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The Effects of China's Growth in Manufacturing Sector in the U.S. Economy

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Abstract

This paper investigates the gain of bilateral trade between China and U.S. in manufacturing sectors when both countries play a role in asymmetric (biased) growth of international trade. Our model includes a special case of Biased Growth Theory in international trade. We collected labor productivity, export and import data by using classification of manufacturing industries, for U.S. and China in 1993, 1998, 2002 and 2006. The results according to Cost-Benefit analysis and econometric model indicated that the China's manufacturing sector is *Import-Biased Growth* and U.S. manufacturing sector is *Export-Biased Growth*. Therefore, The Terms of Trade between U.S. and China in manufacturing sector has been changed in favor of China.

Keywords: Biased Growth, China-U.S. Trade, Labor Productivity, Manufacturing Industries, Terms of Trade.
JEL Classification: F14, F17, F15, F41.

1. Introduction

In last two decades, economy growth in low wage countries such as china and India has been remarkable. China has the fastest economy growth among the countries. It is now the world’s second-largest economy, its biggest exporter (Arora & Vamvakidis, 2010). Export growth has been a major component supporting china's rapid economic expansion. China’s main export partners are the U.S. (17 percent), European Union (16 percent), Asian (10 percent), Japan (7 percent) and South Korea. Exports from China to U.S. have been increased from $45,453 Million in 1995 to $334,141 Million in 2010.

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U.S. balance of payment deficit with China has been increased from $33789 Million in 1995 to $252384 Million in 2010 (U.S. Census Bureau, 2010). This event has worried many developed countries such as United State. In this paper the questions are; whether these concerns are supported by economic literature? Why does concern growth in economics of a country to another country? Is the growth in the rest of the world good or bad for our country?

In the literature, The Biased Growth Theory answers these questions. In this theory, the evaluation indicator is Terms of Trade (TOT). If our country experienced *biased* growth toward goods or commodity that it is exported (*Export-biased growth*), our TOT will be worsened and TOT of rest of the world will be improved (other things equal). Because it is reducing the direct benefits of growth; on the other hand, gain of international trade is reduced for us. While import-biased growth leads to an improvement of our TOT (Krugman & Obstfeld, 2006, Samuelson, 2004). It is interesting to note that in this study we have investigated how change over time the situation of manufacturing sector just in relative price because TOT is relative price in export to import. This study doesn't have any claim on change in total revenue, because total revenue is price multiplied by the quantity while this study focused only on price. Also scope of present study is manufacturing industries sectors and other sectors in economy such as service sector is not considered to scope of this research. However, in recently years China has also invested in enhanced sector[1].

During the 1950s, some economist such as Bhagwati (1969) suggested that growth in the poorer nation would actually be self-defeating. They argued that export-biased growth by poor nation would worsen their terms of trade so much that they would be worse off than if they had not grown at all. This situation is known to economists as the case of *immiserizing growth* (Krugman & Obstfeld, 2006). Immiserizing growth arises when an increase in economic activity is associated with a

1. The New York Times on January 21, 2013 wrote: The Chinese government in recent years has given unprecedented attention to the development of talent, hoping to combat emerging development issues and maintain the Chinese growth engine. The government's plans are a blueprint for developing a highly skilled national work force within the next 10 years. Among the goals is the transformation of China from a manufacturing hub to a world leader in innovation – a grand objective. One step is to increase the pool of highly skilled workers, to 180 million by 2020 from the current 114 million. Another is to ensure that by 2020, 20 percent of the work force has had a college education. That would be 195 million people.

fall in real living standards (Pryor, 2007), The increased economic activity may be reflected in greater inputs of labor, capital, land or any other resources which have an opportunity cost. The immiserizing growth can be occur in case of extreme biased-growth: Strongly export-biased growth must be combined with very steep RS and RD curves, so that the change in TOT is large enough to offset the initial favorable effects of an increase in a country's productive capacity. Most economists now regard the concept of immiserizing growth as more a theoretical point than a real world issue (Krugman & Obstfeld, 2006: 93).

In the last two decades many observers began warning that the growth of newly industrialized countries a threat to the prosperity of advanced nation. For example, a 1993 report released by the European Commission emphasized the fact that "other countries are becoming industrialized and competing with U.S. even in our own markets". One of the best studied in this area is Samuelson (2004), a method to make use of Ricardian model and Biased Growth Theory, offered an example of how technological progress (labor productivity change) in developing countries such as China can hurt advanced countries such as U.S. For example growth of productivity in import sector in developing countries, as a result, shifts the TOT against the exporting country.

Samuelson (2004) examines a bilateral trade between China and U.S. in three scenario according to a paper titled "*Where Ricardo and Mill Rebut and Confirm Argument of Mainstream Economists Supporting Globalization?"* The first: If China and U.S. have a trade together, the result will be the improvement of welfare in both countries more than when they have no a trade together. The second: However trade between China and U.S., if China has experiences remarkable productivity growth in the exported products over time, this will improves TOT of U.S. third**:** if China has experiences productivity growth in the imported products over time, U.S. TOT will be worsening and gain of trade in the United States will lose over time.

Other economists such as Phelps (2004) believe that China's economy growth is a threat for developed countries (such as U.S.) in two aspects. Firstly, its TOT would be worsening. Secondly, payments to product factors in China's trade partners, especially for unskilled labor in manufacturing industries will be lessen. Phelps analysis is the same as Samuelson, he reported that China's growth has a negative effect for the

U.S. and other advanced economies in the West stems from the resulting import substitution by China, thus a decline in abroad demand for U.S. exports, hence deterioration in the U.S. terms of trade. Satty & Cho (2001) have studied about the analysis of decisions of U.S. Congress regarding trade with China. Some economists have a different idea; Alvarez & Claro (2009) introduced an indicator for penetrating of China's import into manufacturing industries of developing countries then, through panel data regression among various industries, they showed that importing from China has negative effect on employment and will exit other firms out of the industry. Devlin et al. (2006) show the effect of growth in China's export on other countries. Some studies reported that China economic growth could lead to welfare improvement in other countries. Although empirical studies due to this course are rare, we can refer to Abeysinghe & LU (2003), Harris et al. (2010) they use Vector Auto Regression (VAR) equations among East Asian countries and showed that the China's growth will lead to a huge market for neighbors and these countries can gain from trade. In contrast some economists believe that China's economic growth has been isolated neighbors for example Yeh & Ho (2010). Also, some of non-economists believe that China's growth can be a threat for U.S. for example Casetti (2003) has reported that China can be a superpower in second half of the century.

2. Method and Model

We start with a model that included *h* manufacturing goods and two countries, U.S. and China. We suppose that the *n* goods have comparative advantage in U.S. and *m* goods comparative advantage in China, when $h=n+m$ is total goods that produce by both countries. We can now obtain the relative supply and demand curves for *n* and *m* goods are as follows:

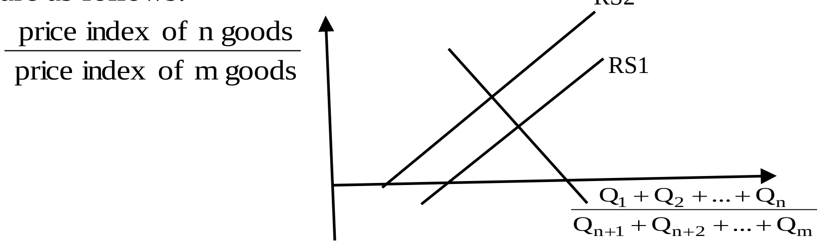

Figure1: Relative Supply and Demand Curves

We know that the U.S. has a comparative advantage in *n* numbers of goods, which is the

numerator in horizontal axis in Fig.1. The vertical axis in Fig.1 is a U.S. Terms of Trade. So, The supply-side shocks, such as increasing productivity in any of $Q_1, Q_2, ..., Q_n$ moves RS curve to the right and decreases TOT of U.S. ($\frac{\text{price index of n goods}}{\text{price index of m goods}}$). On contrast increase productivity in any of $Q_{n+1}, Q_{n+2}, ..., Q_m$ which is the denominator in horizontal axis in Fig.1, moves RS curve to the left and increase TOT of U.S.

How it can be found, that a good is the numerator and the denominator in Figure1?

Our assumption is that, both countries produce all goods. The distribution of any good such as *i* is as follows:

$$\mathrm{Q_i = Q_{iX}^{US} + Q_{iD}^{US} + Q_{iX}^{CH} + Q_{iD}^{CH}} \qquad \mathrm{i = 1,2,...,h \quad and \;\; h = n + m} \tag{1}$$

When Q_i denote the total of *i* that produced in the world. Q_{iX}^{US} is produced of *i* by U.S. and exported to china, Q_{iD}^{US} is produced of *i* by U.S. and consumed in U.S. domestic, Q_{iX}^{CH} is produced of *i* by china and exported to U.S., and Q_{iD}^{CH} is produced of *i* by china and consumed in china. Now, we can write the Relative Quantity of *h* products:

$$\frac{Q_1 + Q_2 + ... + Q_n}{Q_{n+1} + Q_{n+2} + ... + Q_m} = \frac{(Q_{1X}^{US} + Q_{1D}^{US} + Q_{1X}^{CH} + Q_{1D}^{CH}) + ... + (Q_{nX}^{US} + Q_{nD}^{US} + Q_{nX}^{CH} + Q_{nD}^{CH})}{(Q_{n+1X}^{US} + Q_{n+1D}^{US} + Q_{n+1X}^{CH} + Q_{n+1D}^{CH}) + ... + (Q_{mX}^{US} + Q_{mD}^{US} + Q_{mX}^{CH} + Q_{mD}^{CH})} \tag{2}$$

$h = n + m$

We can make an assumption about Eq. (1), that the domestic consumptions are zero:

$$\mathrm{Q_{iD}^{US} = Q_{iD}^{CH} = 0} \qquad \mathrm{i = 1,2,...,h \quad and \quad h = n + m} \tag{3}$$

Assumption.3 says nothing about the relationship between relative quantity and price in Fig.1, but simply makes the Eq. (2) and we obtain the following expression:

$$\frac{(Q_{1X}^{US}+Q_{1X}^{CH})+\ldots+(Q_{nX}^{US}+Q_{nX}^{CH})}{(Q_{n+1X}^{US}+Q_{n+1X}^{CH})+\ldots+(Q_{mX}^{US}+Q_{mX}^{CH})}=\frac{\sum_{i=1}^{n}(Q_{iX}^{US}+Q_{iX}^{CH})}{\sum_{i=n+1}^{m}(Q_{iX}^{US}+Q_{iX}^{CH})},$$

$$h=n+m \tag{4}$$

Then the relative quantity in horizontal axis in Figure 1 is:

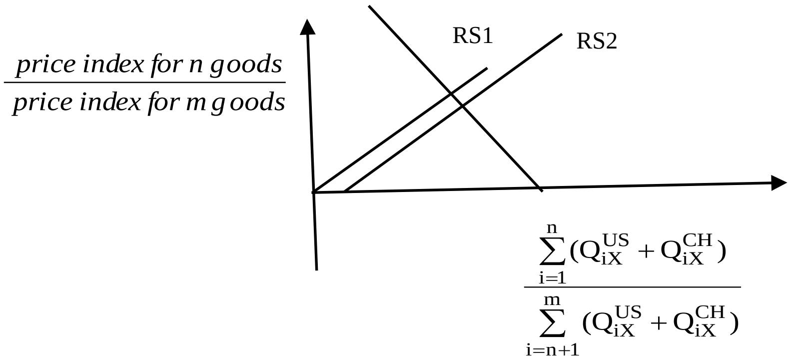

Figure 2: Relative Supply and Demand Curves

It is important to remember that, the *n* numbers of goods in the numerator in Eq. (4) are differences to the *m* numbers goods in denominator. The *n* numbers goods in numerator are U.S. *exporting* goods, and the *m* in the denominator is U.S. *importing* goods. Because *n* goods in the numerator has a comparative advantage in U.S. and *m* in the denominator has a comparative advantage in China. When a good is exporting, we know that its exports more than imports in a country and an importing goods, its exports less than imports. This condition is given by

$$Q_{iX}^{US}>Q_{iX}^{CH} \quad \text{if} \quad i=1,2,\ldots,n \qquad \text{(i is Export U.S. Goods)}$$

$$Q_{iX}^{US}<Q_{iX}^{CH} \quad \text{if} \quad i=n+1,n+2,\ldots,m \qquad \text{(i is Import U.S. Goods)} \tag{5}$$

And

$$\frac{Q_{iX}^{US}}{Q_{iX}^{CH}} > 1 \quad \text{or} \quad \frac{\text{U.S. exported to China of i good}}{\text{U.S. imported from China of i good}} > 1$$
$$\text{if} \quad i = 1,2,...,n \quad \text{(i is Export U.S. Good)}$$
$$(6)$$
$$\frac{Q_{iX}^{US}}{Q_{iX}^{CH}} < 1 \quad \text{or} \quad \frac{\text{U.S. exported to China of i good}}{\text{U.S. imported from China of i good}} < 1$$
$$\text{if} \quad i = n+1, n+2,...,m \quad \text{(i is Import U.S. Good)}$$

Eq. (6) show that the *n* goods in U.S. has $\frac{export}{import} > 1$ condition, and *m* goods has $\frac{export}{import} < 1$ condition. It should be noted that the *n* numbers of goods are in the numerator in Eq.(2), so the any *supply-side shocks, such as productivity growth* in them, leads to supply curve shift to the right, and to worsening TOT of U.S.. In contrast the *m* numbers of goods, when they are in the denominator in Eq. (2).

We would like to test this idea by stylized fact. For this purpose, a question is introduced; which kinds of products (“n” or “m”) have a higher labor productivity growth rate? First, we use scatter graph for relationship between $\frac{export}{import}$ ratios (indicated kind of product) in U.S., and *labor productivity growth rate* of *n* and *m* type of manufacturing industries (in U.S. and China). For this purpose we need to data.

3. Stylized Facts and Data Description

We collected two kinds of request data, labor productivity and export - import for china and U.S. that is classification to manufacturing industries in 1993, 1998, 2002 and 2006. Time period selected based on data availability. It should be noted that, there are various classifications of industries, which the most important are ISIC ، SITC and NAICS. The data related to bilateral trade between U.S. and China according to industry classification can be found in U.S. Census Bureau just by NAICS classification. The data of labor productivity for U.S. and China has been obtained from UNIDO and International Yearbook of Industrial Statistics.

The data of labor productivity in China at 2006 is available based on ISIC Ver.3, but for the 1993, 1998 and 2002, it is available in the form of ISIC Ver.2 in Yearbook of Industrial Statistics. The data of labor productivity in U.S. at 1993 is available based on ISIC Ver.3, but for 1998, 2002 and 2006 it exists in the form of ISIC Ver.2 in Yearbook of Industrial Statistics. So, for comparing the labor productivity growth rate of China and U.S. according to classification of industries, we need to convert ISIC Ver.3 to Ver.2. The other problem is comparing labor productivity with bilateral export-import data of these two countries, because the labor productivity is available in the form of ISIC Ver.2, while the bilateral export-import data are based on NAICS classification. Then, we converted 2Digit codes of ISIC Ver.2 to codes of NAICS via United Nation Statistics Division. Then, all data of bilateral export-import and labor productivity in U.S. and China, in the form of NAICS for 1993, 1998, 2002 and 2006 have been shown in Table 1.

There are two types of data in Table 1, First bilateral export-import ratio of U.S. with China in 1993, 1998, 2002 and 2006. It should be noted that export-import ratio of U.S. is the same as import-export ratio of China, because we consider bilateral trade between two countries. In 1993, the highest export-import ratio of U.S. is related to the Petroleum & Coal Products industry and is equal to 26.7, which means that the export in U.S. to China is 27 times more than import. The Transportation Equipment industry has second rank, whose export-import ratio is 7.8. Indeed, Transportation Equipment- Petroleum & Coal Products- Chemicals- Machinery, Except Electrical and Beverages & Tobacco Products were the five industries with the highest export-import ratio in 1993. In 1998, three industries of these five industries (in 1993) were the same as the first one. In the most industries export-import ratios have declined over time, e.g. in 1993, the export of Petroleum & Coal Products has been 27 times more than import but in 2006 the export is just 0.6 time more than imports in U.S.. This is almost right for all industries (see average of export-import ratio in Table1). Note, in Table 1 the China's export-import ratio has not reported because it is reversing export-import ratio in U.S.

The second type of data in Table 1 is labor productivity growth rate for 19 manufacturing industries in U.S. and China, during 1993-1998, 1998-2002, 2002-2006 and 1993-2006. The average of labor productivity growth rate in Chinese industries, in all periods of time, is more than U.S., e.g. the average of labor productivity growth rate, for 19 industries

Table 1: Labor Productivity Growth Rate and Export/ Import Ratio of U.S. (with China)

Industry	$(\frac{Export}{Import})$ of U.S. (with China only)				Labor productivity growth in U.S.				Labor productivity growth in China			
	1993	1998	2002	2006	1993-1998	1998-2002	2002-2006	1993-2006	1993-1998	1998-2002	2002-2006	1993-2006
FOOD MANUFACTURING PRODUCTS	0.234	1.831	1.068	1.115	0.129	0.216	0.175	0.612	0.521	0.845	1.221	5.234
BEVERAGES & TOBACCO PRODUCTS	$\boxed{1.404}$	0.574	0.146	0.601	0.362	0.134	0.335	1.064	1.011	0.829	0.990	6.319
TEXTILES & FABRICS & TEXTILE MILL PRODUCTS	0.036	0.039	0.049	0.051	0.183	0.180	0.448	1.022	0.266	0.861	0.952	3.597
APPAREL & ACCESSORIES	0.002	0.001	0.003	0.001	0.367	0.266	0.232	1.133	0.148	0.233	0.798	1.544
LEATHER & ALLIED PRODUCTS	0.003	0.007	0.007	0.010	0.300	-0.007	0.383	0.785	0.376	0.319	0.364	1.475
WOOD PRODUCTS	0.035	0.060	0.149	0.129	0.065	0.116	0.258	0.496	0.573	0.843	0.666	-0.473
PAPER	0.926	1.126	0.727	0.430	0.323	0.208	0.262	1.018	1.042	1.013	1.150	7.833
PRINTING,PUBLISHING AND SIMILAR PRODUCTS	0.075	0.175	0.080	0.050	-0.068	-0.391	1.208	0.254	1.038	0.858	0.603	5.071
PETROLEUM & COAL PRODUCTS	$\boxed{26.77}$	0.781	0.721	0.666	NA	NA	NA	NA	NA	NA	NA	NA
CHEMICALS	$\boxed{1.678}$	1.538	1.416	1.117	0.281	0.186	0.861	1.826	0.527	1.138	1.177	6.107
PLASTICS & RUBBER PRODUCTS	0.036	0.060	0.067	0.069	0.200	0.008	0.395	0.688	-0.828	0.651	0.792	3.652
NONMETALLIC MINERAL PRODUCTS	0.082	0.071	0.053	0.066	0.419	0.119	0.338	1.126	-0.109	0.739	1.415	2.744
PRIMARY METAL MFG	0.933	0.230	0.294	0.340	0.377	-0.008	0.689	1.307	-0.104	1.218	2.110	5.184
FABRICATED METAL PRODUCTS,NESOI	0.294	0.140	0.077	0.083	3.150	-0.671	0.265	0.728	0.382	0.686	0.944	3.529
MACHINERY,EXCEPT ELECTRICAL	$\boxed{1.791}$	0.504	0.517	0.335	0.427	0.129	0.275	1.054	0.378	1.191	1.663	7.038
COMPUTER & ELECTRONIC PRODUCTS	0.251	0.157	0.134	0.120	0.322	0.076	0.364	0.942	1.479	0.542	0.507	4.761
TRANSPORTATION EQUIPMENT	$\boxed{7.867}$	3.774	1.780	0.986	0.296	0.140	0.172	0.732	0.550	1.293	0.829	5.498
FURNITURE & FIXTURES	0.023	0.012	0.004	0.006	0.377	0.257	0.174	1.031	1.160	0.333	0.462	3.209
MISCELLANEOU.S. MANUFACTURED COMMODITIES	0.007	0.008	0.010	0.017	0.205	0.384	0.218	1.031	0.859	0.293	0.598	2.842
Average of industries	**2.234**	**0.584**	**0.384**	**0.326**	**0.429**	**0.075**	**0.392**	**0.936**	**0.515**	**0.771**	**0.958**	**4.176**

Resource: International Yearbook of Industrial Statistics & U.S. Census Bureau

during 1993-2006 has been 1 percent in U.S., While 4 percent in China. It is important to know that the level of labor productivity in China is less than U.S., but the growth rate of labor productivity in China has been more than U.S. Wu (2001) find that the labor productivity ratio (China/U.S.) grew at 5.77 percent during 1987-97, which means that the growth rate of productivity in China was 5.77 percentage points faster than U.S.

4. Labor Productivity Growth Rate and Bilateral Trade between China and U.S.

The scatter graph of relationship between ratio value of $\frac{export}{import}$ in U.S. and labor productivity growth rate for 19 manufacturing industries in both U.S. and China is shown in Figs. 3 to 10. All figures shows, the industries that have, value of $\frac{export}{import} > 1$ also they had value of higher labor productivity growth rate, although their numbers is limited. We can see the positive relationship between ratio value of $\frac{export}{import}$ and rate of labor productivity growth especially in Figs. 9 and 10. In other word, U.S. *exported* industries, have higher rate of labor productivity growth in both U.S. and China (Fig. 10). Table 1 show that, Apparel & Accessories, Leather & Allied Products and Miscellaneous Manufactured Commodities have very low value of $\frac{export}{import}$ in U.S. and also very low growth rate of labor productivity in U.S. and China, While the Chemical industry has a high $\frac{export}{import}$ ratio in U.S. and high growth rate of labor productivity in both countries (especially in China). These relationships indicated that, China's manufacturing sector is *Import-Biased Growth* and U.S. manufacturing sector is *Export-Biased Growth*. To further emphasize, we make a econometric model and estimated it and in the next section we calculate cost-benefit in bilateral trade between China and U.S.[1].

1. This relationship can be demonstrated using the correlation coefficient.

Figure 3: U.S. Export/Import (with China) in 1993 and U.S. Labor Productivity Growth rate in 19 Manufacturing During 1993-1998

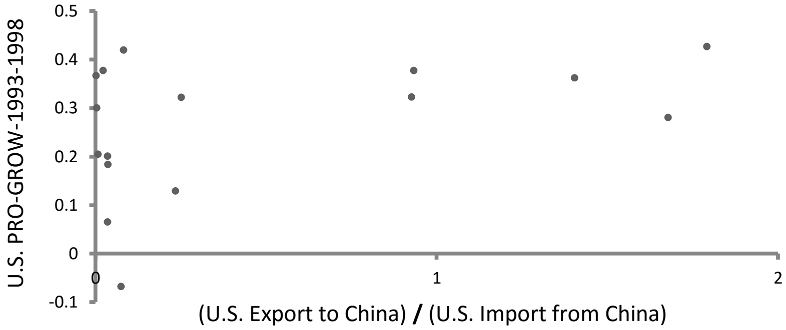

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Figure 4: U.S. Export/Import (with China) in 1993 and China Labor Productivity Growth rate in 19 Manufacturing During 1993-1998

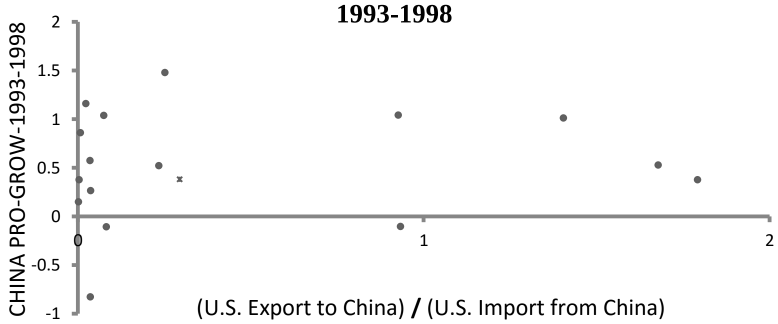

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Figure 5: U.S. Export/Import (with China) in 1998 and U.S. Labor Productivity Growth Rate in 19 Manufacturing During 1998-2002

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Figure 6: U.S. Export/Import (with China) in 1998 and China Labor Productivity Growth Rate in 19 Manufacturing During 1998-2002

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Figure 7: U.S. Export/Import (with China) in 2002 and U.S. Labor Productivity Growth Rate in 19 Manufacturing During 2002-2006

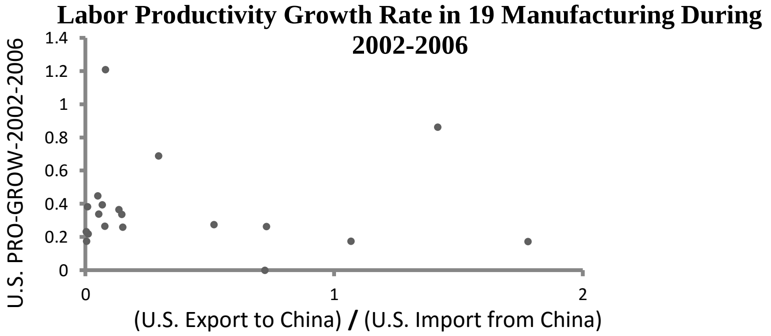

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Figure 8: U.S. Export/Import (with China) in 2002 and China Labor Productivity Growth Rate in 19 Manufacturing During 2002-2006

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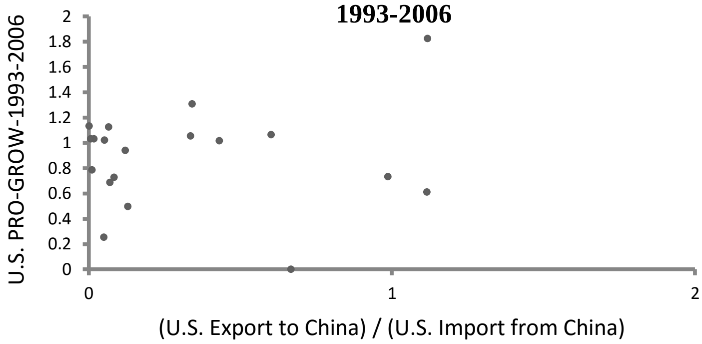
Figure 9: U.S. Export/Import (with China) in 2006 and U.S. Labor Productivity Growth rate in 19 Manufacturing During 1993-2006



Resource: International Yearbook of Industrial Statistics & U.S.Census Bureau

Figure 10: U.S. Export/Import (with China) in 2006 and China Labor Productivity Growth rate in 19 Manufacturing During 1993-2006

Resource: International Yearbook of Industrial Statistics & U.S. Census Bureau

To illustrate the relationship between value of $\frac{export}{import}$ and labor productivity growth within various manufacturing industries is considered an econometric model as follow:

$$(\frac{\text{export}}{\text{import}})_i = \beta_0 + \beta_1(\text{US}-\text{PROGROW})_i + \beta_2(\text{CH}-\text{PROGROW})_i + u_i \qquad (7)$$

Where $(US-PROGROW)_i$ and $(CH-PROGROW)_i$ are labor productivity growth rate in industry *i* in United State and China manufacturing sector respectively. Of course other factors such as economic growth, exchange rate and etc are included in error term. We assume that the other factors is constant, in other word they have not correlation with explanatory variable that are labor productivity growth. Then according to Fig.3 to 10 we estimated four models. Model 1 is according to Fig.1 and 2. Model 2 is according to Fig.3 and 4. Model 3 is according to Fig.5 and 6. Model 4 is according to Fig. 7 and 8. Results of estimate are reported in Table 2.

Table (2): The Estimation Result of Equation (7) –Dependent Variable is $\frac{\textbf{export}}{\textbf{import}}$ of U.S. Country

independent variable	Model (1)	Model (2)	Model (3)	Model (4)
Labor Productivity Growth rate of U.S. $(\mathrm{US-PROGROW})$	2.008** (0.943)	0.929* (0.478)	-0.547 (0.45)	0.13 (0.33)
Labor Productivity Growth rate of China $(\mathrm{CH-PROGROW})$	0.153 (0.207)	1.813** (0.795)	0.274** (0.135)	0.099** (0.038)
Constant	-0.146 (0.206)	-0.895 (0.486)	0.238 (0.266)	-0.229 (0.306)
Observation	*16*	*18*	*17*	*18*
R^2	0.19	0.40	.015	0.34

Note: (*) indicated 10 percent significant. (**) indicated 5 percent significant. (***) indicated 1 percent is significant. All models have been adjusted by white Heteroskedasticity.

In all models the coefficient of labor productivity growth rate is positive, exceptionally in model 3, while it is not significant. These relationships indicated that confirm again on U.S. manufacturing sector is *Export-Biased Growth*. Because the relationship between ratios value of U.S. $\frac{export}{import}$ and labor productivity growth rate in U.S. is positive. China’s manufacturing sector is *Import-Biased Growth* because the relationship between ratio value of U.S. $\frac{export}{import}$ and labor productivity growth rate in China is positive. Note that the value of U.S. $\frac{export}{import}$ is equal to China $\frac{import}{\exp ort}$ because we consider bilateral trade between U.S. and China.

5. Cost-Benefit of Bilateral Trade in Manufacturing Sector between China and U.S.

In this section we calculate Cost-Benefit of bilateral trade between

China and U.S. for U.S. manufacturing sector. According to Eq. (4) and Fig.1, we can see that the relative price is a function of relative quantity:

$$\frac{p_n}{p_m}=f\left(\frac{\sum_{i=1}^{n}(Q_{iX}^{US}+Q_{iX}^{CH})}{\sum_{i=1}^{m}(Q_{iX}^{US}+Q_{iX}^{CH})}\right)=f\left(\frac{\sum_{i=1}^{n}Q_{iX}^{US}+\sum_{i=1}^{n}Q_{iX}^{CH}}{\sum_{i=1}^{m}Q_{iX}^{US}+\sum_{i=1}^{m}Q_{iX}^{CH}}\right)=f\left(\frac{A+B}{C+D}\right) \qquad (7)$$

When

$$A=\sum_{i=1}^{n}Q_{iX}^{US}\ ,\ B=\sum_{i=1}^{n}Q_{iX}^{CH}\ ,\ C=\sum_{i=1}^{m}Q_{iX}^{US}\ ,\ D=\sum_{i=1}^{m}Q_{iX}^{CH}$$

Eq. (7) indicates the relative supply of *n* and *m* goods. It should be noted that, there are n number of goods in numerator in Eq. (7) then, any *supply-side shocks, such as productivity growth* in them, leads to supply curve shift to the right, and to worsening U.S. ToT. In contrast any supply-side shocks in *m* numbers of goods, leads to supply curve shift to the left and to improving ToT of U.S.. This suggests that, the change in labor productivity growth rate lead to shift in the relative supply curve. In other word, $\frac{p_n}{p_m}$ is a function of productivity growth rate in *n* and *m* goods.

$$\frac{p_n}{p_m}=f\left(\frac{A+B}{C+D}\right)=f\left[\text{dlog}(A)\,,\text{dlog}(B)\,,\text{dlog}(C)\,,\text{dlog}(D)\ ,\ Z\right] \qquad (8)$$

When

dlog(A), is average growth rate of labor productivity in U.S. for *n* numbers of industries

dlog(B), is average growth rate of labor productivity in China for *n* number of industries.

dlog(C), is average growth rate of labor productivity in U.S. for *m* number of industries

dlog(D), is average growth rate of labor productivity in China for *m* number of industries

Z is other factors affected on relative price; we assume that Z is constant across two countries. *dlog(A)* and *dlog(B)* have a negative effect on U.S. TOT, but $dlog(C)$ and $dlog(D)$ have a positive impact in Eq. (8). In other word $dlog(A)$ and $dlog(B)$ is cost but $dlog(C)$ and $dlog(D)$ is benefit for relative price (TOT) in U.S. manufacturing sectors:

$$\begin{aligned} \text{Cost} &= \text{dlog(A)} + \text{dlog(B)} \\ \text{Benefit} &= \text{dlog(C)} + \text{dlog(D)} \end{aligned} \tag{9}$$

To apply the Eq. (9), let us turn to Eq.(6) for determine the criteria in exported and imported goods. If ratio of value of export to import more than unit $[(\text{Export/Im port}) \geq 1]$, then they are exported goods. For example, in Table 1, we can see that, the *Transportation Equipment*, *Petroleum & Coal Products*, *Chemicals*, *Machinery except Electrical* and *Beverages & Tobacco Products* in the U.S. are exported goods in 1993, and other industries are imported goods. It should be noted that, the U.S. exported goods are symmetric imported goods for China, because we are investigating the bilateral trade between China and U.S. Table 3 shows the U.S. Cost-Benefit trade in the fourth period. For example if the base year is 1993, and we choose 1993-1998 period for labor productivity growth rate, the values of $dlog(A)$, $dlog(B)$, $dlog(C)$ and $dlog(D)$ using the Table 1 is calculated as follows:

dlog(A)=(0.362+0.281+0.427+0.296)/4=0.341
dlog(B)=(1.011+0.527+0.378+ 0.550)/4=0.616
dlog(C)=(0.129+0.183+0.367+0.300+0.065+0.323- 0.068 +0.200 +0.419 +0.377+3.150+0.322+0.377+0.205)/14=0.454
dlog(D)=(0.521+0.266+0.148+0.376+0.573+1.042+1.038-0.828-0.109-0.104+0.382+1.479+1.160+0.859)/14=0.486

The sum of $dlog(D)$ and $dlog(C)$ during 1993 to 1998 is 0.939[1] (see Table 3), that it is a benefits of U.S. manufacturing sector in

1. These industries include all industries except Transportation Equipment, Petroleum & Coal Products, Chemicals, Machinery except Electrical and Beverages & Tobacco Products.

relative price (TOT). The sum of $dlog(A)$ and $dlog(B)$ is cost for U.S. manufacturing sector, that it is 0.958[1] in 1993 to 1998. Thus the net benefit of U.S. manufacturing sector is -0.018. Similarly, the net benefits during the 1998-2002, 2002-2006 and 1993-2006 for U.S. are negative (Table 3).

The results in Table 3 show that, the bilateral trade between U.S. and China in manufacturing sectors during the period in this study has been losses for U.S. TOT. Another result of cost-benefit analysis is the China's manufacturing sector so-called *Import-Biased Growth;* because average growth rate of labor productivity in China of imported goods *(dlog (B))* is more than exported goods *(dlog (D))*. The U.S. manufacturing sector is called *Exported-Biased Growth;* because average growth rate of labor productivity in U.S. of exported goods *(dlog(A))* is more than imported goods *(dlog (C*)), in all cases except that of 1993-1998.

Table 3: Cost-Benefit of Bilateral Trade between China and U.S. for Manufacturing Sector in U.S.

Average Growth rate of Labor Productivity for A, B, C and D				
	1993-1998	1998-2002	2002-2006	1993-2006
dlog(D)	0.486	0.685	0.934	3.888
dlog(C)	0.454	0.042	0.390	0.912
Benefit= *dlog(D)+dlog(C)*	0.939	0.728	1.324	4.800
dlog(A)	0.341	0.188	0.402	1.219
dlog(B)	0.616	1.072	1.075	5.670
Cost= *-dlog(A)- dlog(B)*	-0.958	-1.260	-1.478	-6.889
Cost-Benefit For U.S. manufacturing (Bilateral Trade whit China)	-0.018	-0.532	-0.154	-2.089

Resource: International Yearbook of Industrial Statistics & US Census Bureau

6. Concluding Remarks

This paper has provided a model that shows China's manufacturing growth impact on U.S. manufacturing sector. Our model includes as a special case of bias growth theory in international trade, the biased growth theory has intended to growth in the rest of the word good or bad for our country. In this theory, the evaluation indicator is Terms of Trade (TOT). If our country had experienced growth *biased* toward the goods it exports

1. These industries include Transportation Equipment, Petroleum & Coal Products, Chemicals, Machinery except Electrical and Beverages & Tobacco Products.

(export-biased growth), our TOT will be worsened and TOT of rest of the world will be improved. We investigated that, how the labor productivity growth in manufacturing sector in U.S. and China effects on TOT in U.S. manufacturing sector. In other word, are manufacturing sector in U.S. and China as an Export-*Biased Growth* or *Import-Biased Growth*? Firstly, we collected required data such as labor productivity, export and import data by using classification of manufacturing industries, for U.S. and China in 1993, 1998, 2002 and 2006. These data have been extracted from UNIDO (Yearbook of Industrial Statistics) and U.S. Census Bureau. Time period selected based on data availability.

The results show that, China's manufacturing sector is *Import-Biased Growth;* because average growth rate of labor productivity in China imported goods is more than exported goods. The U.S. manufacturing sector is *Exported-Biased Growth;* because average growth rate of labor productivity in U.S. exported goods is more than imported goods. According to cost-benefit analysis in this research, bilateral trade between U.S. and China in manufacturing sectors has been worsened for U.S. TOT. It is interesting to note that, this study shown that over time the situation of Chinese manufacturing sector would be a better just in relative price. We don't have any claim to total revenue that it is price multiplied by the quantity.

The result of this research is same as the results of Phelps (2004) that increasing the Chinese exports to U.S. during the time when they were previously exported from U.S., TOT would be worsened over the time. Li Cheng & Zhang Ding (2007) by develops a general equilibrium three-goods in Ricardian models, shows that the productivity progress can change the pattern of trade and welfare between two countries.

The faster growth rate of labor productivity in low level income countries than high levels income countries is called Catch-Up Theory in Abramovitz (1986), Wu (2001). We found that the growth rate of labor productivity in manufacturing sectors in China and U.S. is asymmetric (biased). The asymmetric growth rate of productivity in a country has effect on other countries. This growth rate is similar to that of Japan in 1952-78 and that of South Korea and Taiwan in 1952-95 Maddison (1998), Wu (2001). In other words, they have adopted a policy of import substitution with export growth strategic.

Finally, it should be noted that our results limit to manufacturing industries and we don't have any clime to aggregate of economy. We can expand our idea to both service and manufacturing sectors, because share of service sector in U.S. economy is high but there are difficulties in measuring productivity in services. In the future, transformation of China from a manufacturing hub to a world leader in innovation and services is a grand objective for chine's government. However, import substitution policies and reverse engineering strategy in manufacturing product a lot of history has happened, for example, Japan and South Korea in 1350–70. But we do not have any country that has U.S. power in the field of innovation. These sectors are mainly related to services; for example, the U.S. college education and universities has a much higher efficiency than the others countries.

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