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Study on the upgrading path of China's export structure—a perspective of the evolution of factors structure

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ABSTRACT

The upgrading of export structure has long time been a prominent task of China's foreign trade. It is in great need for China to choose the right path to develop China's export structure and make the adequate policies to achieve the sustainable improving on export basket. To solve the problem of what theory to follow, and which path to choose in upgrading the China's export structure, the paper studied the upgrading path of China's export structure on a perspective of the evolution of factors structure. It used perpetual inventory procedures to estimate China's capital stock and used the data of time series from the year 1990 to 2012 to empirically analyze the implication of capital per labor, human capital and R&D input on export structure. Based on the analysis, it drew the conclusion that the factor comparative advantage theory should be followed to promote export structure, and it also put forward specific strategy and suggestions.

KEYWORDS

Factors structure; Export structure; Upgrading path; Comparative advantage; Evolution of factors endowment.

INTRODUCTION

The upgrading of export structure has long time been a prominent task of China's foreign trade. Chinese scholars have done lots of research on the upgrading and optimization of export structure since 1990s. But up to now capital and technology intensive products are still not in a dominant position in China's export basket, the export structure still needs improving. Why the process of upgrading of China's export structure remains slow is still in dispute among economists. Whether China has applied the right foreign trade policies? Or is it for the reason that conditions for the optimization of China's export structure are not prepared yet? By which path should the upgrading of export structure follow? To give the right answers to these questions will determine the sustainable development of China's export trade. The construction of China (Shanghai) Pilot Free Trade Zone represents that China is now following the development trend of global economy and implementing a more active open strategy. So choosing the right path to develop China's export structure and making the adequate policies to achieve the sustainable improving on export basket is of great importance.

LITERATURE REVIEW

Guo kesha (2003) put up with the opinion that if developing countries fully follow the comparative advantage theory and specialized in labor intensive industries may proves to be optimal in the short run, but in the long run the wellbeing of the export trade will become worse. So a developing country should not be constrained to the comparative advantage theory when participating in international specialization[1]. While the study of Ju jiandong, Lin yifu (2003) shows that comparative advantage is still the foundation of trade, the discrepancy of factor endowment and technology level determines the international specialization and trade basket. The system is also an endogenous choice from the development strategy[2]. Fan gang and Guan zhixiong (2006) studied the China's export basket on the basis of previous research by Guan zhixiong (2002) using revealed comparative advantage valuation to identify the added technology value in the tradable products, and found that the main products in export basket has been transferred from Low-tech products to Middle-tech products, but the high-tech products are not the most important part of the basket[3]. Lu xiaodong and Li ronglin (2007) used the completely decomposed China's trade data to study the change of trade structure and comparative advantage from 1987 to 2005, and build up a more objective measure indicator on the basis of RCA index. They utilized the index to show that during this period of time, China's comparative advantage has changed, and advantages of capital, technology and human capital intensive products had been enforced[4]. Du xiuli and Wang weiguo (2007) also analyzed the technology structure of China's export basket from 1980 to 2003, and found that the technology level had long time been under average level of developing countries[5]. Yao zhizhong (2008) studied the change of China's export structure from the year when China gained the accession to WTO to the year 2008 when global financial crisis broke out, and pointed out that the export structure change was the result of series of comprehensive determinants such as upgrading of labor and Capital and the increasing in technological products disadvantage[6].

This paper analyze from a perspective of the evolution of factor structure, using the empirical data from 1990 to 2012 to empirically study the relationship between export structure and factor structure, and put up with corresponding suggestions according to the analytical results.

MODEL CONSTRUCTION AND DATA PROCESSING

Empirical model

Classic trade theories such as H-O theory states that export mode and structure is endogenously determined by the country's factor endowment. And the evolution of factor structure can also alter the export mode and structure. Accumulation of physical capital and the change of its scarcity relative to labor will influence the export basket through three paths: Firstly the accumulation of physical capital can be the platform and support of the technology innovation. Secondly when the accumulation rate of physical capital exceed that of the labor, the ratio of physical capital to labor will increase, and when the ratio keeps rising and exceeds the country's trade partners, the factor abundance of the capital and labor will also change. Then gradually the capital and technology intensive products become the main products of the export basket. Thirdly, the increase of human capital in value can efficiently boost the technology progress. Lucass (1988) pointed out that accumulation of human capital can save and substitute the quantity of physical capital and labor needed in the production process, and increase the productivity of labor and capital[7]. Lastly, besides the discrepancy of comparative advantage, technology also plays an important role in determining the export structure. Progress in technology can improve the productivity and therefore reduce the products cost. A lower cost level can form the comparative advantage, which make the products to be more competitive.

Summing up all the factors mentioned above, this paper construct an empirical model as follows:

$$EXPS = \beta_0 + \beta_1 KLR + \beta_2 HUMC + \beta_3 TECH + \beta_4 FDI + \beta_5 GFC + \varepsilon_1 \quad (1)$$

Where *EXPS* is the export structure, *KLR* represents physical capital per worker, and average human capital is *Humc*, *TECH* is specified as the technology progress. We use *FDI* as a control variable to represent foreign direct investment, and *GFC* is dummy variable which means global financial crisis.

Data processing

A. Export structure. Lall(2000) used the method of Standard International Trade Classification, Revision 2(SITC2) to classify 230 categories of products into 5 types including: primary products, resource intensive products, low-tech products, medium-tech products and high-tech products[8]. Since medium-tech products are mainly composed of capital goods and medium products, which need a lot of capitals and special skills in the production process. China's scholars had also ascribed this type of products to be capital intensive products. This method had also been applied by United Nations Conference on Trade and Development. Therefore the paper also adopted the method and ascribed the high-tech and medium-tech products to be capital and technology intensive products, and use the percentage ratio of these 76 categories of products (including Iron and steel, Machinery, Communication equipment etc.) to the total export as the export structure indicator. The formula is:

$$EDS = \frac{\text{Capital and technology intensive products}}{\text{Total Export}} \times 100\% \quad \textbf{(2)}$$

B. Capital-Labor Ratio. This indicator reflects relative abundance of capital and labor. To calculate the capital stock we use perpetual inventory method, the formula is

$$K_t = K_{t-1}(1-\delta) + I \quad \textbf{(3)}$$

Four variables are involved here, Current year investment, investment goods price index, depreciation rate, base year capital stock. The paper adopt the conclusion of Ye zongyu(2008) that specified 1952 as the base year and the capital stock in the base year is 610 billion yuan[9]. Depreciate rate is regulated to be 9.6% as Shan haojie(2008) inferred, and data of Total Fixed Capital Formation in Statistical Yearbook of China has been chosen as current year investment. The data of investment goods price index comes from "Statistical Yearbook of GDP of China 1952-2004". As to the indicator of labor, the paper uses the total employment data in Statistical Yearbook of China.

C. Human capital. The data of human capital is difficult to obtain. Since there is a common phenomenon that more educated people usually have a higher level of income, we use education as a substitute indicator. The education indicator is calculated as follows:

$$HC = \sum_{i}^{n} E_i P_i \quad \textbf{(4)}$$

Ei represents corresponding education years of deferent level of education, *Pi* means the share of population of level i in the total employment population. Here primary school education level means 6 years of education, middle school means 9 years, high school means 12 years, education level of college and above represent 16 years, and uneducated only means 2 years education.

D. Technology progress, FDI and GFC. The paper uses the ratio of R&D expenditure to GDP to represent technology progress, as the more input of R&D the easier the technology progress can be made. The data of FDI comes from statistical yearbook of China, both two indicators had been deflated by GDP deflator. The indicator GFC means global financial crisis, the year before 2008 were specified to be 0, and the year after 2008 were regulated as 1 to examine the influence of global financial crisis.

According to the method above, the data of the variables were processed as TABLE 1 shows below:

EMPIRICAL ANALYSIS

Stability test

Using a time series that has a unit root to construct econometric model will cause false regression. So the paper used ADF method to test the stability of the time series of variables. The test equation takes the form of the following three types:

Equation 1(No constant term and trend term)

$$\Delta y_t = \beta y_{t-1} + \varepsilon_t \quad \textbf{(5)}$$

Equation 2(No constant and trend term)

$$\Delta y_t = \phi_0 + \beta y_{t-1} + \varepsilon_t \quad \textbf{(6)}$$

Equation 3(with constant term and trend term)

$$\Delta y_t = \phi_0 + \alpha t + \beta y_{t-1} + \varepsilon_t \quad (7)$$

TABLE 1 : Data of the variables from year 1990-2012

Year	EXPS (%)	Klr(million/capita)	Humc (year)	Tech (%)	FDI (million)
1990	26.22	26.9681	6.67	0.71	59.21
1991	27.67	28.6892	6.89	0.70	75.56
1992	23.88	31.1990	7.00	0.71	12.75
1993	24.91	34.6831	7.11	0.62	395.96
1994	26.85	38.9358	7.34	0.50	642.73
1995	31.86	43.0058	7.45	0.57	623.81
1996	32.98	47.2602	7.56	0.60	627.79
1997	33.58	51.5031	7.74	0.64	621.25
1998	36.71	56.1634	7.77	0.70	577.00
1999	39.06	61.0004	7.85	0.83	476.21
2000	42.03	66.3134	8.06	0.90	443.55
2001	43.83	72.2305	8.33	0.95	471.46
2002	46.66	79.6115	8.38	1.07	486.25
2003	50.74	89.1020	8.52	1.13	448.33
2004	54.15	100.090	8.65	1.23	461.49
2005	55.29	112.475	8.41	1.32	408.27
2006	55.94	127.328	8.46	1.39	368.38
2007	56.87	144.128	8.56	1.40	365.15
2008	56.94	163.182	8.67	1.47	375.92
2009	58.08	188.59	8.78	1.70	329.89
2010	58.88	216.760	9.18	1..76	347.63
2011	57.25	246.599	9.67	1.84	332.94
2012	56.88	278.934	9.77	1.98	291.08

While ε_t means white noise, and ϕ_0 is constant term, t is time trend factor, Δ denotes first order differentiation. The test results are listed in TABLE 2.

TABLE 2 : Variables stability test

Variable	ADF statistics	1% critical value	5% critical value	10% critical value	Conclusion
EXPS	-0.632	-3.788	-3.012	-2.646	Unstable
KLR	3.623	-3.887	-3.052	-2.667	Unstable
Humc	-0.251	-3.788	-3.012	-2.646	Unstable
Tech	-0.444	-3.887	-3.052	-2.667	Unstable
FDI	0.966	-2.680	-1.958	-1.608	Unstable
ΔEXPS	-2.951	-3.809	-3.021	-2.650	stable**
ΔKLR	-3.667	-4.616	-3.710	-3.298	stable **
ΔHumc	-5.049	-3.857	-3.040	-2.661	stable***
ΔTech	-2.479	-3.920	-3.067	-2.673	stable **
ΔFDI	-1.789	-2.686	-1.959	-1.607	stable **

Notes:Δ denotes first order differentiation, *,and ***respectively represents10%,5%and 1% significance level**

TABLE 2 reports that the ADF statistics of all the variables are smaller than 10% critical value, so they are all unstable time series. But after first order differentiation, Humc becomes stable at 1% significance level, and the other variables are stable at 5% significance level. Since all the variables are I(1) variables, the combination of the variables may become stable, which means that there may be stable relationship across variables. So the OLS method can be used in variables regression.

Regression analysis

Since all the variables are I(1) variables, there may be stable relationship among the variables. The paper uses OLS method to estimate the equation, and the results are presented in TABLE 3

TABLE 3 : Regression of the equation

	Equation 1	Equation 2	Equation 3	Equation 4
C	-117.509 (-14.723)***	-91.942 (-5.271)***	-115.727 (-10.616)***	-104.671 (-5.687)***
KLR	9.585 (3.182)***	8.123 (1.950)*	9.157 (2.509)**	8.092 (2.041)*
Humc	9.439(3.281)***	6.600 (2.304)**	10.241 (3.401)***	9.419 (2.903)**
Tech		10.645 (3.091)***		3.982 (1.752)***
FDI			-1.299 (-3.595)***	-0.949 (-1.601)
GFC		-5.222 (-2.821)**	-4.276 (-2.490)**	-4.618 (-2.564)**
Adj. F^2.	0.967	0.981	0.984	0.988
F-stat.	278.97	251.764	286.82	222.917
D.W.stat.	0.872	1.785	1.856	1.934

Notes: *, ** and * respectively represents significance level of 10%,5%and 1%**

From the reports of the TABLE 3, we can see that except variable FDI, all the other variables are significant to EXPS. The final form of the equation should be equation 4. The final equation is :

$$EXPS = -104.671 + 8.092Klr + 9.419Humc + 3.982Tech - 4.618GFC \quad \textbf{(8)}$$

It shows an increase of 1 unit in physical capital per work will cause a 8.92 percentage increase in upgrading of export structure. An increase in average human capital and input of R&D will respectively contributes a 9.49 and 3.982 percentage positive effect to the upgrading of export structure, and the breaking forth of global financial crisis had brought negative effect on the optimization of China's export basket. Since most capital and technology intensive products are medium products, when crisis broke out, it immediately caused the contraction in demand for medium products. The reason why FDI is not significant may be the foreign direct investment had mainly flown into labor-intensive industries to utilize China's abundant labor resource. So the FDI does not exert a significant effect on upgrading of export structure.

Granger causality tests and VAR model

Granger causality test is a method to test whether time series x is the cause of time series y. Only two conditions be satisfied can time series x is called the granger cause of time series y. First, x should be helpful to predict y, second, y should not bet helpful to predict x, otherwise there may be some factors that are the cause of change of both x and y. The results of granger causality tests of above variables are listed in TABLE 4:

TABLE 4 : Results of granger causality tests of variables

Null Hypothesis:	F-Statistics	Probability	Conclusions
Humc does not Granger Cause EXPS	14.1267	0.0016	Rejected
KLR does not Granger Cause EXPS	11.7308	0.0206	Rejected
Tech does not Granger Cause EXPS	3.29596	0.0871	Rejected
EXPS does not Granger Cause Humc	0.13407	0.7188	Accepted
EXPS does not Granger Cause KLR	10.36374	0.0454	Rejected
EXPS does not Granger Cause Tech	11.4863	0.0035	Rejected

TABLE 4 presents that human capital is the granger cause of export structure, while export structure is not the granger cause of human capital, which means human capital has a significant effect on export structure in the long run, while export structure does not has such an effect. TABLE 4 also reports a reciprocal granger cause relationship between physical capital per worker and export structure. Technology progress and export structure share the same relationship. It means that in the long run with the increasing in accumulation of physical per work and technology progress, the export structure will be upgraded since the relative abundance of capital to labor changed. With the expansion of the export of capital and technology products, the accumulation of physical capital accelerated, and it is easier to make technology progress. Since KLR and Tech have a reciprocal cause and long term equilibrium relationship with export structure. It is better to construct VAR model to describe the relationship across the three variables. Using econometric software to construct the VAR model and write the results in a matrix form. Since there are three variables in the model, there should be three corresponding equations, thus the matrix takes the form as follows:

$$V_t = \begin{pmatrix} 0.59 & 3.49 & 1.10 \\ 0.01 & 0.82 & 0.18 \\ -0.19 & 0.45 & 0.55 \end{pmatrix} \times V_{t-1} + \begin{pmatrix} 0.25 & 12.73 & 1.04 \\ 0.00 & 0.14 & 0.02 \\ 0.20 & 2.53 & 0.10 \end{pmatrix} \times V_{t-2} + \begin{pmatrix} -5.93 \\ -0.16 \\ 3.13 \end{pmatrix} \quad \textbf{(9)}$$

Here $Vt = (EXPS_t \;\; Tech_t \;\; KLR_t)'$. The test results of the stability of the model are listed in TABLE 5

TABLE 5 : The test results of VAR model stability

Root	Modulus
0.929278 - 0.126017i	0.937783
0.929278 + 0.126017i	0.937783
0.342286 - 0.657811i	0.741535
0.342286 + 0.657811i	0.741535
-0.294788 - 0.077359i	0.304769
-0.294788 + 0.077359i	0.304769

No root lies outside the unit circle; VAR satisfies the stability condition.

As TABLE 5 shows VAR satisfies the stability condition, which means the system is stable, and the relationship across variables is a dynamic long run stable and reciprocal cause. The coefficients are all positive, which denotes in the long run the increasing in physical per work will cause the change of relative scarcity of capital and labor, and induce the growth in export of capital intensive products, and the expansion of export in turn will accelerate the accumulation of physical capital. As to the technology, the increasing in input of Research & Development will be helpful in technology innovation, which will improve the export baskets, and the more value added in the products, the more profitable it will be. So with the upgrading of export structure, export technology intensive products will be more profitable, which will allow firms to earn more profit and invest more in Research & Development.

CONLUSIONS AND SUGGESTIONS

The main conclusions drawn from the paper are as follow: First, factor comparative advantage should be followed to develop a country's export. The results of empirical analysis shows that factor structure evolution can improve the country's export structure. Second in choosing the upgrading path of China's export structure, policy makers should not only emphasize on the accumulation of physical capital, but also lay stress on human capital appreciation and the technology progress. So the first suggestion is increasing the investment on human capital. The expenditure on public education of China is relatively insufficient, as a proportion of GDP, it has long time been less than 4%, which is the average level of developing countries. The ratio in developed countries is 5.3%. More resources should be inputted into education to promote the education level of labors, and accelerate the accumulation of human capital. Another advice is to increase the input in R&D, and encourage the independent innovation. Technology progress can reduce the cost and promote the comparative advantage of the export products. Improving the system of intellectual property rights and protecting the right of the producers and owners of the technology can allow them to make profits from technology innovation and encourage the input in R&D. Since monopoly especially administrative monopoly will suppress the competition among enterprises and cause insufficient innovation. It is necessary to break the monopoly and give private enterprises admission to enter monopoly industries. The independent innovation will be encouraged by competition and the expected higher return on input.

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