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# The Nature of China's Foreign Trade: *Heckscher-Ohlin* Trade Theory Re-Examined

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***Abstract***

Heckscher-Ohlin trade theory (H-O Theory) is re-examined for the nature of China's foreign trade, i.e. the relative capital intensity (capital-labor ratio) of export and competitive import goods, by adopting so-called input-output (IO) techniques. Eleven countries/regions, mainly based on their shares in China's total trade volume, are selected to disclose China's comparative advantage – the basis on which China participates in international trade according to H-O Theory. We find that, in accordance with classical economics, China resorts to foreign trade in order to economize its capital and dispose of its surplus labor. In orther words, H-O Theory finds support in the data.

**Keywords:** China's foreign trade, Input-Output techniques, comparative advantage, relative capital intensity.

## 1. Introduction

About fifty years ago, in two articles (Leontief 1953; Leontief 1956) Leontief conducted the computation and comparison of the total quantities of capital and labor (directly and indirectly) required to produce two composite goods in the US, namely exports and competitive imports[1], each of which is worth one million dollars. Then, by comparing relative capital intensity of exports and competitive imports goods, he found that the participation of US in international trade was "based on its specialization on labor intensive, rather than capital intensive…", known as *Leontief Paradox* later on (Brecx 1967).

Nowadays, China's re-entry into the world economy, by means of international trade, has been perhaps the most visible of its reforms (Young 2000) since early 1980s (Lardy 1992). Particularly, after China's accession to the WTO in 2001, the average annual growth of China's foreign (merchandize) trade reaches 28.1% from 2001 to 2006 (in the same period, that of GDP is only 10.1%). In addition, China's international trade structure changes much in these years, in particular, international production fragmentation has great impact on China's foreign trade, "… is one of the most important characteristics of international trade … stretches across many countries … specializes in particular stages of a good's production sequence…" (Hummels, Ishii et al. 2001) , which, labeled by different terms[2] for this phenomenon, arouses much interest amongst international economists (Krugman 1995; Feenstra and Hanson 1996; Feenstra and Hanson 1997; Hummels, Ishii et al. 2001; Grossman and Helpman 2005; Yang and Pei 2007).

In order to capture China's international trade feature as well as structure among other countries (Hilgerdt 1943), eleven trading partners[3], mainly based on their shares of China's total export/imports volume, are selected. According to classical economic theory as in writings of *Heckscher & Ohlin (H-O Theory*) (Heckscher, Ohlin et al. 1991), China, the most labor abundant country by some criteria, should specialize in production stage that is supposed to be labor intensive and, for sure, imports capital intensive goods for economic sence. In other words, China is supposed to have the comparative advantage of labor, however, it has the comparative disadvantage of capital.

Although a large body of literature about the comparative advantage of H-O theory as well as China's foreign trade (Yue and Hua 2002; Romalis 2004; Duchin 2005; Rodrik 2006; Schott 2006; Strømman and Duchin 2006; Bernard, Redding et al.

[1] Competitive imports refer to the commodities which, although imported, are nevertheless produced at home in substantial amount. "…imports of commodities which can be and are, at least in part, actually produced by domestic industries…" according to Leontief (1953), and Brecx (1967) as well.
[2] For example, slicing up the value chain, vertical specialization, international fragmentation of production, international disintegration of production, international outsourcing, and import dependence ratio etc.
[3] Including the EU15 (incl. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland (Republic of), Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom), the US, Japan, India, Hong Kong, China, Taiwan Province, China, Brazil, Canada, Mexico, Republic of Korea and Singapore, which accounts over four fifths of total exports of China in 2002, and rest of the world (RoW).

2007; Coxhead 2007) provides lots of information for either issue, unfortunately, so far, there is little systematic knowledge of empirical analysis of comparative advantage for China, nor application of the combination of such theory and empirical tool, i.e. comparative advantage and input-output (IO) techniques, for carrying out the analysis and explanation of China's multilateral trade.

For this research, we have a very specific definition of China's multilateral trade, for doing which the eleven selected countries/regions, are taken into account as an example to investigate the nature of China's international trade. We find that, in accordance with the classical economics, China resorts to foreign trade in order to economize its capital and dispose of its surplus labor for eleven out of twelve selected regions.

The rest of this paper is divided into three sections. The new methodology and data are described and given in the next section. The third section presents the emperical results of the model computations and discussion, and the final section concludes.

## 2. Methodology and Data

The IO technique is applied to detect the nature of China's multilateral trade with its selected trade partners, precisely, its specific comparative advantage with different countries/regions (i.e. the capital-labor intensity for both production of competitive import and export goods). In fact, we extend Leontief's method in order to detect China's comparative advantage.

### *2.1. The Multilateral Trade IO Table*

The 'ideal' multilateral trade IO table contains full information on the regional origins from where the specific region/country imports as well as input structure within these origions themselves. Such a table, however, is not available since our data are not rich enough for that. In our case, for practical reason, the import matrix could be entered as column, which indicates imported flow of total input from some country/region to each sector. Besides the competitive import column, there are imported final demands. For simplicity, we do not divide them by origion, but enter them as a whole, which make sense for this research. In fact, all imports are treated as two parts, namely intermediate inputs, i.e. competitive imports, and final demands.

For domestic-produced final demands, there are two sorts: domestic final demands, including consumption and gross capital formation; and exports, sorted by different destinations.

<table>
<tr><td rowspan="2">$X^D$</td><td colspan="2">F</td><td rowspan="2">$x$</td></tr>
<tr><td>$f^D$</td><td>$EX^r$</td></tr>
</table>

| $X^{Mr}$ | $F^M$ | $m$ |
|---|---|---|
| $v$ | | |
| $x$ | | |
| $l$ | | |
| $k$ | | |

Figure 1. Chinese foreign trade IO table: $X^D$, matrix of the domestic flow of input from sector $i$ to $j$; $X^{Mr}$, matrix of imported flow of input, from country/region $r$, from sector $i$ to $j$; $f^D$, column vector of domestic final demands (incl. consumption - rural household, urban household, and government; gross capital formation - fixed capital and inventory); denote $EX^r$, column vector, exports to different destination $r$; $F^M$, column vector of imported final demands; $v$, row vector of value-added (depreciation, compensation of labors, net taxes on production, and operating surplus); $l$, row vector of employment; $k$, row vector of capital.

It is clear from Figure 1 that, unlike with traditional IO Tables, import and exports features can be detected quite precisely. Furthermore, such a table may produce a detailed estimation of China's comparative advantage *vis-à-vis* its specific trading partners. Hence, this table enables the disclosure of the nature of China's multilateral trade.

We can get two equations for supply and final demands in row-wise,

$$\sum_{j=1}^{n} X_{ij}^{D} + f_i^{D} = X_i \qquad (i = 1, 2, \ldots, n) \qquad (1)$$

$$\sum_{r=1}^{c} X_{i.}^{Mr} + F_i^{M} = M_i \qquad (i = 1, 2, \ldots, n);\ (r = 1, 2, \ldots, c) \qquad (2)$$

Denote,

$A^D \equiv [\,A_{ij}^D\,] = [\,X_{ij}^D\ / X_j]$, matrix of domestic input coefficients;

Then, the equation (1) can be rewritten as follows:

$$A^D X + f^D = X \qquad (3)$$

Similarly, we can get other share structures,

$A_K \equiv [k_j] = [K_j / X_j]$, row vector of capital coefficient;

$A_L \equiv [l_j] = [L_j / X_j]$, row vector of labor (employment) coefficient;

$T_{EXr} \equiv [ex^r] = [EX_i^r\ / \sum_{i=1}^{n} EX_i^r\,]$, column vector of export share structure for country/region $r$;

$T_{Mr} \equiv [m^r] = [\,X_{i.}^{Mr}\ / \sum_{i=1}^{n} X_{i.}^{Mr}\,]$, column vector of competitive import share structure for country/region $r$.

Based on definitions above, one step further, we can get matrix for estimation of China's comparative advantage as well as the index of relative capital intensity (capital-labor ratio) in producing competitive import and export commodities,
**a.** $K_{EXr}=[A_K](I-A^D)^{-1}[T_{EXr}]$, capital requirements per ten thousand RMB of exports (to country/region *r*); $K_{Mr}=[A_K](I-A^D)^{-1}[T_{Mr}]$, capital requirements per ten thousand RMB of competitive import replacements from (country/region *r*).
**b.** Not unlike capital requirements, $L_{EXr}= [A_L](I-A^D)^{-1}[T_{EXr}]$, gives labor requirements per ten thousand RMB of exports (to country/region *r*), and $L_{Mr}=[A_L](I-A^D)^{-1}[T_{Mr}]$ gives labor requirements per ten thousand RMB of competitive import replacements (from country/region *r*).
Denote,
$\alpha_{EXr}= K_{EXr}/ L_{EXr}$, the capital-labor ratio of exports (home country-China);
$\alpha_{Mr}= K_{Mr}/ L_{Mr}$, the capital-labor ratio of competitive imports for China (trading partners);

Then, $\alpha= \alpha_{EXr}/\alpha_{Mr}$, depends, obviously, only on the relative (*rather than absolute*) amounts of capital and labor used per unit of each of these composite commodities. Thus, it can be used as an index of comparative capital-labor intensity in producing export and competitive import commodities, i.e., as long as the quotient α smaller than one, China is aiming at economizing its capital while disposing its surplus labor force.

### *2.2. Data Resource Constraints and the Processing*

Since China's 2002 IO table, released by National Bureau of Statistics of China, is the type that mixes imported and domestic intermediate inputs as well as final demands together, by adopting the proportion-assumption method, we have done the split-up for the research. Based on the 2002 IO table capturing China's processing exports compiled by Chen (Lau, Chen et al. 2006; Lau, Chen et al. 2007), we work out the table with seperated domestic and imported intermediate inputs. Then, by assuming the ratios of labor of each degree, categoried by education level, to the total employment in 2002 are identical to year 2004, we get whole sets of labor information[4]. By using data on China Economic Census Yearbook 2004, capital, i.e. (original value of) fixed assets, is collected and entered in.

For the exports/import data by countries/regions by IO sector of year 2002, they are calculated according to the *HS*[5]*-IO Concordance* provided by National Bureau of Statistics of China and maintained by Chen (Lau, Chen et al. 2006; Lau, Chen et al. 2007), and detailed trade data from China Customs[6].

## 3. Emperical Results and Discussions

According to the assumptions in H-O Theory, countries which intensively use the relative abundant factor to manufacture will have comparative advantage in goods. While technology available to each country is identical, which rules out Ricardian

[4] China Economic Census Yearbook 2004, China Statistical Yearbook (various years), released by National Bureau of Statistics of China.
[5] The Harmonized Commodity Description and Coding System (HS).
[6] We would like to thank Dr. Zhi Wang for the useful dataset he provided.

theory of trade, in that countries are either capital abundant or labor abundant depending on their relative capital intensity (capital-labor ratio) as compared to their trading partners. We have good reason to assume China has the same technology as its partners for the processing trade[7] dominate (take processing exports for example, it accounts for 55.3% of total exports in 2002) China's trade pattern. Therefore, China and its peers differ in their relative capital intensity, and the goods they produced differ in their required combinations of *K* and *L* needed to produce them.

China is regarded as the most labor-abundant country in the world by some criteria, see Table 2. Its economic relationships with its trade partners are supposed to be based mainly on the exports of such "labor-intensive" goods in exchange for foreign products which – if we were to make them at home – would require little labor and large quantities of Chinese capital. Thus, from an economic point of view china will produce such "labor-intensive" goods domestically and will exchange for capital-intensive products via trade.

The findings of the comparative endowment-abundance analysis is summarized in Table 1 in the following:

| Trading Partners | α | | | | | |
|---|---|---|---|---|---|---|
| | $\alpha_L$ | $\alpha_{L5}$ | $\alpha_{L4}$ | $\alpha_{L3}$ | $\alpha_{L2}$ | $\alpha_{L1}$ |
| EU15 | 0,762 | 0,911 | 0,882 | 0,827 | 0,790 | 0,719 |
| US | 0,977 | *1,000* | *1,022* | *1,014* | 0,993 | 0,955 |
| Japan | 0,569 | 0,843 | 0,741 | 0,649 | 0,610 | 0,514 |
| HK | 0,520 | 0,614 | 0,609 | 0,581 | 0,538 | 0,488 |
| Taiwan | 0,821 | 0,867 | 0,864 | 0,849 | 0,843 | 0,795 |
| ***Brazil*** | ***2,269*** | 1,052 | 1,539 | 1,965 | 2,133 | 2,493 |
| Canada | 0,925 | 0,930 | 0,960 | 0,958 | 0,940 | 0,907 |
| ***India*** | ***0,690*** | 0,799 | 0,728 | 0,692 | 0,689 | 0,687 |
| Mexico | 0,783 | *1,212* | *1,046* | 0,901 | 0,831 | 0,709 |
| Korea Rep. | 0,554 | 0,956 | 0,763 | 0,642 | 0,593 | 0,500 |
| Singapore | 0,528 | 0,602 | 0,596 | 0,555 | 0,556 | 0,494 |
| RoW | 0,541 | 0,486 | 0,539 | 0,493 | 0,513 | 0,581 |
| **WLD** | **0,634** | **0,672** | **0,687** | **0,637** | **0,636** | **0,627** |

Table 1. Domestic capital-labor input ratio of Chinese exports and of competitive import replacements.

Note 1. HK-Hong Kong, China; Taiwan-Taiwan Province, China; RoW-China's other trading partners excluding the eleven regions listed in the table; WLD-China's all trading partners in the world as a whole.
Note 2. $\alpha_{L(NO.)}$-the index of comparative capital-labor (*NO.*) intensity in the production of export and competitive import goods, *L5*-the labor that has the education degree of Graduate and above, *L4*-the

[7] Processing trade refers to the business activity of importing all or part of the raw and auxiliary materials, parts and components, accessories, and packaging materials from abroad free of duty, and re-exporting the finished products after processing or assembly by enterprises within Mainland China. Imported goods under the item of processing trade (usually called processing import) can only be used to produce exported goods in which case known as processing exports, but not allowed for other purposes, otherwise, it would be considered to violate the regulations. In addition, processing exports can be divided into two categories: Processing and Assembling (P & A) exports and Processing with Imported Materials (PIM) exports.

labor that has Bachelor's degree, *L3*-the labor that has degree of Technical College, *L2*-the labor that terminated as senior high school student, and *L1*-the labor that has the education of middle school and below.

In addition, the relative capital intensity are given in Table 2 below.

| | Capital* [Gross fixed capital stock (end of the year, in 2000 $ PPP); K] | Employment (L) (Thousands) | K/L (Capital-Labor Ratio; USD/Labor) |
|---|---|---|---|
| EU15 | 25556705024681 | 168982 | 151239,21 |
| US | 23833429838710 | 138214,42 | 172438,09 |
| Japan | 11927736665046 | 63300 | 188431,86 |
| HK | 453730916305 | 3220 | 140910,22 |
| Taiwan | 717469468536 | 9454 | 75890,57 |
| Brazil | 2618749744370 | 66373,2 | 39454,93 |
| Canada | 2431536896570 | 15364,8 | 158253,73 |
| ***India*** | 3311056687445 | 381101,47 | ***8688,12*** |
| Mexico | 1840881352071 | 39631,649 | 46449,78 |
| Korea Rep. | 2491403936488 | 22169 | 112382,33 |
| Singapore | 373941335506 | 2223,2 | 168199,59 |
| **China** | **11820196405001** | **737400** | **16029,56** |

Table 2. Relative capital intensity of different regions for year 2002.
Source: 1. K[8]: Abdul Azeez Erumban and Marcel P. Timmer (2007) "*Capital Services in PWT: New Results*", revised version of the Paper presented at the Workshop on "*Recent Developments in International Comparisons of Output and Productivity*", Groningen; 2. L: The Conference Board and Groningen Growth and Development Centre, Total Economy Database, November 2007.
Note: *Capital stock has been generated using Perpetual Inventory method, using PWT 6.2 investment data.

Obviously, China participates in international trade by maximazing its comparative advantage in labor-abundance while economizing its capital for almost all selected regions, which in accordance with classical economics (we can see from Table 2 the relative capital intensity for each region). Given all that, still we can find some slight differences within one region. Especially for the US, given the fact that China has comparative advantage of labor for the Sino-US bilateral trade, it is found that China's relative capital intensity, i.e. the capital-labor ratio, for labors that have degree of Technical College and above are bigger than that of the US, which indicates China's upgrading of capital content of such kind of exports to the US. In addition, estimates in the appendix give additional proof. Furthermore, as Schott (Schott 2006) stated, China's diverse regions, say Shanghai and Guizhou, may be ignored by aggregate assessment of China as a whole, which suggests that China may begin to export capital-intensive goods to the US long before the aggregate economy appears ready to do so, this also announced by Rodrik (Rodrik 2006) from policy point of view as "Government policies have helped…".

[8] We would like to show our deep appreciation to dr. Marcel Timmer for his helpful comments as well as drs. Abdul Erumban for his end-estimate capital stock data.

On the other hand, the *Leontief Paradox* finds support in China-India trade. One possible explanation is that many of the industries that most intensively use raw materials turned out to be the most capital-intensity ones (Romalis 2004). India is relatively abundant in raw materials and, in most cases, exports simply transformed raw materials, which, as Romalis noted, often end up being classified as capital-intensive exporting. The *Leontief Paradox* disappears, however, for the China-India trade when ignoring agriculture and non-tradeable sectors from our analysis. This interpretation also holds for the *Leontief Paradox* of China-Brazil trade, which, remains in the entire process of calculation, for China as a whole, witnesses the reality of China's condition similar to India, claimed by Coxhead (Coxhead 2007) as "a new resource curse". As a matter of fact, China's import of sector 4 (Metal ore mining) accouts for 36% of total import from Brazil while export of sector 19 (Tele-communication equipment, computer and other electronic equipment) takes one fifth of the total export volume.

## 4. Conclusion

The aim of this paper is to re-examine the H-O theory for China's multilateral trade with its selected trading partners in IO framework. All that is required to make these tests are two steps: to begin with, augmentation of the traditional IO model, i.e. the imported intermediate inputs and exports, which are sorted by origions and destinations; then, introducing an index of relative capital intensity (capital-labor ratio) to compute and compare two composite goods in China, namely exports and competitive imports. We find that, in accordance with the classical economics, say H-O theory, China resorts to foreign trade in order to economize its capital and dispose of its surplus labor from the investigation of selected regions, which indicates that the H-O theory finds support in the data. The abundance of labor in China still plays important role in the determination of its production structure and multilateral trade.

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## Appendix:

A1. China's 2002 IO Table Sectors Description

| IO Code | Description | IO Code | Description |
|---|---|---|---|
| 1 | Agriculture | 22 | Scrap and waste |
| 2 | Coal mining, washing and processing | 23 | Electricity and heating power production and supply |
| 3 | Crude petroleum and natural gas products | 24 | Gas production and supply |
| 4 | Metal ore mining | 25 | Water production and supply |
| 5 | Non-ferrous mineral mining | 26 | Construction |
| 6 | Manufacture of food products and tobacco processing | 27 | Transport and warehousing |
| 7 | Textile goods | 28 | Post |
| 8 | Wearing apparel, leather, furs, down and related products | 29 | Information communication, computer service and software |
| 9 | Sawmills and furniture | 30 | Wholesale and retail trade |
| 10 | Paper and products, printing and record medium reproduction | 31 | Accommodation, eating and drinking places |
| 11 | Petroleum processing, coking and nuclear fuel processing | 32 | Finance and insurance |
| 12 | Chemicals | 33 | Real estate |
| 13 | Nonmetal mineral products | 34 | Renting and commercial service |
| 14 | Metals smelting and pressing | 35 | Tourism |
| 15 | Metal products | 36 | Scientific research |
| 16 | Common and special equipment | 37 | General technical services |
| 17 | Transport equipment | 38 | Other social services |
| 18 | Electric equipment and machinery | 39 | Education |
| 19 | Telecommunication equipment, computer and other electronic equipment | 40 | Health service, social guarantee and social welfare |
| 20 | Instruments, meters, cultural and office machinery | 41 | Culture, sports and amusements |
| 21 | Other manufacturing products | 42 | Public management and social administration |

A2. Domestic capital-labor input ratio of Chinese exports and of competitive import replacements (excluded sectors of 26-42).

| Trading Partners | α | | | | | |
|---|---|---|---|---|---|---|
| | $\alpha_L$ | $\alpha_{L5}$ | $\alpha_{L4}$ | $\alpha_{L3}$ | $\alpha_{L2}$ | $\alpha_{L1}$ |
| EU15 | 0,728 | 0,893 | 0,872 | 0,797 | 0,756 | 0,694 |
| US | 0,983 | *1,072* | *1,087* | *1,069* | *1,011* | 0,949 |
| Japan | 0,507 | 1,030 | 0,725 | 0,568 | 0,541 | 0,469 |
| HK | 0,460 | 0,576 | 0,555 | 0,516 | 0,475 | 0,438 |
| Taiwan | 0,782 | 0,973 | 0,876 | 0,816 | 0,806 | 0,758 |
| ***Brazil*** | ***2,598*** | 1,068 | 1,882 | 2,520 | 2,509 | 2,708 |
| Canada | 0,919 | *1,001* | *1,005* | 0,988 | 0,942 | 0,893 |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***India*** | ***0,652*** | 0,708 | 0,637 | 0,615 | 0,640 | 0,665 |
| Mexico | 0,738 | *1,506* | *1,091* | 0,857 | 0,787 | 0,676 |
| Korea Rep. | 0,490 | *1,020* | 0,676 | 0,531 | 0,518 | 0,460 |
| Singapore | 0,513 | 0,702 | 0,667 | 0,564 | 0,541 | 0,480 |
| RoW | 0,537 | 0,734 | 0,699 | 0,608 | 0,566 | 0,503 |
| **WLD** | **0,616** | **0,837** | **0,768** | **0,682** | **0,645** | **0,583** |

A3. Domestic capital-labor input ratio of Chinese exports and of competitive import replacements (only sectors of manufacturing included, i.e. sectors 2-25).

| Trading Partners | α | | | | | |
|---|---|---|---|---|---|---|
| | $\alpha_L$ | $\alpha_{L5}$ | $\alpha_{L4}$ | $\alpha_{L3}$ | $\alpha_{L2}$ | $\alpha_{L1}$ |
| EU15 | 0,872 | 0,914 | *1,009* | 0,999 | 0,912 | 0,821 |
| US | 0,851 | *1,073* | *1,057* | 0,994 | 0,905 | 0,785 |
| Japan | 0,808 | *1,136* | *1,088* | 0,995 | 0,877 | 0,729 |
| HK | 0,551 | 0,585 | 0,648 | 0,664 | 0,574 | 0,515 |
| Taiwan | 0,891 | 0,990 | 0,963 | 0,945 | 0,922 | 0,857 |
| ***Brazil*** | ***1,185*** | 0,823 | 0,898 | 1,074 | 1,131 | 1,259 |
| Canada | 0,832 | *1,002* | 0,999 | 0,959 | 0,878 | 0,781 |
| India | 1,079 | 0,742 | 0,837 | 0,970 | 1,017 | 1,153 |
| Mexico | 0,910 | *1,590* | *1,360* | *1,150* | 0,991 | 0,804 |
| Korea Rep. | 0,811 | *1,156* | *1,054* | 0,956 | 0,874 | 0,742 |
| Singapore | 0,716 | 0,736 | 0,837 | 0,800 | 0,749 | 0,674 |
| RoW | 0,558 | 0,753 | 0,822 | 0,720 | 0,619 | 0,483 |
| **WLD** | **0,708** | **0,863** | **0,904** | **0,847** | **0,759** | **0,647** |