Title:

Is China Abundant in the Unskilled Labor?

- The departures from the HOV theorem and their implications

Ding Jianping
Department of Economics, Hitotsubashi University
Tokyo, Japan

Correspondence:
Ding Jianping
Add (Home): CG1, 4 13 5 Higashi Kunitachi-shi, Tokyo, Japan, 186-0002
Tel & Fax: +81 42 577 9608
Department of Economics, Hitotsubashi University
Add (Office): 2 1 Naka Kunitachi-shi, Tokyo, Japan, 186-8601
Tel : +81 42 580 8588
Email: ggem413@srv.cc.hit-u.ac.jp

The above addresses are ***subject to change*** on April 1st, 2000
Correspondence may address to:
Room 204, No.6, Lane 21, Ping Li Road, Putuo District, Shanghai
P.R. China, Post Code: 200065

Acknowledgements

The author received very useful comments and suggestions from Prof. Kyoji Fukao, Juro Teranishi, Hiroshi Tsubouchi, Makoto Ikema, Jota Ishikawa, Yue Ximing, and Ippei Yamazawa from Hitotsubashi University. However, all errors are solely the author's if any.

Is China Abundant in the Unskilled Labor?

-The departures from the HOV theorem and their implications

Abstract:

China will exert a great impact on the world market after its accession to the World Trade Organization (WTO) with its labor-intensive exports, since China has more than one fifth of the world's population[1]. Among which farmers make up 78.1%[2] of the share. This paper intends to measure the skill content embodied in China's net exports by using Maskus' (1994) methodology. All the occupations in China are classified in accordance with educational attainment. Although the empirical results match the Heckscher-Ohlin-Vanek (HOV) theory generally, some departures are apparent. China is not rich in all of its unskilled laborers because of "taste biases." Other constraints will also figure heavily in the measurement of skill content.

About the author
Dr. Ding Jianping is a special researcher in Department of Economics, Hitotsubashi University (Tokyo, Japan) at present. He was a member of Societies of International Trade, International Finance and Customs in China before 1993.

Is China Abundant in the Unskilled Labor?

-The departures from the HOV theorem and their implications

I. Introduction

Being a populous country, China will exert a large impact on international markets with its labor-intensive goods. If measured by absolute quantity (amount of labor), no country in the world can rival China. As advocated by the HOV theory, countries tend to export goods that are intensive in the factor with which they are abundantly supplied. Constrained by the data availability of natural resources and physical capital[3], we can only examine human capital stock, but it displays the main features of China's exports. Similar to other developing countries, China has experienced the natural-resource exporting stage for a long period. Only after economic reform did China begin to leap

the ladder of “labor-intensive-exports,” up which many other developing countries are still struggling. Nevertheless, does China really export its abundance as suggested by the ratio of its population? What implications can be induced from the departures of the HOV theorem? With these questions in mind, we endeavor to answer them empirically.

There is a large amount of literature and empirical studies on “factor content” among industrialized countries, however few are related to developing countries. Bowen *et al*. (1987) include the countries and regions like Brazil, Hong Kong, Korea, Mexico, and the Philippines, and leave China untouched. Bowen and Sveikauskas (1992) extend their factor content study by adding Burma and Egypt, but with more focus on developed countries. Wood (1991) analyses the factor content of North-South trade by using broad data without reference to individual countries. Maskus *et al*. (1994) group all developing countries together and compare their trade with the UK and the US. The UK is revealed as being specialized in capital-intensive activities in relation to developing countries. However, the result for the US is against conventional wisdom in that professional and skilled non-manual labors are ranked lower in the determination of US net exports with developing countries. This paper is the first attempt to use the input-output table of developing countries (China) as the benchmark to study factor content, instead of the single input-output table for the U.S., which has been predominantly used in previous studies.

After broad analysis on physical and human capital, recent studies have shifted attention to the detailed composition of human capital stock, since the future of international competition will be based around scientific and technological aspects. Webster (1993) attaches the educational content to his study, by advocating that human capital is an important determinant of country’s specialization in process of international trade. Maskus *et al*. (1994) began human capital stock studies with an empirical analysis of the US and the UK. Shortly after that, Engelbrecht (1996) did the same with an empirical test on West Germany.

This paper is based on the categorization of different occupations by educational attainment in the empirical analysis, and finds that labor content, when correctly classified, will reveal the ranking of abundance. Moreover, it is easy to be misled in cases of “taste biases,” shortage of other relevant factors, hidden unemployment, and when trading with natural-resource-biased countries, because all will prevent an

accurate measurement of labor content. Finally, extremely uneven distribution of the occupations across sectors will overvalue one factor while undervaluing the other.

The remainder of the paper proceeds as follows. In the next section, a short discussion is given on HOV and Maskus' (1994) methodology. Section Three specifies China's *A* and grouping of human capital by ANOVA. Empirical tests on factor content ranking are conducted in Section Four. Finally, Section Five draws the main conclusions. Specification of the occupations with different trading partners is attached to the appendix 1. The process of data compilation is specified in the appendix 2.

II. HOV Theorem and Maskus' Methodology

Before presentation of the HOV model, the following symbols should be specified. Matrices and vectors are indicated by capital letters, country or the world by right lowercase letters, factor number by left uppercase letter. The notations are thus listed as follows.

T_i = $n \times 1$ vector of the net exports by country *i*;

F_i = $m \times 1$ vector of factor endowments of country *i*, and $F_w = \Sigma_i F_i$;

A_i = $m \times n$ matrix of factor input requirements where the element a_{jk} indicates the amount of factor *j* used to produce one unit of commodity *k* in country *i*. Relaxation of the assumption from $m = n$ to $m \leq n$ is adopted in this paper[4].

Q_i = $n \times 1$ vector of commodities produced in country *i*;

C_i = $n \times 1$ vector of commodities consumed in country *i*;

Y_i = *GNP* of country *i*, and $Y_w = \Sigma_i Y_i$;

B_i = trade balance of country *i*.

Then the identities can be established between outputs, inputs and factor intensities

$$F_i \equiv A_i Q_i . \qquad (1)$$

Similarly, trade is related to outputs and consumption by the following identities

$$T_i \equiv Q_i - C_i . \qquad (2)$$

With the above identities introduced, we restate the HOV theorem. Given: (I) a competitive equilibrium with commodity price equalization, (II) constant returns to scale production functions with nonreversible factor intensities for all goods, (III)

identical technologies in all countries (IV) identical and homothetic preferences for all countries. In addition, (V) *incomplete specialization* is included, which is not specified in the Hechscher-Ohlin theorem. This assumes that China produces all the goods under the trade. Therefore, the input-output matrix *A* is the same for all countries i.e., $A_i = A$, and endowments and trade are related by the set of equations

$$AT_i = F_i - \alpha_i F_w . \qquad (3)$$

where $\alpha_i \;\; i = 1, \ldots, I$ is a set of positive scalars, that is, $\alpha_i = (Y_i - B_i)/Y_w$ with subscript *i* indicating individual country *i.*

From the assumptions aforementioned, we obtain identical input-output coefficients. As all countries face the same prices (I), the identical homothetic preference (III) implies that equal proportions of all commodities will be consumed.

$$C_i = \alpha_i Q_w \qquad (Q_w = C_w) \qquad (3A)$$

By summarizing the relations among the above identities, we find that identity (2), (1) and (3A) implies (3):

$$AT_i = A(Q_i - C_i) = F_i - \alpha_i A Q_w = F_i - \alpha_i F_w \qquad (4)$$

As long as A and T_i are provided, the most direct way to estimate the factor abundance is simply compute AT_i, the net export in factor services, which theoretically is equal to the excess supply of factors ($AT_i = F_i - \alpha_i F_w$). Since the matrix *A* is not square, therefore, it cannot be inverted. Consequently, trade has a degree of indeterminateness equal to $n - m$. However, any given net export of factor services $F_i - \alpha_i F_w$ can still be achieved in many different bundles of net exports T_i. In empirical study, only identical matrices *A* for different countries are required, not equal numbers of factors and commodities.

Murkusen *et al.* (1995) explicitly demonstrate the factor-ranking relationship for the case of *m* factors and *n* goods, with $n \geq m$. The ranking of factor abundance and scarcity for country *i* by virtue of its share of world endowments of each other stands logical as follows:

$$\frac{{}^1F_i}{{}^1F_w} > \frac{{}^2F_i}{{}^2F_w} > \cdots > \frac{{}^jF_i}{{}^jF_w} > \alpha_i > \frac{{}^{j+1}F_i}{{}^{j+1}F_w} > \cdots > \frac{{}^mF_i}{{}^mF_w} \qquad (5)$$

Under the HOV theorem, country *i*'s share lies somewhere in the middle of this *chain*.

For the sake of empirical estimation based on a country's data, ranking of factors indicated by inequality (5) is usually carried out in the following steps.

We start by rewriting equation (4) in order to make a comparison in the form of inequality (5).

$$F_i = AT_i + \alpha_i F_w \qquad (5A)$$

$$\frac{F_i}{F_w} = \frac{AT_i}{F_w} + \alpha_i = \alpha_i\left(\frac{AT_i}{\alpha_i F_w} + 1\right) = \alpha_i\left(\frac{AT_i}{F_i - AT_i} + 1\right) = \alpha_i\left(\frac{F_i}{F_i - AT_i}\right) \qquad (5B)$$

For simplicity, let us assume that there are only two factors, and *Factor 1* is relatively abundant than *Factor 2*.

$$\frac{{}^1F_i}{{}^1F_w} > \frac{{}^2F_i}{{}^2F_w} \quad \text{or} \quad \frac{{}^1F_i}{{}^1F_i - {}^1AT_i} > \frac{{}^2F_i}{{}^2F_i - {}^2AT_i} \qquad (5C)$$

This is subject to $\left({}^jF_i - {}^jAT_i\right) > 0$. Multiply both sides of inequality (5C) by $\left({}^1F_i - {}^1AT_i\right)\left({}^2F_i - {}^2AT_i\right)$, the inequality will be

$${}^1F_i\left({}^2F_i - {}^2AT_i\right) > {}^2F_i({}^1F_i - {}^1AT_i) \quad \text{or} \quad {}^1F_i \times {}^2F_i - {}^1F_i \times {}^2AT_i > {}^2F_i \times {}^1F_i - {}^2F_i \times {}^1AT_i \qquad (5D)$$

$$-{}^1F_i \times {}^2AT_i > -{}^2F_i \times {}^1AT_i \qquad (5E)$$

We can infer from equation (1) and (2) that the following equation is also valid.

$$F_i = AQ_i = A(T_i + C_i) \qquad (5F)$$

To simplify the notations, we redefine $AT_i = F_i^T$ and $AC_i = F_i^C$. Thus equation (5F) will become

$${}^jF_i = {}^jF_i^T + {}^jF_i^C \qquad j = 1, 2. \qquad (5G)$$

Replace inequality (5E) by equation (5G), we will arrive at

$$-\left({}^1F_i^T + {}^1F_i^C\right) \times {}^2F_i^T > -\left({}^2F_i^T + {}^2F_i^C\right) \times {}^1F_i^T \quad \text{or} \quad -{}^1F_i^C \times {}^2F_i^T > -{}^2F_i^C \times {}^1F_i^T. \qquad (5H)$$

Divide both sides of equation (5H) by $-{}^1F_i^C \times {}^2F_i^C$, we finally reach

$$\frac{{}^1F_i^T}{{}^1F_i^C} > \frac{{}^2F_i^T}{{}^2F_i^C}, \qquad (6)$$

where, ${}^jF_i^T$ and ${}^jF_i^C$ are total (direct plus indirect) factor requirements of net exports and consumption of factor *j*. This applies to any pair of factors (pair-wise comparison), i.e. ratios of net export requirements to consumption can be used to establish factor abundance rankings. Consumption implies the proportion relative to the world because

of identical homothetic tastes assumption. Rankings of inequality (6) are valid for an arbitrary number of factors, given the validity of the HOV theorem under fairly general circumstances. Similar to inequality (5), inequality (6) is also a chain of factor comparison in a multi-factor case.

$$\frac{{}^{1}F_i^T}{{}^{1}F_i^C} > \frac{{}^{2}F_i^T}{{}^{2}F_i^C} > \cdots > \frac{{}^{j}F_i^T}{{}^{j}F_i^C} > 0 > \frac{{}^{j+1}F_i^T}{{}^{j+1}F_i^C} > \cdots > \frac{{}^{m}F_i^T}{{}^{m}F_i^C} \qquad (7)$$

It also follows that country *i*'s net exports of the service of any factor ${}^{j}F_i^T$ (${}^{j}F_i^T = {}^{j}AT_i$) are *positive* if its abundance ranking for that factor lies above the consumption share, and its net exports are *negative* if its ranking lies below that share. Thus, a country exports the services of its abundant factors and imports the services of its scarce factors when factor abundance is measured relative to a global standard.

Therefore, this paper, like many previous studies, such as Webster (1993), Maskus *et al.* (1994) and Engelbrecht (1996), starts from less stringent assumptions. Then we apply Maskus' methodology. Given the techniques and data of China, the estimations of this paper do not represent a formal test of the HOV theorem. Our approach has been to provide summary estimates on the factor intensity of trade, which allows a degree of insight that a more formal procedure would deny.

To determine the human capital stock required to produce this trade flow with China's coefficients, we multiply *n*-item trade vector *T* by a *m*×*n* matrix *A*, in which the elements a_{jk} (j = 1, 2, …, m; k = 1, 2, …, n) represent an average of China's direct requirements for labor of *m* occupation (in the form of wage share) to export one unit. This implies that whether China's endowment *j* exceeds world endowment *j* or not. The ranking will be dramatically altered if the content of consumption acts as a denominator.

III. Selecting Matrix *A* and Grouping Human Capital

As aforementioned, this paper distinguishes itself by adopting China's matrix *A*, unlike the previous studies, with majority based on that of the U.S., such as Leamer (1992), Maskus (1994) and many others. Webster (1993) and Engelbrecht (1996) apply matrices of their own countries (U.K. and Germany) to the factor-content studies. Although being the same industrialized countries, U.K and Germany have their separate technical requirements and demonstrate different results. This allows meaningful examinations of

factor-content studies. Selecting China's matrix *A* is also to this endeavor. It may contain more implications since China is a developing country. Wong (1995:111) lists several advantages of using domestic coefficients[5]. Theoretically, all the assumptions made above are taken for granted because of using all the data from a single country. Empirically, it is easier to identify different inputs (occupations, and physical capital in this paper) with relative codes in input-output table. Furthermore, using the technologies of a country's trading partner proves to be very difficult in practice.

According to the statistics of China's occupational classification, all of the employed fall into eight categories. Although the definition for each occupation is specified in detail by Feng *et al*. (1994), it is also based on industrial classification, and career transfer within the same skill category is not addressed. Is it credible to regard these categories as eight factors of production? Can we take it for granted that "machine assemblers and precision instrument workers" are similar to "wood, bamboo, flax, rattan and straw processing workers," despite the fact that these two kinds of workers have different levels of educational attainment? Webster (1993:152) studies this problem of disaggregation and aggregation of factor inputs, "On the one hand, unwarranted disaggregation violates the theoretical basis of the model, and on the other hand, excessive aggregation risks overlooking important sources of international specialization." Let us assume that there exists no arbitrary barrier, which prevents a career change at the same level of educational attainment. Obviously, China's official occupational classification disregards this point. Career by industrial sector is not a type of production factor. As a factor, it should be relatively stable. This requires special training either at university level or in vocational schools. It is ridiculous for a graduate of literature to apply for a position in chemical lab. However, it is possible to ask a farmer to engaging in fishing. Basic education (primary school, middle school and high school) is suitable for a broad range of carriers. The longer vocational training required, the higher cost incurred for the individual, and therefore, it is unlikely for him to move to other trades. The lower the educational attainment, the more likely there will be movement between occupations. Due to the temporary mobility of workers between sectors and the chance of fluctuation, a benchmark must be set. Since the workers with low educational attainment are considered mobile, we classify the occupations in line with high educational attainment (i.e. university, college and vocational school

graduates) and aggregate 62 occupations into six groups.

Group 1, "farmers and other agricultural manual labor" covers those people with primary school education or no education at all, engaged in manual work in the fields. ***Group 2***, named "tertiary and resource-related workers," contains the low educated service workers and those who tie closely onto natural resources. In fact, the resource matters in their export performance, i.e., the less resource, the fewer workers.

Group 3, termed "manufacturing manual workers," though with relatively higher education than the previous two, still demands hand-operations (physical labor) in most cases.

Group 4, entitled "manufacturing technical workers," consists mostly of graduates with majors in natural science.

Group 5 "managerial, administrative and others" is full of graduates of social science and others.

Group 6 called "scientific intellectuals" with the highest educational attainment.

(Insertion: Table 1.)

As a factor of production (group as a whole), it should be identified by its special characteristics; both in education attainment and in export performance. Analysis of variance (ANOVA) is the test used to verify the above classifications, "Thus, if 'within category variations' are statistically insignificant in relation to 'between category variations' we can conclude that the level of aggregation employed does not ignore important effects" (see Webster, 1993: 152). The results of ANOVA test by "occupational" and "educational" classifications are presented in Table 2. The "*F* ratio" demonstrates whether the variation "between category" is larger or smaller than "within category." While the "occupational aggregation" (seven groups classified by the State Statistical Bureau) fails in export performance test, the "skill aggregation" (six groups) survives both tests and is significant.

(Insertion: Table 2.)

IV. Empirical Results of Human Capital Rankings

After the aggregation of 63 occupations into six groups in line with educational attainments, and after the application of Maskus' methodology, the skill ranking of China's net exports is obtained. We have demonstrated, as expected according to HOV

theorem, that China is rich in the unskilled and poor in the skilled workers in its net exports generally, but not in absolute terms.

Constrained by the data, we are unable to access to data of occupations and input-out tables over a long period form the past[6]. Nevertheless, let us assume approximation to reality of factor intensity and technical coefficients (with 1992 as a benchmark). This can be justified by the composition of China's population with 70% □80□ in the rural areas between the 1950s and 1990s (estimation period).

1. General framework of China's human capital stock

We intend to reveal which occupational group is the most abundant within the category of low educational attainment, and similarly, which is the scarcest within the high category. Replacing historical trade data and adding physical capital data are only to serve as a verification of the rankings. Meanwhile, an attempt is made to find out the departures from the HOV, due to some constraints arising from production, policy distortions, and violation of the assumptions.

(Insertion: Figure 1A and B.)

(1) The groups within the category of low educational attainment

"Farmers and other agricultural manual labor" (***Group 1***) fluctuates notably at each stage. Only in 1950s were the farmers found to be abundant. Since then, the ranking drops to the bottom. On the average, this group stands the *fourth*. The Chinese farmers have been sustaining 20% of the world population with only 7% of the world's arable land. In accordance with the HOV theorem, the Chinese farmers should be regarded as an abundant factor since its share in the labor force (72%) exceeds the world average (49%).[7] Markusen *et al*. (1995) list "taste biases" as one of explanations of Leontief's paradox, which violate the assumption of "identical and homogeneous preferences." The Chinese have a strong preference for food consumption, amounting to 61% of total household expenditure, which nearly doubles the world average (32.44%)[8]. This will, in turn, claim on food supplies. Therefore, consumption preference and arable land appear to be the major constraints. In addition to that, policy failure is also the consequence. This is reflected by:

(A) *Uncontrollable birthrate*: A glimpse of China's population growth will give a better understanding. Mao's ideology "the more people, the higher productivity" accelerated "birth-boom" and the correction came too late. The population growth is indicated as

follows:

(Insertion: Table 3.)

Only after 1974 did China adopt a "family planning" policy (i.e., one family one child). Though the absolute agricultural output is the highest in the world, after "consumption," it is lower than the world average (see Table 4). What makes the situation even worse is the continuing growth of population in absolute number, which makes the size and the consumption ratio almost unchanged throughout the period.

(Insertion: Table 4.)

(B) *Hidden unemployment*: Although limited by the arable land, Chinese farmers were long confined to the fields by "resident registration." They were not allowed to leave the rural areas or to engage in other trades even if they had nothing to do in slack seasons before the "economic reform" (some restrictions still linger on). What made the situation even worse was that the countryside had been regarded as a "dumping place" of unemployment. The typical example is the "Great Cultural Revolution," during which thousands of urban graduates were "dumped" into the rural areas. It seems that the rural areas can always hold the urban jobless in economic recessions. Natural disasters interrupted by political turmoil further deteriorate the situation.

The "economic reform" and "open-door" policy released the Chinese farmers to work to their full capacity. The surplus rural labor (hidden unemployed) could freely move to other trades or undertake "contracts" in the urban areas. However, the past shadow still prevents the adequate measurement of the Chinese farmers' contribution to the exports. The Chinese farmers, at the lowest "educational attainment," are regarded as the most volatile according to the principle of factor classification, but in reality, that is not the case. Featherbedded by hidden unemployment, absolute number of farmers may not be as great as indicated by the statistics.

What arouses a great concern is low educational attainment of this group. 23% of the farmers are semi-illiterates and 45% of them only have primary school education. On the average, the ratio of one technician to hundreds of farmers makes dissemination of advanced knowledge almost impossible. With a trend of the global agriculture toward capital-intensiveness, the demand for highly educated farmers will increase accordingly and it is hard for China to keep abreast with this progress.

"Tertiary and resource-related workers" (***Group 2***) comes the *second* in the abundant

ranking. The ever-growing domestic consumption of limited natural resources and the fledgling service industry make it impossible for this group to climb up the ranking. During the "Great Cultural Revolution," China had few commodities to export except for natural resources; this situation lasted until the initial stage of the economic reform in 1980. Since 1990s, China became the first in the world coal and the fifth in crude petroleum production, however, the economic development accelerates the demand as well. Being tied to the natural resources, group 2 will step down the ladders in the year to come with growing domestic consumption of natural resources.

"Manufacturing manual workers" (***Group 3***) has maintained the *first* ranking ever since 1960s, their role has been increased after the economic reform and with the growth of trade. Especially after 1987, China jumped to the top position in exporting textiles and apparel, reaching 14 % share of the world. Group 3 is regarded as an abundant factor even after taking share of consumption into account. There are almost no constraints on its supply. This group demands only "primary, middle school" educational attainment (compulsory for every child in China), little physical capital inputs (sewing machines, forging machines and mills), low consumption share, and resource dependency.

It is common for a country at its initial stage of economic takeoff that middle school education plays a crucial role in its exports. This is true to Group 3, with more than half graduated from middle schools. This happened in Japan in early 1950s and other newly industrialized Asian countries in late 1960s. Moreover, the ratio of middle school graduates in China is approximate to the world average[9]. With exception of 1950s, Group 3 is regarded as an "inexhaustible" factor. After China's accession to WTO, the tariff against the exports of this group will be reduced (closer to the assumption of HOV: "absence of impediments to trade"), Group 3 will, as expected, keep its first ranking and reveal China's real abundance in future.

(2) The groups within the category of high educational attainment

"Manufacturing technical workers" (***Group 4***) and "Scientific intellectuals" (***Group 6***) have been regarded as the most *scarcity* in China with no seen improvement in rankings (except for the period of crop failures and huge trade deficits). This can be interpreted either by fewer graduates of natural sciences (chemicals, physics and others) or by serious shortage of physical capital. Capital is indispensable for any scientific research projects because we cannot imagine that the scientists can conduct experiments with a

piece of paper. Suspension of university enrollment during the “Great Cultural Revolution” causes “time-lag,” casting a shadow on the measurement of these groups for next decades. Human capital investment is an accumulated process, different from physical capital, because development of new skills often involves a lengthy investment. The crop failures tend to improve the rankings of technical workers and scientists due to an uneven distribution of these groups between the industries. Although more than 70% of the population is engaged in farming, “scientific intellectuals” are highly represented in manufacturing sectors. As a result, the more farm products are exported, the lower rank “scientific intellectuals” will be, and vice versa. The extreme uneven distribution of Group 6 between two industries in China is depicted as follows:

(Insertion: Table 5.)

The above structure produces a misleading result during the crop failure. Likewise, the previous empirical studies attribute this “departure” to “huge trade deficit,” i.e., when a country running huge trade deficit, it is unlikely to reveal its truth. This happened during the oil shock or big famine, large expenditure on imports reflected by big minus of some elements in “net export vector” will topple all the results.

“Managerial, administrative and others” (***Group 5***) is not a scarce factor for keeping the *third* position. Supervisors and administrative personnel make up the majority of it. Although this group demands relatively higher educational attainment, there are few constraints, such as physical capital, on this group since social science does not demand that. Comparatively speaking, it is easier for people to transfer to the social sciences than to the natural ones because the later requires a prolonged systematic education. Moreover, even distribution of this group across the sectors makes the ranking very stable.

As reiterated by Keesing (1965) and Webster (1993), skills and higher educational content get a decisive edge in international competition, since the education is largely provided by the state, therefore, skill contents reflect the past government educational policy. The endless political movements in 1960s and 1970s weakened China’s international competitiveness. Moreover, relatively small proportion expenditure on education both by state and household (lower than the world average) gives rise to the future concerns.

Mingled with other factors (constraints, i.e., physical capital, consumption

preference, natural resources, and arable land), the estimation of human capital eventually reveals itself. *Not all the low-educated groups are rich, and nor the entire high-educated groups are poor in China*.

2. Inclusion of physical capital and problems of sector-aggregation

Any "multi-factors and multi-goods" case can be regarded as "two-factors and two-goods" model by aggregation. In order to verify the ranking of physical capital, the original commodity matrix of input-output table must be sorted out to fit the data of physical capital stock. Up to now the sources of China's physical capital stocks are listed in the following table.

(Insertion: Table 6.)

By using directly the data from Wang *et al*. (1998) and adapting agricultural sector form Chow (1993), we aggregate 42-commodity matrix (may be regarded as 42 sectors) into 16-sector matrix. Needless to say, the aggregation destroys the useful information entailed in those aggregated commodities. The problems of aggregation are listed as follows:

1. "Other manufacturing industrial sectors" (***Big Others***) averages capital stocks of different industrial sectors.
2. Inclusion of "***seemingly-related***" sectors in "manufacture of *chemica*l products" and "*electric* machinery and instrument" may lead to the biased results. To avoid *problem 1* (Big Others), then *problem 2* (seemingly-related) will occur.

The two problems of aggregation have effects on the ranking of human capital stock by raising status of "scientific intellectuals" (G6) and lowering the rankings of G4 and G1. The empirical results are presented in Table 7.

(Insertion: Table 7.)

The general framework of human capital ranking is not greatly reshaped after aggregation. The conclusions are thus reached.

(Insertion: Table 8.)

(1) The most scarcity in China is "physical capital" (K). This is consistent with the conventional wisdom that it is unlikely for a low-income developing country to be rich in machinery and plant building. However, among the human capital stocks, "manufacturing technical workers" (G4) is ranked lower than "scientific intellectuals" (G6) is misleading due to the aggregation problems.

(2) The most abundance is “manufacturing manual workers” (G3) with relative low educational attainment. Aggregation of sectors does not affect the ranking of this group.

(3) “Farmers” (G1) ranking is worsened after aggregation for the unknown reasons. The aggregation of several sectors (agriculture, forestry, livestock production, fishing and others) into one sector seems justifiable.

The more sectors are, the much information will retain. The aggregation of sectors will destroy much of the information indispensable to accurate measurement of China’s human capital stock. The present study deals exclusively with ranking of human capital based on two assumptions.

First, the ranking between physical capital and human capital is relatively stable. Keesing (1965), Webster (1993), Maskus *et al*. (1995), and Engelbrecht (1996) *narrow down* their analyses to human capital ranking exclusively.

Second, the ranking of human capital will *not alter* as long as sectors in *IO table are kept unchanged*. If the detailed data concerning physical capital becomes available, the accurate measurement of all factors will be possible.

V. Conclusions

China has a large supply of cheap labor relative to its supply of other factors; therefore, China will tend to produce relatively more goods that use its abundant factors intensively. This is confirmed by the empirical study. The main findings of this paper indicate that China is not rich in all of its low-educated labor and poor in its entire high-educated profession due to many constraints. A special attention should be paid to the subgroups within the “low-educated category.” 900 million[10] farmers are not ranked as China’s first abundance. Thus, absolute large numbers are not an “abundant factor” after taking consumption preference into account. The rest of findings are as follows.

First, the most abundant factor in China is “manufacturing manual workers” with low educational attainment because of fewer constraints (physical capital, land, and natural resources). In absence of serious impediments to trade from its trading partners (after China’s accession to WTO), there is room for the further expansion of this group.

Second, the consumption share of Chinese farmers is such a big one as to swallow

its contribution to exports. It is undeniable that the Chinese have a strong preference for food consumption, thus leading to the departure from the assumption of HOV. Large hidden unemployment in the rural areas and absolute growth in number prevent the proper measurement. It obviously violates the “full employment” proposition of HOV. The historical distortions, i.e., the “resident registration” which pegs the Chinese farmers to the land and the “dumping place” of urban jobless during the “Cultural Revolution”, swell the real numbers of Chinese farmers.

Third, it goes in agreement with the conventional wisdom that China is lacking in skilled workers, especially “manufacturing technical workers” and “scientific intellectuals.” The scarcity of these high-educated groups is not only due to the physical capital constraint, but also to the suspension of higher education during the political turmoil in 1960s and 1970s. Besides, the difference can be seen between the natural and social sciences, such as fewer manufacturing technicians and more administrative personnel. For a developing country, it may be rich in managerial and administrative personnel. An uneven distribution between agricultural and manufacturing sectors tends to overvalue China’s “scientific intellectuals” status when trading with the countries exporting large amounts of farm products.

Finally, adding a factor such as physical capital does not alter the rankings of human capital so long as the *n* keeps unchanged. Therefore, any aggregation of commodities or sectors will affect the rankings to some extent because relevant information is damaged. China is badly in need of physical capital, which serves as a premise for China’s technicians and intellectuals to climb the ranking.

Further studies on capital stock and natural resources are highly necessary if the adequate data becomes available. Meanwhile, bilateral testing of factors based on unified input-output and occupational codes will reveal more findings.

Appendix 1

Specialization of the Skills with the Different Trading Partners

It is possible to rank the endowment of any country by computing its share of each endowment in the global supply, with the most abundant factor being the highest share and the scarcest factor being the lowest one. However, it lacks in theoretical support

when ranking factors in bilateral trade. Wong (1995) compares this case to "$F_i + F_r = F_w$" (where *i* is home country; *r* is rest of other countries; *w* is the whole world), and assumes that it is similar to the chain inequality (7). Maskus *et al*. (1994) bypass this issue by discussing international specialization. With the same approach, this appendix addresses the probability of specialization in occupations (skills) bilaterally.

(Insertion: Table 9.)

The above tables can also be illustrated as follows (Figure 2A/B).

(Insertion: Figure 2A and B.)

Since the above tables and figures are arranged in the order of trade volume with China, we rearrange them in the following way to identify which group (educational level) has specialization possibility and which has not. These trading partners are classified into three categories by economic development, i.e., developed, newly developed, and developing countries.

(Insertion: Table 10.)

The results give little enlightenment to educational attainment or occupational specialization. They seem to serve as proxies of natural resources between China and its trading partners. For example, the average arable land per country in the world is 11%, the China's ratio is 10%, below the world average; whereas, the ratio of U.S. is 20%, France 35% and Thailand 41%, exceeding the world average[11]. This phenomenon also arises in Maskus *et al*. (1994) when they interpret the advantage of the American farmers, who serve as a proxy for the large land endowment in U.S. bilateral trade. Keesing (1965: 288) argues, "In measurements of total trade, natural resources tend to dominate trade patterns and obscure the role of labor skills."

The high-educated category ranks lower (or in negative signs), any specialization seems impossible. This matches the HOV theorem in that China is not only lower than the world average in educational attainment, but also lower than most of the Asian developing countries. Only to Thailand is China's "scientific intellectuals" found to be "plentiful" It is misleading to regard that China has a higher educational attainment ratio than that of Thailand. All statistics compiled by the United Nations Educational, Scientific and Cultural Organization (UNESCO) confirm that it is not the case, i.e.,

China has a lower ratio in all aspects. This phenomenon is also due to the uneven distribution of the group among the sectors.

However, it cannot be inferred that ranking of the high-educated groups will rise simply by provision of sufficient physical capital. China did a large purchase of facilities and equipment from abroad in attempt to modernization of its industry in a very short time span. None are very successful. The lessons have been learnt over and over again that educational investment is an accumulated process.

Appendix 2
Data Compilation and Aggregation

1. Data relevant to matrix *A*:

(1) Department of National Economic Accounting, State Statistical Bureau of P. R. China (1996) *Input-Output Table of China 1992* (Value) China Statistical Publishing House. The book provides information for 118 commodities (118×118 matrix).

(2) The Population Census Office under the State Council and Department of Population Statistics, State Statistical Bureau, P. R. China, (1994) *Tabulation on the 1990 Population Census of the People's Republic of China, Volume 2* China Statistical Publishing House. The book lists Table 6-26 and Table 6-27 (p. 728-859), providing all the data required for the empirical test. The detailed information of human capital stock in China is available, by occupation (309 professions), by education (7 levels) and by industry (75 sectors). As a direct input, labor statistics contain 64 aggregate occupational employment classifications (which can be further subdivided into 309 occupations with 7 rankings of educational attainments).

Matching of the census data to the input-output (IO) table proves to be a demanding task, however according to the industrial classification description of China's IO table 1992 (p. 378-395), the allocation is carried out with little effort. There is no wage data by occupation, and we substitute for it by using sector average wage originating from the *Yearbook of Labor Statistics of China, 1993* (p.195—300). In China, the wage variance can be disregarded due to the "perverted equality" of income distribution in the past.

2. Data of Imports and Exports:

(1) Year 1955, 1964 and 1980: The trade data before China's economic reform in 1955, 1964, and shortly after the reform 1980 are originated from internal source processed by *Asian Historical Statistics Project* under the Institute of Economic Research, Hitotsubashi University, Tokyo, Japan. All the import and export data are precise (1955, and 1964 are in China's unique classifications, 1980 is in SITC, and 1996 is in HS classification), which makes it possible to find the respective commodity category in China's IO table.

(2) Year 1992: "Net Exports" (1992) is directly derived from China's IO table (1992) compiled by Department of National Economic Accounting, State Statistical Bureau of P. R. China (1996) (*Input-Output Table of China 1992* (Value) China Statistical Publishing House.)

(3) Year 1996: It is originated from *China's Customs Statistics Yearbook, 1996,* edited and published by General Administration of Customs, P. R. China.

(4) The data for bilateral trade with *14 countries* is taken from *China's Customs Statistics Yearbook, 1992,* edited and published by General Administration of Customs, P. R. China. However, In order to make use of all available information, the selected countries for factor content comparison are China's major trading partners, ranging from developing countries to industrialized ones. The transaction volume with these countries is around 76% of China's total trade excluding Hong Kong, Macao and Taiwan.

References

Bowen, Harry P. Leamer, Edward E. and Sveikauskas, Leo, "Multicountry, Multifactor Tests of the Factor Abundance Theory," *The American Economic Review*, 5, 1987, p. 791-809.

Bowen, Harry P. and Sveikauskas, Leo, "Judging Factor Abundance," *The Quarterly Journal of Economics*, 2, 1992, p. 599-620.

Engelbrecht, Hans-Jurgen, "The Composition of the Human Capital Stock and the Factor Content of Trade: Evidence from West(ern) Germany," *Economic System Research*, 3 1996, p. 271-291.

Feng, Guiling, and Zhu, Zijie, *Complete Work of Classification of China's Occupation*, (ZhongGuo ZhiYe FenLei DaQuan), China Labor Publishing House, 1994.

Keesing, Donald B., "Labor Skills and International Trade: Evaluating Many Trade Flows with a Single Measuring Device," *Review of Economics and Statistics*, 47, 1965, 287-294.

Leamer, Edward E., "The Leontief Paradox, Reconsidered," *Journal of Political Economy*, 3, 1980, p. 495-503.

Leamer, Edward E., "Testing Trade Theories," *Working Paper* 3957 Cambridge, MA, *NBER*, 1992.

Leamer, Edward E. and Levinsohn, James, "International Trade Theory: The Evidence," in

Gene M. Grossman and Kenneth Rogoff , eds., *Handbook of International Economics*, III, Elsevier, 1995, p. 1339-1394.
Leontief, Wassily, "Domestic Production and Foreign Trade: The American Capital Position Re-examined," *Economia Internazionale*, 7, 1954, p. 3-32.
Markusen, James R., Melvin, James R., Kaempfer, William H. and Maskus, Keith E., *International Trade: Theory and Evidence*, McGraw-Hill, Inc. 1995.
Maskus, Keith E. and Webster, Allen, "Factor Specialization in U.S. and U.K. Trade: Simple Departures from the Factor-Content Theory," Schweizerische-Zeitschrift-fur-Volkswirtschaft-undStatistik) *Swiss Journal of Economics and Statistics*, 3, 1995, p. 419-439.
Maskus, Keith E., Catherine D. Sveikanskas, and Webster, Allan, "The composition of the Human Capital Stock and its Relation to International Trade: Evidence from the US and Britain," *Weltwirtschaftliches Archiv, Review of World Economics*, 130, 1994, p.51-70.
Maskus, Keith E. and Webster, Allen, "Estimating the HOV Model with Technology Differences Using Disaggregate Labor Skills for the United States and the United Kingdom," *Review of International Economics*, 1, 1999, p. 8-19.
Trefler, Daniel, "The Case of the Missing Trade and Other Mysteries," *The American Economic Review*, 5, 1995, p. 1029-1046.
Webster, Allen, "The Skill and Higher Educational Content of UK Net Exports," *Oxford Bulletin of Economics and Statistics*, 2, 1993, p. 141-159.
Wong, Kar-yiu, *International Trade in Goods and Factor Mobility*, The MIT Press, 1995.
Wood, Adrian, "The Factor Content of North-South Trade in Manufactures Reconsidered," *Weltwirtschaftliches Archiv, Review of World Economics*, 4, 1991, p. 719-742.

Table 1.
Groups of Human Capital Embodied in China's Net Exports to the World, 1992

Occupational Description	Group	Average Educational Attainment	Ratio of net exports to consumption
Farmers and other agricultural manual labor	G1	0.06321	0.01004
Tertiary and resource-related workers	G2	0.14432	0.04250
Manufacturing manual workers	G3	0.18105	0.11874
Manufacturing technical workers	G4	0.27722	-0.00246
Managerial, administrative and others	G5	0.50949	0.02616
Scientific intellectuals	G6	0.85235	-0.00382

Notes:

1. "Average Educational Attainment" is the ratio of those with university, college and vocational school attainments against the total group numbers.
2. "Ratio of net exports to consumption" refers to ratio of factors embodied in China's net exports relative to factors embodied in consumption.

Sources:

Occupation and educational attainment data are originated from *Tabulation on the 1990 Population Census of P.R. China* Volume 2, compiled by the Population Census Office under the State Council and Department of Population Statistics, State Statistical Bureau, P.R.China. The aggregation is done according to ANOVA in Section 3.

Table 2. Analysis of Variance (ANOVA) of China's Human Capital Classification

A. 6 Categories divided by educational attainment

Source of variation	Sum of squares	Degrees of freedom	Mean square error	F ratio	Prob > F
	I. According to Eduational Attainment				
Between groups	2.81973804	5	0.5639476	43.86	0.0000
Within groups	0.73293897	57	0.0128586		
Total	3.55267701	62	0.0573012		
	II. According to Net Export Performance				
Between groups	0.08489215	5	0.0169784	2.04	0.0867
Within groups	0.47462360	57	0.0083267		
Total	0.55951575	62	0.0090244		

B. 7 Categories divided by the State Statistical Bureau.

Source of variation	Sum of squares	Degrees of freedom	Mean square error	F ratio	Prob > F
	I. According to Eduational Attainment				
Between groups	2.28581456	6	0.3809691	16.84	0.0000
Within groups	1.26686244	56	0.0226225		
Total	3.55267700	62	0.0573012		
	II. According to Net Export Performance				
Between groups	0.02276540	6	0.0037942	0.40	0.8786
Within groups	0.53675036	56	0.0095848		
Total	0.55951575	62	0.0090244		

Number of observation = 63

Notes:

1.Since there is only one observation of "laborers not elsewhere classified "in educational attainment, we classify it to the "subtotal of staff and personnel" because of similar educational attainment."

2. "*F* ratio" indicates numerator and denominator as follows: *F* = variance explained by education (or occupation)/unexplained variance.

3. "Educational attainment" refers the ratio of those gradates from university, college and vocational school against the total numbers of the group.

4. "Net Export Performance" is the ratio of net exports to consumption.

Table 3. Growth of Population in China

Year	1954	1964	1969	1974	1986
Population	600 million	700 million	800 million	900 million	1060 million
Time Span		10 years	5 years	5 years	12 years

Table 4. Ranking of China's Agricultural Output in the World during 1949 1994

	1949	1957	1965	1978	1980	1985	1992	1993	1994
Cereal	—	3	2	2	1	2	1	1	1
Meat*	3	2	3	3	3	2	1	1	1
Cotton	4	2	2	3	2	1	1	1	1
Peanuts	2	2	3	2	2	2	2	2	1
Rape seed	2	2	2	2	2	1	1	1	1
Sugarcane	—	3	—	9	9	4	3	3	3
Tea	3	3	3	2	2	2	2	2	2

Notes: * refers to the ranking of pork, beef, and mutton during 1949-1992, and all meat in 1993.
Source: State Statistical Bureau, P.R.China, *China Statistical Yearbook, 1995*.

Table 5. Uneven Distribution of Scientific Intellectuals between the Sectors

Agricultural Sectors	Manufacturing Sectors
Ratio of Scientific Intellectuals: 4.59%	Ratio of Scientific Intellectuals: 91.09%
Farm Products Exports →∞, G6↓	Manufactures Exports →∞, G6↑

Table 6. Incorporation of Physical Capital into the Ranking

Author & Publication	Time Span	Sectors
Chow (1993) Chow, Gregory (1993) Capital formation and economic growth in China, *The Quarterly Journal of Economics* 108, (3):.809-842.	1952-1985	1. Agriculture 2. Industry 3. Construction 4. Transportation 5. Commerce
Wang *et al*. (1998) Wang Yongfeng, Ren Ruoen and Liu Xiaosheng (1998) Estimation of physical capital stock in China's manufacturing sectors, (working papers), Institute of Management, Beijing Aviation and Spaceflight University	1979-1995	1. Manufacture of food 2. Manufacture of beverages 3. Manufacture of tobacco 4. Manufacture of textiles 5. Manufacture of wearing apparel 6. Manufacture of leather, fur and their products 7. Sawmill and wood processing 8. Paper products and printing industry

		9. Manufacture of chemical products 10. Manufacture of rubber and plastic products 11. Non-ferrous metals and materials 12. Manufacture of metal products 13. Machinery and transport equipment 14. Electric machinery and instrument 15. Other manufacturing industrial sectors

Table 7. Ranking of Factors Embodied in China's Net Exports

	Year 1955		Year 1964		Year 1980		Year 1992		Year 1996	
S	1.60%		1.00%		0.94%		2.21%		2.77%	
T	1,023,217,507		1,357,957,364		-2,764,922,470		24,014,594,058		101,553,431,500	
	Ratio	Rank	Ratio	Rank	Ratio	Rank	Ratio	Rank	Ratio	Rank
G1	**0.004161**	**1**	-0.002706	6	-0.018661	6	0.010041	4	0.000275	4
G2	0.002005	2	0.000561	3	-0.001238	2	0.042502	2	0.025260	2
G3	0.001068	3	**0.002052**	**1**	**0.001728**	**1**	**0.118743**	**1**	**0.081813**	**1**
G4	-0.000778	5	0.000186	5	-0.005211	5	-0.002465	5	-0.019617	5
G5	0.000488	4	0.000743	2	-0.003096	3	0.026159	3	0.001946	3
G6	-0.000851	6	0.000210	4	-0.004922	4	-0.003815	6	-0.020880	6
G1	**0.002545**	**1**	-0.001224	7	-0.009888	7	0.008486	5	0.001803	5
G2	0.001824	2	0.000209	4	**0.001045**	**1**	0.026204	2	0.029502	2
G3	0.000377	5	**0.001002**	**1**	-0.000227	4	**0.053042**	**1**	**0.040054**	**1**
G4	-0.000444	6	0.000091	5	0.000666	2	-0.002266	6	-0.004794	6
G5	0.000790	4	0.000232	3	0.000225	3	0.015782	3	0.013835	3
G6	0.001020	3	-0.000394	6	-0.004270	6	0.008558	4	0.006003	4
K	-0.000606	7	0.000264	2	-0.001425	5	-0.010560	7	-0.022083	7

Notes:

S: China's share in the total of world trade (%).

T: Value of net exports (unit: RMB yuan).

G1: Farmers and other agricultural manual labor.

G2: Tertiary and resource-related workers.

G3: Manufacturing manual workers.

G4: Manufacturing technical workers.

G5: Managerial, administrative and others.

G6: Scientific intellectuals.

K: Physical capital.

Ratio: The calculation is based on inequality (7) in Section 2.

Source:

(1) Data of import and export: 1955, 1964, and 1980 are originated from internal source of Institute of Economic Research, Hitotsubashi University, Tokyo, Japan; 1992 is directly from the Input-Output Table 1992; 1996 is derived from *Customs Statistics Yearbook 1996* edited by General Administration of Customs, P.R. China.

(2) G1□G6 are from the same source as Table 1, K is estimated in this section.

Table 8. Summary of Rankings on China's Human Capital Stock

Group	Benchmark: Year 1992	Average rankings across years 1955□1996	Re-ranking after exclusion of physical capital
G1	4	4.2	5
G2	2	2.2	2
G3	1	1.4	1
G4	5	5.0	6
G5	3	3.0	3
G6	6	5.2	4

Table 9. China's Human Capital Embodied in its Bilateral Trades

	Indonesia		Thailand		Malaysia		Korea, R.		Singapore		Australia		Britain	
Y	670		1,840		2,790		6,790		15,730		17,260		17,790	
T	2.0247		1.3187		1.4749		5.0253		3.2653		2.3309		1.9356	
	Ratio	R	Ratio	R	Ratio	R	Ratio	R	Ratio	R	Ratio	R	Ratio	R
G1	**0.00075**	**1**	-0.00011	6	**0.00184**	**1**	**0.00639**	**1**	0.00137	2	-0.00092	2	0.00031	3
G2	-0.00112	3	0.00039	4	**-0.00146**	**6**	0.00310	2	0.00096	3	-0.00263	6	0.00080	2
G3	-0.00428	6	0.00051	2	-0.00116	5	0.00059	3	**0.00172**	**1**	**-0.00028**	**1**	**0.00095**	**1**
G4	-0.00131	4	0.00026	5	-0.00033	3	-0.00166	6	0.00070	5	-0.00171	3	-0.00081	5
G5	-0.00174	5	0.00047	3	-0.00064	4	0.00002	4	0.00091	4	-0.00204	5	-0.00027	4
G6	-0.00066	2	**0.00052**	**1**	-0.00032	2	-0.00055	5	0.00063	6	-0.00188	4	-0.00115	6
	Italy		Netherlands		Canada		France		Germany, F.		U S A.		Japan	
Y	20,460		20,480		20,710		22,260		23,030		23,240		28,190	
T	2.8420		1.7077		2.5785		2.2580		6.4600		17.4863		25.3492	
	Ratio	R	Ratio	R	Ratio	R	Ratio	R	Ratio	R	Ratio	R	Ratio	R
G1	**0.00099**	**1**	**0.00194**	**1**	-0.00944	6	-0.00167	4	**0.00065**	**1**	-0.00489	4	0.01062	2
G2	0.00014	3	0.00111	2	-0.00153	4	0.00023	2	0.00048	3	0.00095	2	0.00517	3
G3	0.00079	2	0.00110	3	**0.00006**	**1**	**0.00033**	**1**	0.00062	2	**0.01493**	**1**	**0.01087**	**1**
G4	-0.00203	5	0.00085	4	-0.00203	5	-0.00182	5	-0.00475	5	-0.00798	5	-0.01345	5
G5	-0.00133	4	0.00041	5	-0.00147	2	-0.00103	3	-0.00305	4	-0.00233	3	-0.00525	4
G6	-0.00256	6	0.00023	6	-0.00150	3	-0.00190	6	-0.00612	6	-0.00826	6	-0.01474	6

Notes:

Y: Current GNP per capita in respective countries (US$). The data is originated from World Bank *World Tables 1994* the Johns Hopkins University Press.

T: Counterpart country's share in China's total trade (%). All the bilateral trade data are from General Administration of Customs, P.R. China (1993) *Customs Statistics Yearbook, 1992 III*.

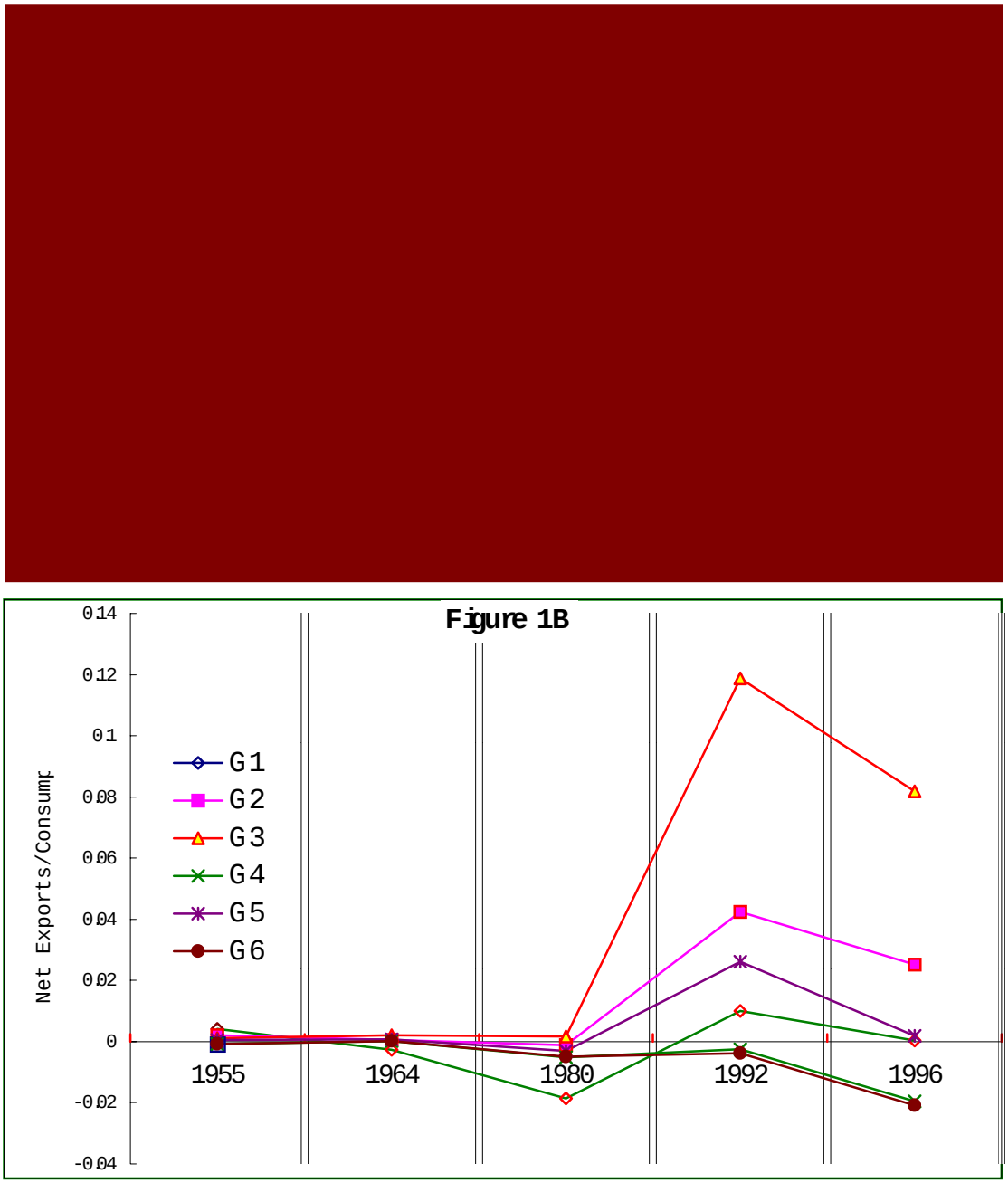
R: It refers "Ranking."

Rest of data and sources is the same as Table 8.

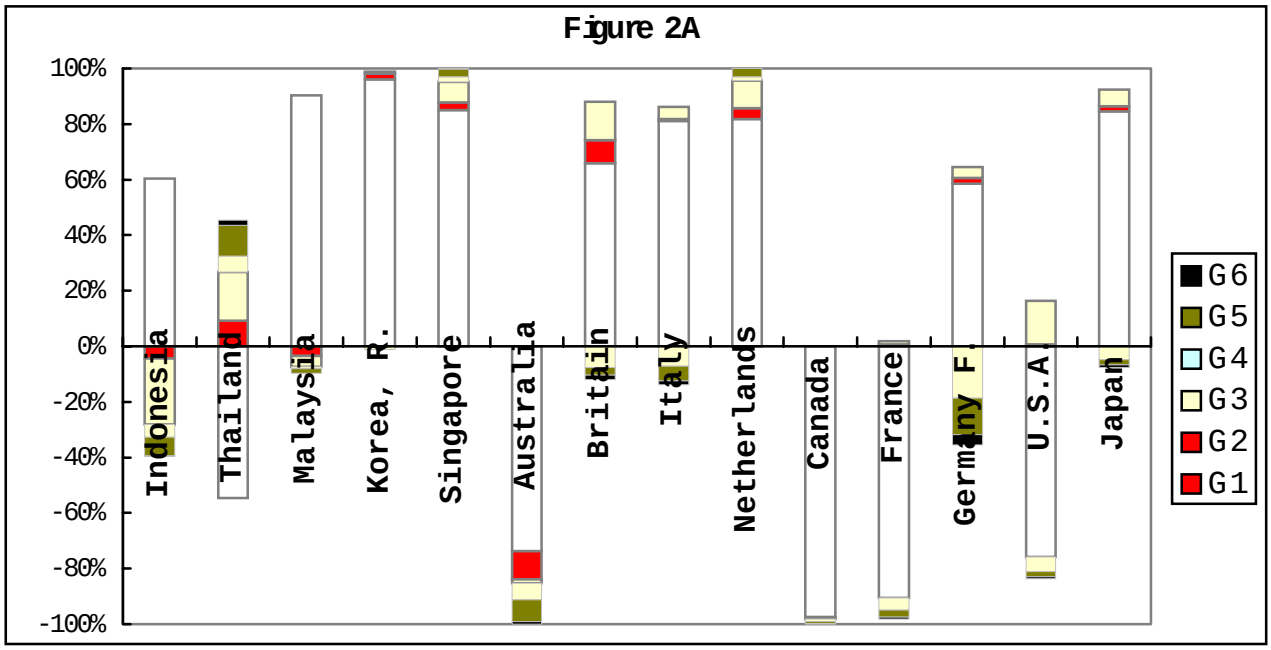
Table 10. Specialization of Various Groups towards Different Trading Partners

Low-educated Groups	Specialization Possibility	Developed country	Asian NICS	Asian developing countries

(Group 1) Farmers and other agricultural workers	Yes	Italy, Germany. R, Netherlands, Japan	Korea, R., Singapore	Indonesia, Malaysia
	No	Canada, U.S.A., France,		Thailand
(Group 2) Resource-related workers	Yes	Britain, France, U.S.A., Japan, Netherlands, Italy, Germany, R.	Korea, R., Singapore	Thailand
	No	Australia, Canada,		Indonesia, Malaysia
(Group 3) Manufacturing manual workers	Yes	Britain, Canada, France, U.S.A., Japan, Italy, Netherlands.	Singapore, Korea, R.	Thailand,
	No			Indonesia, Malaysia



Notes: Figure 1A. Human capital embodied in China's net exports in absolute terms;
Figure 1B. Ratio of human capital embodied in China's net exports to its consumption.



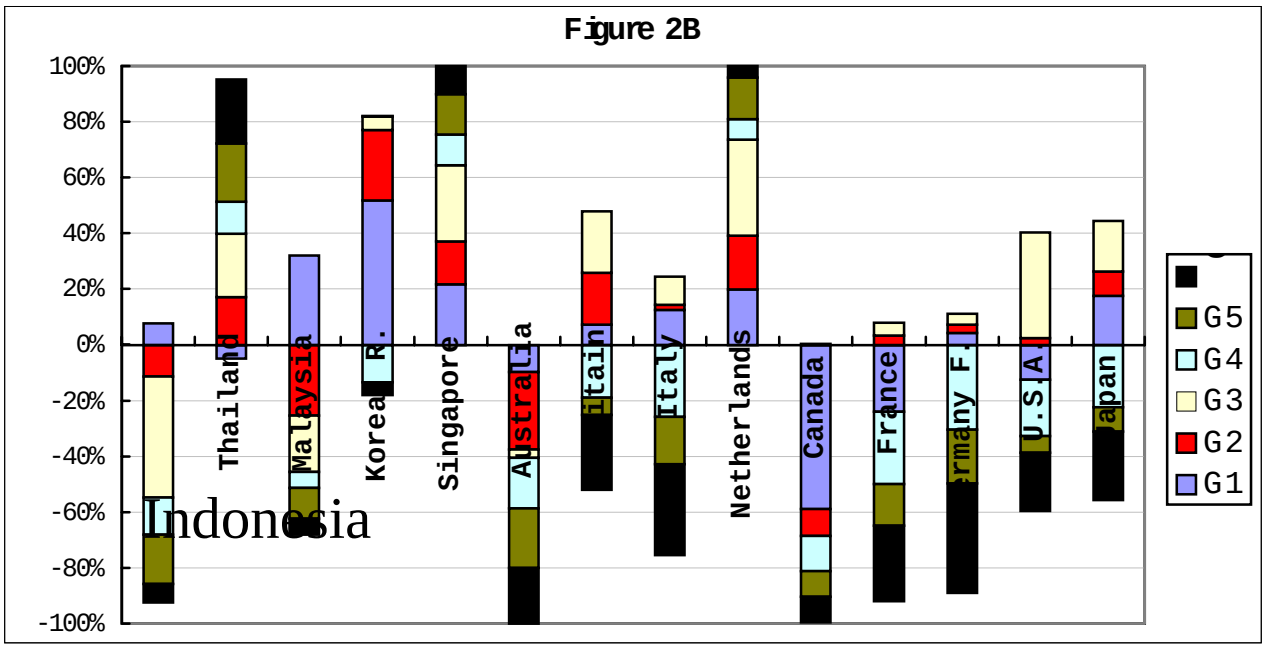


Figure 2A: China's human capital embodied in bilateral trade in absolute terms;
Figure 2B: China's human capital embodied in bilateral trade with numerator of net export and denominator of consumption.

[1] It is adapted from Table 1.1 in *Statistical Yearbook 1993* compiled by the United Nations Educational, Scientific and Cultural Organization (UNESCO, 1993), printed in France.

[2] It is 1992 data originated from *China Population Statistics Yearbook, 1998* compiled by Department of Population and Employment Statistics, State Statistical Bureau, P.R. China.
[3] Refer to Section 4 for primary estimation of physical capital within 16 commodities.
[4] Generally speaking, HOV uses an even model, which is true to studying trade in goods, requiring inversion of the technology matrix. This condition is not necessary for a factor-content study adopted by Maskus (1985), Trefler (1995), and Davis, *et al*., (1997), all of whom use uneven model. The detailed explanation is also given by Markusen, *et al*., (1995).
[5] This may be regarded as using domestic matrix *A*.
[6] China began publishing its input-output table in 1987, the table of neither MPS nor SNA. In 1992, China moved towards SNA type of national accounting system and this made it possible for international comparison.
[7] The figures are originated from World Bank *World Development Report 1996*, Oxford University Press.
[8] It is also adapted from World Bank *World Development Report 1993*.
[9] This can be verified by World Bank *World Development Report 1996* Oxford University Press.
[10] It is according to the paper in *China Population Statistics Yearbook, 1994* compiled by Department of Population and Employment Statistics, State Statistical Bureau, P.R. China, Page 390.
[11] Canada is an exception, which below the world average in 1993. Data is originated from *World Development Report 1996* (p. 208-209), the World Bank.