is $c_i/z_i(j)$, where c_i consists of the cost of labor and of intermediate inputs, and $z_i(j)$ is the realization of technology in good j . Technology has a Fréchet distribution, $F_i(z) = \Pr[Z_i \leq z] = \exp(-T_i z^{-\theta})$, with two parameters. The first parameter is $T_i > 0$, where higher T_i means a higher average realization for country i , so T_i reflects country i 's absolute advantage. The second parameter is $\theta > 1$, where larger θ implies lower technology differences across countries. Taking

¹ To describe our model as simply as possible, we introduce only the essence of the complete model by Eaton and Kortum [2002].

geographic barriers, d_{ni} , into account, the cost of exporting good j produced in country i to country n is the price of good j from country i under perfect competition:

$$p_{ni}(j) = \left(\frac{c_i}{z_i(j)} \right) d_{ni}$$

We assume that geographic barriers consist of both natural and artificial barriers, the distance, $dist_{ni}$, sharing border, b_{ni} , and belonging to FTA, fta_{ni} . Countries buy the good j from the cheapest source, so the distribution of prices is $G_{ni}(p) = \Pr[P_{ni} \leq p] = 1 - F_i(z) = 1 - F_i(c_i d_{ni}/p)$. Therefore, trade shares are expressed as the probability that country i provides a good at the lowest price in country n :

$$\frac{X_{ni}}{X_n} = \int_0^\infty \prod_{s \neq i} [1 - G_{ns}(p)] dG_{ni}(p) = \frac{T_i (c_i d_{ni})^{-\theta}}{\sum_{i=1}^N T_i (c_i d_{ni})^{-\theta}}$$

where X_{ni} is the amount of the manufacturing imports from i to n ; and X_n is country n 's total spending. We assume that production in country i combines labor and intermediate inputs, with labor share β , wage w_i , and overall price index as index of intermediate goods price, $c_i = w_i^\beta p_i^{1-\beta}$.

We can express trade shares as functions of wages, w_i , geographic barriers, d_{ni} , and technology parameters, T_i . Normalizing by the importer n 's home sales, X_{nn} , gives:

$$\frac{X_{ni}/X_n}{X_{nn}/X_n} = \frac{X_{ni}}{X_{nn}} = \frac{T_i}{T_n} \left(\frac{w_i}{w_n} \right)^{-\theta\beta} \left(\frac{p_i}{p_n} \right)^{-\theta(1-\beta)} d_{ni}^{-\theta}$$

Applying an equation of X_{ni}/X_n to home sales, X_{ii}/X_i , X_{nn}/X_n , we obtain:

$$\frac{p_i}{p_n} = \frac{w_i}{w_n} \left(\frac{T_i}{T_n} \cdot \frac{X_i/X_{ii}}{X_n/X_{nn}} \right)^{-1/\theta\beta}$$

Plugging this relative price of intermediates into previous equation and taking logarithms, we obtain the empirical equation, i.e.:

$$(1) \quad \ln \frac{X'_{ni}}{X'_{nn}} = S_i - S_n - \theta \ln dist_{ni} - \theta b - \theta fta_{ni} + \delta_{ni}$$

where $\ln X'_{ni} = \ln X_{ni} - \frac{1-\beta}{\beta} \ln \left(\frac{X_i}{X_{ii}} \right)$. Source countries' competitiveness is defined as

$S_i = \frac{1}{\beta} \ln T_i - \theta \ln w_i$; and the geographic barrier is defined as $\ln d_{ni} = \ln dist_{ni} - b_{ni} - fta_{ni}$

X_{ni} is manufacturing imports from i to n and X_{ii} is gross manufacturing production less manufacturing exports. X_n is country n 's total spending, which comprises home purchases plus imports from everywhere else. β is a constant labor share, setting $\beta = 0.21$. S_i is the coefficient on source country dummies; $dist_{ni}$ is the distance between country n and i ; b_{ni} is the dummy variable of the effect on n and i on sharing a border; fta_{ni} is the dummy variable of the effect of n and i both belonging to FTA; and δ is the error. Then we estimate the source of competitiveness, S_i :

$$(2) \quad S_i = \alpha_0 + \alpha_R \ln R_i - \alpha_H \left(\frac{1}{H_i}\right) - \theta \ln w_i + \tau_i$$

We use our estimates of S_i from equation (1), and R_i is country i 's R&D expenditure, H_i is the human capital, and τ is the error.

2.2 Sample Countries and Data

We estimate China's competitiveness in comparison with OECD countries, East Asian countries, and South Asian countries including India. Thus, 18 our sample countries are: China; the main OECD countries, namely, Australia, Canada, France, Germany, Italy, UK, US, and Japan; South Korea; ASEAN5, namely, Indonesia, Malaysia, the Philippines, Singapore and Thailand; and the South Asian countries, India, Sri Lanka, and Pakistan. The sample period is from 1999 to 2003. Thus the number of observations in equation (1) is 1530 ($= 18 \times 17 \times 5$), and the number of observations in equation (2) is 90 ($= 18 \times 5$).

Our dependent variable in equation (1) is a transformation of bilateral manufacturing trades, from country i to country n . We use 4-digit SITC bilateral trade data from the World Trade Analyzer by Statistics Canada. X_{ni} is bilateral manufacturing trade from country i to country n ; we aggregate SITC 5–8. X_n (X_i) is importer's (exporter's) total spending; we add importer's (exporter's)

manufacturing production and importer's (exporter's) imports from the world. Manufacturing production data are value added in US\$ from World Development Indicators (WDI) Online from the World Bank. X_{nn} (X_{ij}) is importer's (exporter's) home sales; we subtract importer's (exporter's) manufacturing export from importer's (exporter's) manufacturing production. β is a constant labor share, setting $\beta = 0.21$.²

The first explanatory variables in equation (1), distance between country's capital, is from World Atlas by Microsoft. FTA³ includes the European Union (EU), North American Free Trade Agreement (NAFTA), ASEAN Free Trade Area, and South Asian Preferential Trading Arrangement (SAPTA) in all sample periods. In addition, FTA started for Japan and Singapore from 2002, Australia and Singapore from 2003, and China and ASEAN from 2003.

Explanatory variables in equation (2) are as follows: wage in manufacturing (hourly wage, US\$) is from the US Bureau of Labor Statistics (BLS)⁴ and LABORSTA Internet by International Labor Organization (ILO),⁵ R&D expenditure (US\$) is from World Development Indicators (WDI) Online by the World Bank.⁶ We use per capita GDP (PPP, international \$) from WDI Online as an indicator of Human Capital.⁷ Table 1 presents the five-year (1999–2003) average of the explanatory variables in equation (2).

3. Estimating the Competitiveness and its Source

We estimate equation (1) by feasible GLS, taking account of heteroscedasticity across the panel data, as well as assuming the random effect and the fixed effect, which is referred to as robust

² Setting $\beta = 0.21$ is the same assumption as Eaton and Kortum [2002].

³ From the list on the WTO (World Trade Organization) homepage.

⁴ We use BLS if it is available: Australia, Canada, France, Germany, Italy, Japan, Korea, Singapore, Sri Lanka, UK, and US.

⁵ We transform daily (8 hours), weekly (50 hours), and monthly (200 hours) wages into an hourly wage.

⁶ There are missing values in Australia (1999, 2001, 2003), India (2001–2003), Indonesia (1999, 2002, 2003), Malaysia (1999, 2001, 2003), the Philippines (1999–2001, 2003), and Sri Lanka (1999, 2001–2003). We have substituted the data of the closest available year in these cases.

⁷ We tried to use average years of schooling or secondary school enrollment, however, there are no data available for some countries.

OLS⁸, with a time dummy. We also perform year-to-year regression by robust OLS. Tables 2 and 3 report the estimation results in equation (1), and Table 4 is the ranking of competitiveness, which is also referred to as comparative advantage, from the estimates of S_i . The estimates of S_i indicate that China was the fourth most competitive country in 2003, closely following Germany. In 2002, China was ranked the third most competitive country, closely followed by Germany. In other words, China and Germany were similarly competitive. The United States was the most competitive country in 2003, followed by Japan. In 1990, Japan was the most competitive country (Eaton and Kortum [2002]). This suggests the revival of manufacturing industries in the United States after the competitive losses to Japan of the 1980s. South Korea was more competitive in 1999 but lost to China in the years from 2000 to 2003. India, the second most populous developing country, is much less competitive than China. Sri Lanka and Pakistan are the least competitive countries. Distance substantially inhibits trade. FTA enhances international trade, while borders do not have a significant effect.⁹

Then we estimate equation 2, using estimated competitiveness, \hat{S}_i , from equation (1). The estimation results are shown in Table 5 and Table 6. A country's competitiveness increases with higher R&D expenditures, higher level of human capital, and cheaper labor costs. Obviously, low wages in China contribute to its international competitiveness. In 1999, China's wages were below those in Sri Lanka and the Philippines. Since 1999, China's wages have been rapidly increasing, such that Sri Lanka and the Philippines had lower wages than China in 2003 (Figure 1). Moreover, Adams *et al.* [2006] pointed out that in coastal areas – such as Shanghai, Jiansu and Guandong provinces – wages (in \$US) are much higher than the national average. From the year-by-year regression results, interestingly, the impact of wages on competitiveness has declined from 1999 to 2003. This may imply that China's low wages plays a less important role than they used to do. From the regression results in 2003, China would be as competitive as South Korea even if the wage level

⁸ Robust OLS assumes the White's heteroscedasticity consistent covariance matrix for OLS.

⁹ The correlation coefficients between the explanatory variables are: $\text{Corr}(\text{dist}_{ni}, b_{ni}) = -0.64$, $\text{Corr}(\text{dist}_{ni}, \text{fta}_{ni}) = -0.71$, $\text{Corr}(b_{ni}, \text{fta}_{ni}) = 0.59$. Thus, there are no serious multicollinearity problems here.

rose. This may be caused by appreciation of the RMB, by 60 percent.¹⁰

Does this wage rise weaken China's competitiveness? A country's wage may increase with level of technology. If the wage rise is attributable to technology improvement, it does not hurt China's competitiveness. We calculate the state of technology parameter, $T_i = (e^{\hat{\delta}_i} w_i^\theta)^\beta$ which is also referred to as the absolute advantage of country i , using data on wage and the estimates of the parameter on wage, θ .¹¹ Table 7 reports the rankings of state of technology. China's ranking is number 12, which is far behind the OECD countries and Singapore, and is closely following Malaysia. However, China steadily improved its state of technology over the sample period. In 2002–2003, China's state of technology was ahead of Malaysia and followed Canada and Australia closely. Meanwhile, India and other South Asian countries, Pakistan and Sri Lanka, remained at the lowest level with regard to the state of technology.

We consider that there are two factors that contribute to technology improvement in China. The first factor, as considered in our model, is the improvement of R&D and human capital. R&D expenditures have been rapidly increasing, as well as per capita GDP in PPP. As shown in Figure 2, China's R&D doubled from 1999 to 2003, while per capita GDP increased by 50 percent. The other factor, we did not take into account in our model, is foreign direct investment.¹² As suggested above, inflows of technology through foreign direct investment and spillovers from foreign invested firms to China's manufacturing sector play a key role in the advance of technology. Thus, the wage rise caused by technology improvement does not weaken China's competitiveness.¹³

In viewing China's competitiveness, it is important to understand that technology is mobile. Unlike financial investment, foreign direct investment comprises not only capital flows but also inflows of technology and management skills. As shown in Figure 3, China has been absorbing

¹⁰ From the regression in 2003, $S_i(\text{China}) = -1.022$, $S_i(\text{Korea}) = -1.426$, and $dS_i/d\ln w_i = -0.848$.

¹¹ We use the average of 1999–2003 and estimates of the Panel GLS result, as well as annual wage data and year-to-year regression results.

¹² Tamura and Xu [2006] estimated China's bilateral foreign direct investment regression and trade, using the same method as Eaton and Tamura [1994], and found that foreign direct investment into China does promote trade.

¹³ It is worthy to note that a wage rise has the same economic effects as appreciation of RMB. An appreciation of RMB caused by technology improvement in China does not hurt China's competitiveness.

foreign investment as well as foreign technology, because of its ‘open door’ policy. The sharp increase of registered capital of foreign invested enterprises suggests that foreign firms seek entry to China with the intention of eventually penetrating China’s local markets for sales in the future. However, they begin by setting up subsidiaries or joint ventures in China to produce products for export to their home country, using the cheap Chinese labor force (Adams *et al.* [2006]). Direct foreign invested firms play a great role in expansion of exports. As Figure 4 indicates, foreign invested firms’ share in exports has been more than 40 percent since the late 1990s. Certainly, this contributes to trade imbalances with the United States and the EU. Meanwhile, foreign invested firms import about 20 percent of total imports in China.

Indirectly, spillovers from foreign invested firms to China’s manufacturing sector strengthen China’s competitiveness in the locally owned sector. The openness to foreign direct investment implies that China is a recipient of foreign technology. Recently, Wei and Liu [2006] assessed productivity spillovers from R&D, exports, and the very presence of foreign direct investment in China’s manufacturing sector, based on a panel of indigenous and foreign-invested firms for 1998–2001. There are positive interindustry productivity spillovers from R&D and exports, and positive intra- and interindustry productivity spillovers from foreign presence to indigenous Chinese firms within regions. Furthermore, OECD-invested firms seem to play a much greater role in interindustry spillovers than overseas Chinese firms from Hong Kong, Macao, and Taiwan do within their respective regions.

As suggested above, foreign direct investment has been a major factor in improving China’s technology. It is remarkable that the effect of foreign direct investment on technology improvement is so much more pronounced, compared with India.

The following is the regression of S_i on an R&D, wage, and PPP basis per capita GDP for 2003.

$$S_i = 26.576 + 0.501\ln(R\&D) + 1.503\ln(GDP\ per\ capita,\ PPP) - 0.848\ln(wage)$$

s.e. (5.993) (0.126) (0.568) (0.403) $R^2 = 0.785$

Based on the above estimation results of equation (2) for 2003, we predict the competitiveness of each country. Table 8 reports these rankings of predicted competitiveness, as well as the estimated competitiveness of equation (1). Surprisingly, the ranking based on predicted competitiveness is quite different from that based on estimated competitiveness. Table 8 suggests that India is more competitive than Italy, South Korea, Singapore, Thailand and Malaysia based on predicted competitiveness, whereas Table 8 shows India is less competitive than the above countries, based on estimated competitiveness. Perhaps the effect of wages on competitiveness is overestimated in equation (2). This results in a greater competitiveness in the prediction for India as well as for Pakistan and Sri Lanka. In comparison, the competitiveness for China is underestimated. This raises an important issue – ‘What is responsible for this difference?’ This is attributable to foreign direct investment. The openness to foreign direct investment has made a significant difference between China and India. Similarly, foreign direct investment also contributes to estimated competitiveness for Thailand, Malaysia, Indonesia, and the Philippines. The openness to foreign direct investment implies openness to foreign technology. Finally, wages may converge across countries with capital flows and technology flows. From this viewpoint, China may provide a new economic growth model for developing countries.

4. Conclusion

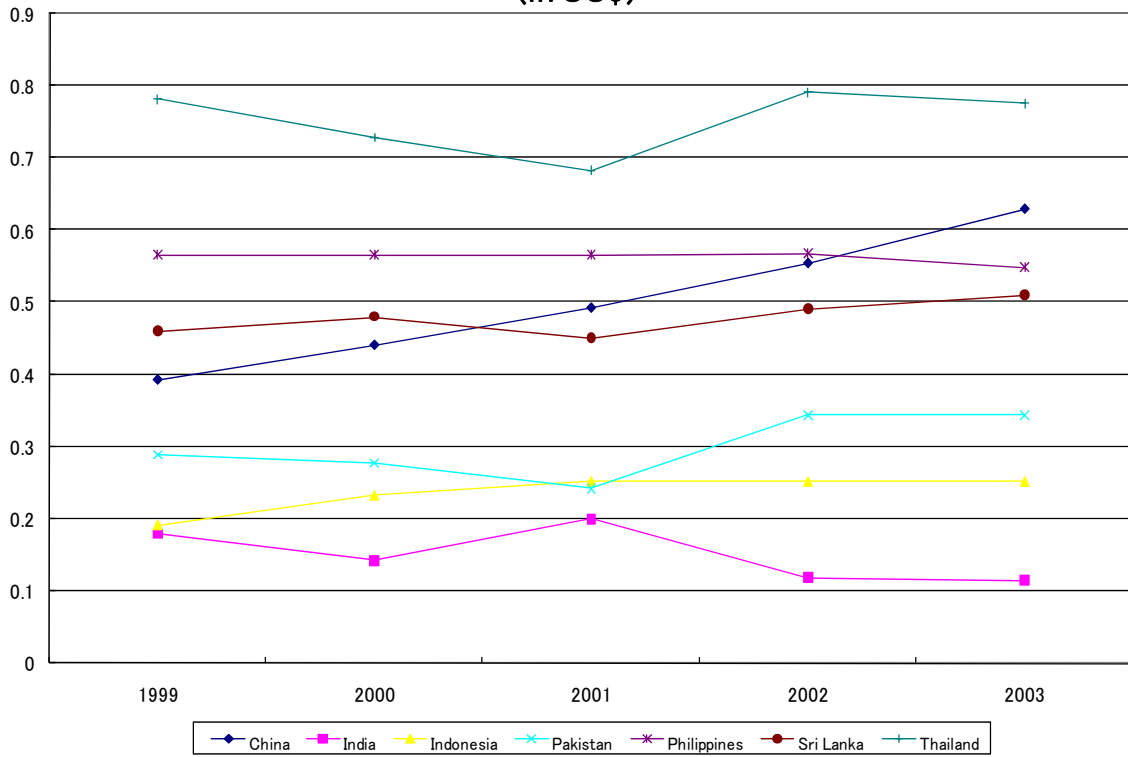
In this paper, we explore China’s absolute advantage, its comparative advantage, and its geographical barriers, using bilateral international trade matrix ($N \times N$ data) for China and major Asian and OECD countries in 1999–2003. Our findings suggest that China is as competitive as Germany, following Japan and the United States. In addition, China’s low wages contributes to its competitiveness. However, the impact of wage levels on China’s competitiveness has declined. Therefore, a wage rise, which may be caused by appreciation of the RMB, will not substantially change China’s comparative advantage. Recently, China’s wages have been increasing with its technology improvement. Rapid expansion in R&D is an important factor that contributes to technology improvement in China. Also, in relation to China’s competitiveness, it is important to understand that technology is as mobile as capital flows. Foreign direct investment includes not

only capital flows but also inflows of technology and management skills. Direct foreign invested firms play a great role in expansion of export. Indirectly, spillovers from foreign invested firms to China's manufacturing sector strengthen China's competitiveness in the locally owned sector. The openness to foreign direct investment implies openness to foreign technology. Finally, wages may converge across countries with capital flows and technology flows. China may provide a new economic growth model for developing countries.

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**Figure 1 : Low Wage Countries' Hourly Wage in Manufacturing
(in US\$)**



**Figure 2 : China's R&D expenditure and GDP per capita
(in PPP)**

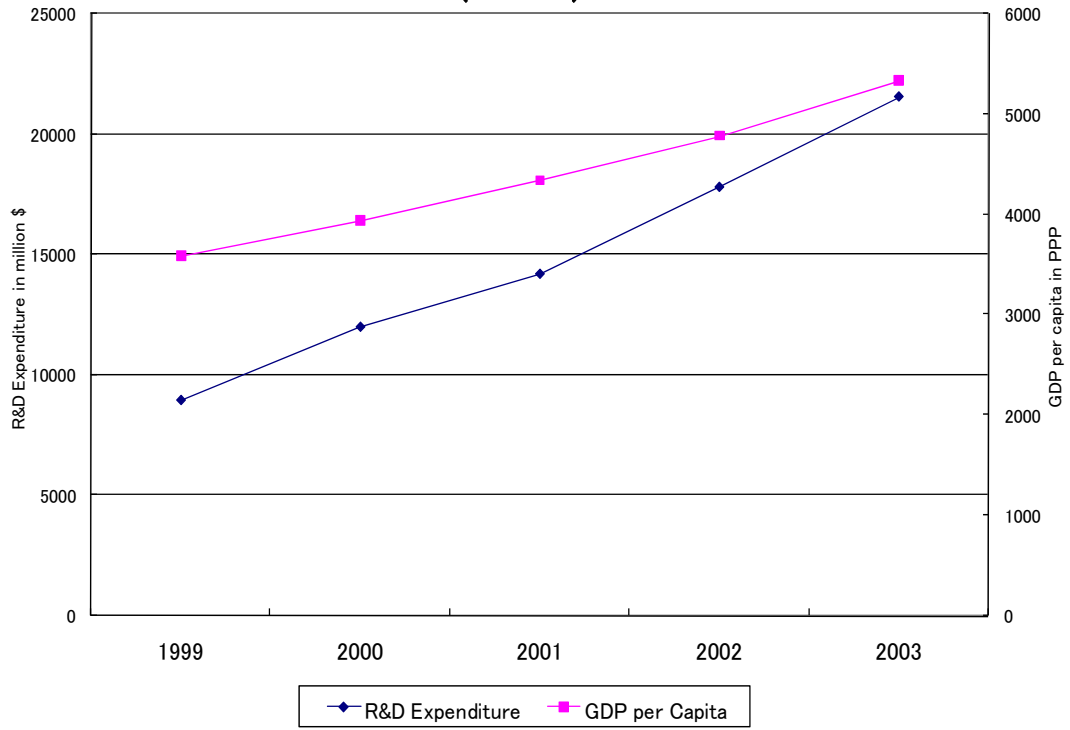


Figure 3

Foreign Direct Investment and Registered Capital of Foreign Invested Enterprises

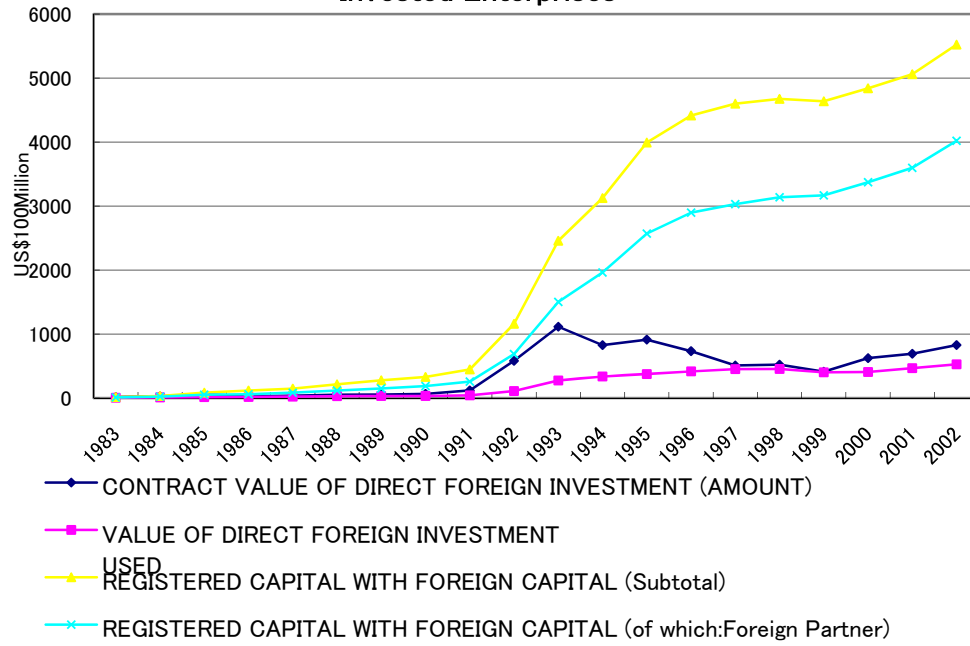


Figure 4



Table 1

Explanatory Variables in EQ 2: Average 1999–2003

	R&D expenditure(US\$)	Wage(per hour, US\$)	GDP per capita(PPP)
Australia	6622606048	15.762	26901.048
Canada	14549012928	17.012	28325.102
China	14897340474	0.502	4394.430
France	32688496446	17.276	26595.228
Germany	52120176260	24.714	25886.726
India	3813523593	0.151	2515.181
Indonesia	101639628	0.236	3051.276
Italy	13591292490	15.172	25917.778
Japan	129717377623	20.116	26617.852
Korea, Rep.	12935318971	8.354	17130.616
Malaysia	527142100	1.939	8697.374
Pakistan	121244642	0.300	1923.515
Philippines	85268477	0.563	4152.076
Singapore	1816252210	7.000	23402.660
Sri Lanka	23504958	0.478	3598.130
Thailand	322016818	0.752	6662.314
United Kingdom	29047112671	18.142	27844.060
United States	271880045525	20.520	35322.682

Table 2

Estimation Results: Equation 1

Dependent Variables: Transformations of Bilateral Manufacturing Trade [ln(X'ni/X'nn)]
 Number of Observations = 1530

	OLS(robust)		Random Effect		Panel GLS	
	est.	s.e.	est.	s.e.	est.	s.e.
Source Country=Exporter Si						
Australia	-3.068	0.095	-3.068	0.097	-3.064	0.096
Canada	-3.252	0.084	-3.252	0.097	-3.250	0.096
China	-1.295	0.076	-1.294	0.101	-1.283	0.099
France	-1.965	0.073	-1.965	0.098	-1.967	0.097
Germany	-1.131	0.071	-1.131	0.099	-1.130	0.097
India	-3.201	0.093	-3.200	0.100	-3.195	0.098
Indonesia	-3.013	0.077	-3.013	0.098	-3.009	0.097
Italy	-2.052	0.071	-2.052	0.098	-2.051	0.097
Japan	-0.401	0.080	-0.400	0.100	-0.404	0.098
Korea Rp	-1.535	0.085	-1.535	0.101	-1.537	0.100
Malaysia	-2.533	0.073	-2.533	0.099	-2.533	0.098
Pakistan	-5.118	0.133	-5.118	0.100	-5.117	0.098
Philippines	-3.726	0.107	-3.726	0.099	-3.727	0.098
Singapore	-2.068	0.105	-2.068	0.100	-2.067	0.098
Sri Lanka	-6.228	0.148	-6.228	0.099	-6.222	0.098
Thailand	-2.719	0.070	-2.718	0.100	-2.716	0.098
UK	-1.666	0.078	-1.666	0.099	-1.666	0.097
Deatination Country=Importer Sn						
Australia	0.567	0.077	0.567	0.097	0.569	0.096
Canada	-0.307	0.087	-0.307	0.097	-0.308	0.096
China	-1.211	0.110	-1.210	0.101	-1.204	0.099
France	-0.543	0.092	-0.543	0.098	-0.542	0.097
Germany	-0.705	0.091	-0.705	0.099	-0.704	0.097
India	-1.166	0.128	-1.166	0.100	-1.164	0.098
Indonesia	-1.219	0.111	-1.219	0.098	-1.219	0.097
Italy	-1.117	0.103	-1.117	0.098	-1.115	0.097
Japan	-1.325	0.091	-1.325	0.100	-1.323	0.098
Korea Rp	-0.344	0.088	-0.343	0.101	-0.342	0.100
Malaysia	0.458	0.104	0.459	0.099	0.456	0.098
Pakistan	-0.739	0.104	-0.739	0.100	-0.745	0.098
Philippines	-0.082	0.098	-0.082	0.099	-0.089	0.098
Singapore	1.272	0.090	1.273	0.100	1.270	0.098
Sri Lanka	0.566	0.123	0.566	0.099	0.562	0.098
Thailand	-0.162	0.092	-0.162	0.100	-0.158	0.099
UK	-0.054	0.104	-0.054	0.099	-0.053	0.097
Distance(ln(distni))	-0.537	0.039	-0.536	0.037	-0.537	0.036
Shaired border(bni)	-0.034	0.081	-0.034	0.073	-0.036	0.072
FTA(ehni)	0.612	0.088	0.615	0.078	0.618	0.076
Time Dummy 99	-0.125	0.054				
Time Dummy 00	-0.014	0.052				
Time Dummy 01	-0.006	0.050				
Time Dummy 02	-0.017	0.051				
Const	-3.759	0.383	-3.799	0.373	-3.792	0.367
AdjustedR2	0.886		0.8855			
LOG Likelihood					-1452.5	

Table 3

Estimation Results: Equation 1, Year by Year (1999–2003)

Dependent Variables: Transformations of Bilateral Manufacturing Trade [$\ln(X'_{ni}/X'_{nn})$]
 Number of Observations = 306

	OLS(robust): 1999		OLS(robust): 2000		OLS(robust): 2001		OLS(robust): 2002		OLS(robust): 2003	
	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
Exporter										
Si										
Australia	-3.103	0.243	-3.167	0.226	-3.027	0.208	-2.977	0.207	-3.080	0.214
Canada	-3.342	0.206	-3.322	0.202	-3.290	0.189	-3.218	0.188	-3.140	0.186
China	-1.623	0.184	-1.442	0.172	-1.308	0.156	-1.055	0.165	-1.022	0.175
France	-1.926	0.184	-1.962	0.177	-2.004	0.149	-2.007	0.161	-1.954	0.162
Germany	-1.170	0.178	-1.254	0.158	-1.141	0.151	-1.109	0.161	-0.992	0.161
India	-3.425	0.222	-3.326	0.220	-3.259	0.207	-3.084	0.213	-2.922	0.209
Indonesia	-3.094	0.195	-2.957	0.169	-2.967	0.164	-3.005	0.183	-3.060	0.181
Italy	-2.106	0.185	-2.178	0.163	-2.065	0.153	-2.004	0.161	-1.948	0.157
Japan	-0.345	0.186	-0.335	0.187	-0.463	0.175	-0.476	0.186	-0.395	0.185
Korea Rp	-1.542	0.219	-1.516	0.196	-1.659	0.187	-1.564	0.191	-1.426	0.193
Malaysia	-2.556	0.176	-2.513	0.167	-2.572	0.159	-2.519	0.172	-2.519	0.160
Pakistan	-5.223	0.334	-5.117	0.270	-5.139	0.299	-5.178	0.336	-4.950	0.309
Philippines	-3.726	0.256	-3.762	0.248	-3.794	0.240	-3.660	0.247	-3.705	0.247
Singapore	-2.083	0.272	-2.124	0.283	-2.045	0.210	-2.076	0.227	-2.025	0.226
Sri Lanka	-6.385	0.367	-6.194	0.321	-6.205	0.322	-6.155	0.330	-6.218	0.369
Thailand	-2.838	0.174	-2.758	0.157	-2.766	0.151	-2.657	0.161	-2.591	0.167
UK	-1.677	0.198	-1.730	0.185	-1.659	0.171	-1.697	0.181	-1.610	0.171
Importer										
Sn										
Australia	0.552	0.194	0.636	0.180	0.607	0.179	0.576	0.168	0.489	0.175
Canada	-0.268	0.225	-0.311	0.206	-0.291	0.202	-0.284	0.193	-0.328	0.192
China	-1.346	0.285	-1.210	0.236	-1.212	0.254	-1.061	0.241	-1.193	0.278
France	-0.550	0.241	-0.432	0.216	-0.500	0.213	-0.553	0.202	-0.652	0.206
Germany	-0.704	0.230	-0.627	0.209	-0.660	0.211	-0.745	0.206	-0.780	0.210
India	-1.282	0.327	-1.278	0.273	-1.195	0.275	-1.126	0.309	-0.921	0.291
Indonesia	-1.127	0.295	-1.102	0.300	-1.128	0.234	-1.322	0.221	-1.393	0.230
Italy	-1.167	0.251	-1.014	0.227	-1.057	0.236	-1.173	0.240	-1.137	0.249
Japan	-1.327	0.218	-1.349	0.211	-1.274	0.212	-1.324	0.209	-1.324	0.220
Korea Rp	-0.332	0.223	-0.354	0.211	-0.296	0.205	-0.303	0.197	-0.379	0.203
Malaysia	0.555	0.252	0.453	0.256	0.472	0.239	0.418	0.230	0.420	0.232
Pakistan	-0.705	0.270	-0.881	0.250	-0.886	0.240	-0.723	0.227	-0.474	0.210
Philippines	-0.006	0.257	-0.021	0.222	-0.201	0.218	-0.179	0.231	0.016	0.215
Singapore	1.407	0.227	1.227	0.213	1.336	0.206	1.196	0.199	1.221	0.197
Sri Lanka	0.612	0.293	0.739	0.293	0.492	0.282	0.452	0.283	0.557	0.284
Thailand	-0.179	0.237	-0.115	0.215	-0.060	0.205	-0.199	0.197	-0.234	0.215
UK	-0.076	0.257	-0.050	0.240	-0.026	0.243	-0.063	0.237	-0.009	0.242
Distance(ln(distni))	-0.522	0.092	-0.505	0.093	-0.567	0.088	-0.545	0.086	-0.533	0.095
Shared border(bni)	-0.100	0.208	-0.124	0.193	-0.100	0.176	-0.036	0.174	0.167	0.183
FTA(ehni)	0.590	0.244	0.692	0.226	0.587	0.223	0.678	0.210	0.571	0.185
Const	-3.943	0.919	-4.036	0.920	-3.484	0.869	-3.731	0.844	-3.884	0.924
AdjustedR2	0.879		0.8882		0.8985		0.892		0.8914	

Table 4**Competitiveness Ranking: EXP(Si): US=1****Panel GLS**

Country	exp(Si)
US	1.000
Japan	0.668
Germany	0.323
China	0.277
Korea Rp	0.215
UK	0.189
France	0.140
Italy	0.129
Singapore	0.127
Malaysia	0.079
Thailand	0.066
Indonesia	0.049
Australia	0.047
India	0.041
Canada	0.039
Philippines	0.024
Pakistan	0.006
Sri Lanka	0.002

1999	
Country	exp(Si)
US	1.000
Japan	0.708
Germany	0.310
Korea Rp	0.214
China	0.197
UK	0.187
France	0.146
Singapore	0.125
Italy	0.122
Malaysia	0.078
Thailand	0.059
Indonesia	0.045
Australia	0.045
Canada	0.035
India	0.033
Philippines	0.024
Pakistan	0.005
Sri Lanka	0.002

2000	
Country	exp(Si)
US	1.000
Japan	0.716
Germany	0.285
China	0.237
Korea Rp	0.220
UK	0.177
France	0.141
Singapore	0.120
Italy	0.113
Malaysia	0.081
Thailand	0.063
Indonesia	0.052
Australia	0.042
Canada	0.036
India	0.036
Philippines	0.023
Pakistan	0.006
Sri Lanka	0.002

2001	
Country	exp(Si)
US	1.000
Japan	0.629
Germany	0.320
China	0.270
UK	0.190
Korea Rp	0.190
France	0.135
Singapore	0.129
Italy	0.127
Malaysia	0.076
Thailand	0.063
Indonesia	0.051
Australia	0.048
India	0.038
Canada	0.037
Philippines	0.023
Pakistan	0.006
Sri Lanka	0.002

2002	
Country	exp(Si)
US	1.000
Japan	0.621
China	0.348
Germany	0.330
Korea Rp	0.209
UK	0.183
Italy	0.135
France	0.134
Singapore	0.125
Malaysia	0.081
Thailand	0.070
Australia	0.051
Indonesia	0.050
India	0.046
Canada	0.040
Philippines	0.026
Pakistan	0.006
Sri Lanka	0.002

2003	
Country	exp(Si)
US	1.000
Japan	0.674
Germany	0.371
China	0.360
Korea Rp	0.240
UK	0.200
Italy	0.143
France	0.142
Singapore	0.132
Malaysia	0.081
Thailand	0.075
India	0.054
Indonesia	0.047
Australia	0.046
Canada	0.043
Philippines	0.025
Pakistan	0.007
Sri Lanka	0.002

Table 5
Estimation Results: Equation 2

Dependent Variables: Estimated Competitiveness [Si]
 Number of Observations = 90

	OLS(robust)		Random Effect	
	est.	s.e.	est.	s.e.
R&D Expenditure (ln(Ri))	0.494	0.054	0.495	0.047
Per capita GDP (ln(H))	1.684	0.316	1.553	0.414
Wage (ln(wi))	-0.960	0.215	-0.892	0.224
Time dummy 1999	0.312	0.242		
Time dummy 2000	0.175	0.248		
Time dummy 2001	0.114	0.253		
Time dummy 2002	0.044	0.255		
Const	-28.073	3.154	-26.824	3.588
AdjustedR2	0.771		0.766	
LOG Likelihood				

Table 6
Estimation Results: Equation 2, Year by Year (1999–2003)

Dependent Variables: Estimated Competitiveness [Si]
 Number of Observations = 18

	OLS(robust): 1999		OLS(robust): 2000		OLS(robust): 2001		OLS(robust): 2002		OLS(robust): 2003	
	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
R&D Expenditure (ln(Ri))	0.507	0.130	0.490	0.132	0.505	0.125	0.482	0.133	0.501	0.126
Per capita GDP (ln(H))	2.026	0.636	1.628	0.730	2.173	0.796	1.601	0.712	1.503	0.568
Wage (ln(wi))	-1.147	0.389	-0.932	0.500	-1.268	0.509	-0.911	0.497	-0.848	0.403
Const	-31.065	5.845	-27.355	7.211	-32.435	7.677	-27.030	7.246	-26.576	5.993
R2	0.789		0.758		0.766		0.763		0.785	

Table 7

State of Technology (Absolute Advantage) Ranking: Ti

Panel GLS	
Country	Ti
United States	2.268
Japan	1.682
Germany	1.505
United Kingdom	1.264
France	1.175
Italy	1.124
Korea, Rep.	1.111
Singapore	0.959
Australia	0.916
Canada	0.894
Malaysia	0.671
China	0.665
Thailand	0.534
Philippines	0.407
Indonesia	0.397
India	0.349
Pakistan	0.268
Sri Lanka	0.233

1999	
Country	Ti
United States	2.505
Japan	1.924
Germany	1.692
United Kingdom	1.398
France	1.321
Italy	1.245
Korea, Rep.	1.170
Singapore	1.031
Australia	1.015
Canada	0.968
Malaysia	0.676
China	0.568
Thailand	0.519
Philippines	0.399
Indonesia	0.351
India	0.322
Pakistan	0.248
Sri Lanka	0.217

2000	
Country	Ti
United States	2.210
Japan	1.706
Germany	1.415
United Kingdom	1.208
France	1.132
Korea, Rep.	1.099
Italy	1.059
Singapore	0.942
Australia	0.867
Canada	0.861
Malaysia	0.664
China	0.629
Thailand	0.527
Philippines	0.406
Indonesia	0.404
India	0.340
Pakistan	0.266
Sri Lanka	0.236

2001	
Country	Ti
United States	2.759
Japan	1.998
Germany	1.803
United Kingdom	1.498
France	1.366
Italy	1.299
Korea, Rep.	1.216
Singapore	1.092
Australia	1.056
Canada	1.053
Malaysia	0.702
China	0.629
Thailand	0.505
Philippines	0.387
Indonesia	0.371
India	0.329
Pakistan	0.233
Sri Lanka	0.220

2002	
Country	Ti
United States	2.215
Japan	1.583
Germany	1.457
United Kingdom	1.222
France	1.130
Italy	1.098
Korea, Rep.	1.091
Singapore	0.931
Australia	0.903
Canada	0.872
China	0.716
Malaysia	0.674
Thailand	0.547
Philippines	0.416
Indonesia	0.409
India	0.348
Pakistan	0.275
Sri Lanka	0.240

2003	
Country	Ti
United States	2.142
Japan	1.572
Germany	1.484
United Kingdom	1.229
France	1.142
Italy	1.112
Korea, Rep.	1.110
Singapore	0.928
Australia	0.891
Canada	0.878
China	0.743
Malaysia	0.667
Thailand	0.555
Philippines	0.413
Indonesia	0.411
India	0.368
Pakistan	0.293
Sri Lanka	0.240

Table 8
Predicted Competitiveness by estimates of Equation (2)

Ranked by estimated competitiveness in 2003

Country	Estimated	Predicted	Residual
USA	0.000	-0.161	0.161
Japan	-0.395	-0.908	0.512
Germany	-0.992	-1.665	0.673
China	-1.022	-1.378	0.356
S. Korea	-1.426	-1.908	0.483
UK	-1.610	-1.524	-0.086
Italy	-1.948	-1.892	-0.056
France	-1.954	-1.551	-0.403
Singapore	-2.025	-2.301	0.276
Malaysia	-2.519	-3.248	0.729
Thailand	-2.591	-3.067	0.476
India	-2.922	-1.738	-1.184
Indonesia	-3.060	-4.049	0.989
Australia	-3.080	-2.289	-0.791
Canada	-3.140	-1.788	-1.351
Philippines	-3.705	-4.280	0.575
Pakistan	-4.950	-4.760	-0.190
Sri Lanka	-6.218	-5.049	-1.169

Ranked by predicted competitiveness in 2003

Country	Estimated	Predicted	Residual
USA	0.000	-0.161	0.161
Japan	-0.395	-0.908	0.512
China	-1.022	-1.378	0.356
UK	-1.610	-1.524	-0.086
France	-1.954	-1.551	-0.403
Germany	-0.992	-1.665	0.673
India	-2.922	-1.738	-1.184
Canada	-3.140	-1.788	-1.351
Italy	-1.948	-1.892	-0.056
S. Korea	-1.426	-1.908	0.483
Australia	-3.080	-2.289	-0.791
Singapore	-2.025	-2.301	0.276
Thailand	-2.591	-3.067	0.476
Malaysia	-2.519	-3.248	0.729
Indonesia	-3.060	-4.049	0.989
Philippines	-3.705	-4.280	0.575
Pakistan	-4.950	-4.760	-0.190
Sri Lanka	-6.218	-5.049	-1.169