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Trade Openness, Economic Growth and the Vicissitude of Labor-intensive Industries: The Case of China[1]

Abstract

In this paper, we use China's 1986-2008 data to make an empirical analysis on the interrelationship between trade openness, economic growth and the structural change of labor-intensive industries by using simultaneous equation models and a VAR model. Our empirical study leads to the three conclusions. First, trade openness has accelerated economic growth, though with some negative impact on the development of labor-intensive industries; Second, economic growth has had a positive effect on trade openness, but again negatively impacted the development of labor-intensive industries. Third, the expansion of labor-intensive industries has had negative effects on both trade openness and economic growth.

Methodologically we rely on the transformation theory of industrial structure as an analytical framework to empirically study these three paradoxical outcomes. We introduce the three variables: trade openness, economic growth and the change of labor-intensive industries, as dependent as well as independent variables into our empirical models. And then we use technological progress, the share of secondary industries to GDP, total employment and investment ratio as control variables in order to test the robustness of the empirical results. In addition to explaining the factors responsible for changes in labor-intensive export industries we also provide two policy implications: First, labor-intensive industries should be scaled down to improve the efficiency of resources allocation. Second, China should timely transform its industrial structure of the export sectors from the one that is dominated by labor-intensive industries to the one that is dominated by capital (technology)-intensive industries so as to induce the export sectors to move in the direction favorable to the transformation of China's present outward pattern of economic development.

Keywords: trade openness; economic growth; labor-intensive industries; transformation of outward pattern of economic development; simultaneous-equations model; VAR model
JEL: F14; F43; L16; L52

Introduction and Literature Review

In this paper, we empirically analyze the systematic relationship between trade openness, economic growth and the structural change of labor-intensive exporting industries in China. In this paper, labor-intensive export industries are defined as those industries that mainly rely on utility of a great quantity of labor force instead of relying on technology and equipment to a greater extent, such as textile, apparel, toys, leather and fur products, and furniture etc. In China, most of products made by these industries are exported.

Historically, China's high rate of economic growth was highly correlated with trade openness and the development of labor-intensive export industries. From 1979 to 2006 China's imports and exports contributed to its average growth rate of 17.2%. In 2005 China surpassed Germany and its amount of foreign trade ranked the third in the world. In 2009 China outstripped Japan and became the second largest trading country with a total amount of $2203.7 billion. In 2013, China became the world's biggest country of goods trade.

Our goal is to investigate the changes in China's exports from labor-intensive industries in the period 1986 to 2008; in the years before and after its accession into the WTO. In order to better understand the vicissitude of labor-intensive industries and other factors responsible for growth and structural transformation we build up simultaneous equation models, employ regression analysis and a VAR model.

The relationship between trade openness, economic growth and vicissitude of industrial structure has been widely analyzed in the economic literature. More recent studies enrich such analyses by adding a question of concurrent transformation of industrial structure from the labor (resource)-intensive type to the capital (technology)-intensive one. S. Kuznets [1966; 1971] pioneered his research on the relationship between economic growth and the change of economic structure in the countries with different factor endowments.

H. B. Chenery, S. Robinson and M. Syrquin [1986] offered a standard analytical framework for researching the relationship between industrial structure and economic growth. It implied that with the growth of income per capita, upgrading the share of modern manufacturing to that of traditional agriculture would boost economic growth in developing countries. M. Syrquin [1988] extends this analytical framework to a long-run process of structural transformation that includes industrialization, urbanization and agricultural transformation, as well as the shifts of such behavioral relations as accumulation of physical and human capital, the composition of demand, employment, production, saving, trade etc. However, this analytical framework does not address the detailed mechanisms of how factor endowments enter the process of structural transformation. Neither does it explain how factor endowments, economic growth and the shifts of behavioral relations interact with one another to finally attain the structural transformation.

Since 1990s, there has emerged an increasing amount of literature trying to explain the influences exerted by economic growth and shifts of behavioral relations (in particular, technological change and investment in human capital) on the structural change. S. Redding [1996] studies the relationship between investment in human capital and in R&D which determines long-run rate of growth. He shows that the two kinds of multiple equilibria characterized by *low-skill* and *low-quality traps* may arise due to the two kinds of investment in the manufacturing sector exhibiting indivisibilities, pecuniary externalities and strategic complements. It seems to him that expectation will determine which equilibrium to select, so there exists a potential role for government policy in accelerating growth by coordinating expectation.

A. Acemoglu [2000] introduces the price effects and the market size effect into his analysis in order to check whether a technical change is biased towards particular factors. He shows that the former encourages innovation favoring scarce factors so as to develop the technologies to produce expensive goods, while the latter leads to a technical change directed at abundant factors so as to employ the technologies that have a larger market. According to him, the relative strength of the two effects is determined by the elasticity of substitution between the factors; profit-seeking motive determines the amount of R&D directed at different factors and different sectors shapes the direction of a technical change and determines the equilibrium bias of technology; the form of the innovation possibilities frontier determines how relative costs of different types of innovation changes with the current state of technology.

How human capital is contributed to economic growth has been discussed ever since 1960s, but how human capital is correlated with a structural change is a subject appearing in the literature pretty recently. In an overlapping generation model, K. Yuki [2008] points out that both, the shift of production, employment and consumption from the traditional sector to the modern sector and the extent of education of the population, are the sources for the economic development. He argues that, for a successful structural change, an economy must start with an initial wealth distribution that enables a sufficient proportion of the people to receive education. Once an economy takes off, a structural shift and human capital accumulation continue until the economy reaches a steady state with high income and equal distribution. If an economy does not succeed in a structural shift, thus sufficient productivity of the traditional sector becomes a prerequisite for economic development.

D. Nicet-Chenaf and E. Rougier [2009] find that if human capital is misallocated or unemployed, the demand for particular skills in the modern sector is too low relative to the disposable amount of human capital on the market. An increase in human capital has no remarkable effect on economic growth. It is particularly true in those economies that have fallen into a *low-level development trap* for lack of investment in equipment and with a bad allocation of labor and skills across the sectors. The effect of education on economic growth will be more significant if the economy has entered into a structural change that increases the demand for skilled labor. Their econometric evidence has shown that the reduction in the traditional share to GDP and a higher diversification of export will have a positive impact on economic growth. So, the authors pay a particular attention to the role of entrepreneurs to increase demand for skills in the modern sector.

Based on the data of 28 OECD countries, M. Peneder [2003] aims for an empirical research on the effect of the structural change on aggregate income and growth. In his paper, three mechanisms for the linkage between meso-structure and macro-performance are identified. (1) the sectoral difference in the income elasticity of demand shifts industry shares in overall consumption. (2) the positive relationship between a structural change and economic growth can be called *structural bonus*[2] which postulates an upgrade from industries with lower value added per labor input to those with higher. (3) the negative effect of a structural change on growth can be attributed to *structural burden* which shift labor force away from industries with high productivity growth to industries with low productivity growth. He also recorded the three stylized facts of the sectoral change. (1) The share of the service sector is positively correlated with income level, but its lagged levels have negative impacts on GDP per capita and the annual growth rate. (2) As for the technology-driven and high-skill manufacturing sector, its lagged levels and first differences for the shares of total exports relative to the OECD countries exert a significantly positive effect on the level of GDP per capita and economic growth. (3) Both increase in exports and in imports, and hence the application of technological advanced products contributes positively to growth.

A structural change is bound to connect an industrial policy which is a magic key that leads the East Asian Economies, in particular South Korea, to a great success in economic development. Many economists have summarized Korea's successful lessons, L.E. Weatphal is one of the representatives. He [1990] writes that Korea's so-called industrial policy is in fact a package of policy tools, including taxes and subsidies, credit rationing, various kinds of licensing, public announcements, creation of public enterprises, continuously designing and implementing the plans for the targeted industries etc. He evaluates that the magic key of Korea's industrial policy lies in how these policy tools have been used: either neutrally used to encourage export or non-neutrally used to promote infant industries and what the Korea's government do is, on the market well-functioning basis, to selectively intervene so as to indirectly affect allocation of resources among industries and to achieve dynamic efficiency in the sense of attaining Korea's international competitiveness in the targeted industries.

Industrial policy has brought forth a huge success to Korea. In 1960 Korean economy was dominated by agriculture and mining. It has taken 30 years for Korea to complete the enhancing process of industrial structure. Now, Korea has become the world 11^{th} largest economy and one of the main exporters of technology-intensive goods (such as semiconducting products including smart cellphone, computer, and automobiles and components). In 2013, South Korea ranked the third place among the world largest 10 export economies.

J.Y. Lin [2012] also summarizes the successful experiences of the East Asian economies, demonstrating that a country's comparative advantage and an optimal industrial structure are determined by factor endowments. Transformation of industrial structure of a country requires changing the focus of factor endowment flows from labor-intensive or natural resources driven to more capital intensive industries. Consequently, Lin predicts that labor-intensive industries in China and other emerging market economies will be losing comparative advantages.

Since the late 1970s, the transformation of industrial structure has been one of the key factors facilitating China's high rate of economic growth. Thus, many Chinese economists focus not only on changing China's industrial structure, but also on the vicissitude of China's labor-intensive industries. W. Liu and S.R. Li [2002] conclude that China's economic growth was mainly fueled by the tertiary industry, which reduced the role of primary and secondary industries. W. Li and H. Zhang (2008) argue that the alternation of priority in three types of industries has significantly increased China's economic growth, though the magnitude of the effect is gradually diminishing.

By introducing the industrial structure into a framework of stochastic frontier production function, R.G. Zheng, C.H. Gan and D.F. Yu, [2010] discover that the adjustment of industrial structure has caused both short-run and long-run effects on economic growth. However, when it comes to the allocation of resources its impacts is limited to the short-run. Following findings by H. Sun and Z.X. Shi [2011], the adjustment of industrial structure has a significant Granger impact on economic growth. Therefore, an industrial policy to restructure and optimize the industrial structure is an active and effective way to promote economic growth in China.

In addition, some people dispute on whether the "Hypothesis of Structural Bonus" is tenable for China's case. X.P. Li and X.X. Lu [2007] argue that the structural change in China's manufacturing sectors has not led to the emergence of "structural bonus" because the resources such as labor and capital have not been allocated to those highly efficient industries. C.H. Gan and R.G.. Zheng [2009] show that only the allocation of labor among these industries has surely created the *structural bonus*, but the allocation of capital among these industries has not.

There is a heated debate on the historical role played by labor-intensive industries in promoting export and growth and on the impact made by labor-intensive industries on enhancing industrial structure in the literature on China's labor-intensive industries. Some Chinese economists uphold that China's labor-intensive industries should continue to develop.

D.W. Wang, M.Y. Wang and L. Chen [2004] point out that since China's entry into WTO and with the gradual fall of the proportion of traditional capital-intensive heavy industries and the rapid growth of labor-intensive light industries, China's industrial structure has even more conformed to its structure of factor endowments. They argue in favor of developing the light industrial sectors and labor-intensive industries as the major direction of China's adjustment of industrial structure.

According to X.D. Zhang & J.W. Sun [2006], since 1990s, China's international competitiveness in technology (capital)-intensive industries has been rising while China's international competitive advantage of traditional labor-intensive industries has been declining. However, comparative advantage in labor still plays a key role in some productive links (such as processing or assembly) to upgrade the international competitiveness of technology (capital)-intensive industries. They believe that the vertical specialization of global division of labor is an effective means that enables *the effects of technological spillovers* and *effects of industrial linkage* to display in China's labor-intensive industries; enhancing the quality and efficiency of labor, generating a *win-win* outcome for both developed and developing countries.

According to F. Cai and D.W. Wang [2009], by extending the "Flying Geese Pattern" into inland China, China will maintain its comparative advantage and international competitiveness of the labor factor while conducting industrial transfers within different regions. According to this pattern, the advanced east regions will adjust the structure of the competitive advantage to the rising labor costs and the middle and western regions will accept labor-intensive industries transferred from the east regions, thus leading to nation-wide sustainable development.

G. Li, K.T. Shen and C.X. Guo [2009] point out that the implementation of "New Labor Contract Law" will speed up the trend of substitution of capital for labor. In this process, protecting wages from a decline is critical, which requires increase in wages of the high--skilled workers. G. Li, J.H. Liao and Y.N. Xiang's research [2011] shows that for more than 30 years, despite quantitative changes in China's factor endowments, the qualitative change has not happened and China's comparative advantage still rests on labor-intensive products. They expect that before the year of 2025, China will follow the principle of comparative advantage and labor-intensive industries will grow even faster.

Other Chinese economists argue that China should seize the opportunity to reshuffle the industrial structure of export in order to transform the present outward pattern of economic development. B.Q. Ren, H.W. Huang and J.Y. Xu [2005] admit that since late 1970s, China's strong export was profited by the extensive expansion of labor-intensive export industries based on cheap and unskilled rural labor, low labor productivity and low added value. In late 1990s, when the global IT industry transferred the added value chains into China, China's high-tech industries represented by IT industry were catching up and a series of high-tech export goods replaced traditional labor-intensive products. Since 2005, the wages of labor began rising while labor productivity began to decline. The authors argue that China faces an opportunity to rebuild its industrial structure; however it also faces the danger of "trap of comparative advantage".

In researching changes in industrial structure, Y. Xu and E.Z. Zhang [2008] use input--output-table data to calculate outsourcing ratio of China's 35 manufacturing industries. They find that outsourcing has served as a fine converter to enhance industrial structure because it has not only introduced capital-saving technologies, but also has led the industrial structure to change from a labor-intensive one into a capital-intensive one.

M.Z. Zhang and M. Li [2011] analyze the impact of global division of labor in the context of vertical specialization on China's industrial upgrading. They find that intra--industry upgrading deviates from inter-industry upgrading in China and the process of global vertical specialization has made positive effects on inter-industry upgrading, but negative effects on intra-industry upgrading. Since 1990s, the international competitiveness of China's labor-intensive industries has shown a falling trend while the international competitiveness of China's capital (technology)- intensive industries (such as manufacture of office work and communication equipment, manufacture of machinery and transportation equipment etc.) has followed a rising trend. They conclude that in the context of vertical specialization in global division of labor, industrial upgrading is not just limited to the industrial shift from labor-intensive industries to capital (technology)-intensive industries in the sense of final products, but in the sense of escalating along the product value-added chains within the same industry. If China neglects the escalating along the intra-industry value-added chains, she will be captured in the "low level trap of comparative advantage".

J. Wang and X.Z. Zhang [2012] demonstrate that just like oil and other natural resources, unduly abundant labor resources sometimes generate the "effects of resource curse". Their empirical work shows that China's labor-intensive industries rely on large input of capital and intermediate goods to produce cheap goods for export, and in this way, they use capital which should has been invested into capital (technology)-intensive industries. That approach impedes technological innovation, and hinders the employment of high-skilled workers. Consequently, from a long-term perspective, they declare that the excessive growth of labor-intensive industries is unfavorable to China's economic development.

As indicated in the above literature review, the question whether and/or how China's labor-intensive industries should continue to develop has been widely debated. In this paper, we adopt the transformation theory of industrial structure as an analytical framework to empirically examine the process of vicissitude of China's labor-intensive export industries. We explain the factors that gave impetus to the growth of labor-intensive export industries, and reasons for China to start a new industrial upgrading and transforming the industrial structure for export from labor-intensive industries to capital (technology)-intensive industries.

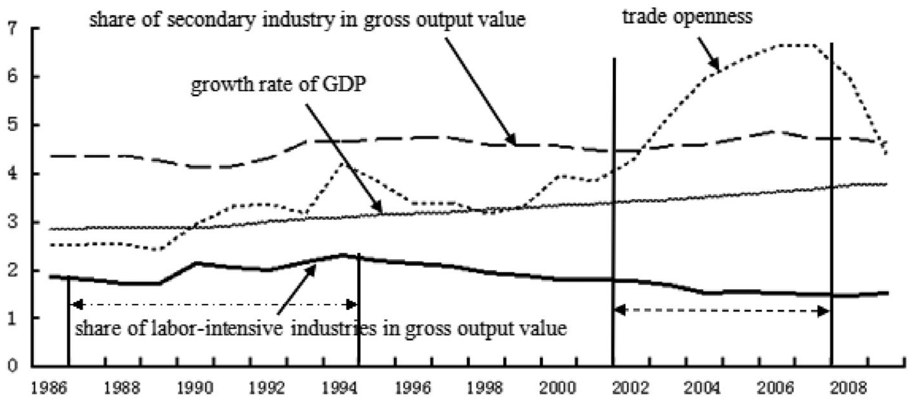
In the following Section 2 the sample description and empirical models are presented, and; empirical analysis and the testing results are unfolded in Section 3. Main conclusions and policy implications are provided in Section 4.

Sample Specification and Empirical Models

As mentioned above, this paper analyzes the systematic relationship between trade openness, economic growth and the structural change of labor-intensive export industries in China. In order to better understand the co-relations between these variables, we have drawn the following Figure 1.This Figure provides the key points: (1) Economic growth and the proportion of labor-intensive industries in gross output value show inverse relation; (2) Throughout most of the examined period, economic growth and trade openness show a direct relation; (3) The share of labor-intensive industries in gross output value is declining while the trade openness is changing irregularly.

In this paper, we focus primarily on points one and three. In Figure 1 the year of 2002 when China entered the WTO can be taken as a watershed. Before 2002 trade openness as a whole was relatively stable, but after 2002 it displayed a tendency of increasing ascendant. Until 2008 when the world financial crisis broke out, trade openness demonstrated a sudden decline. The share of labor-intensive industries in gross output value was increasing till 1994. This implied that labor-intensive industries had made a great contribution to GDP growth from mid-1980s to mid-1990s. After 1994, these industries demonstrated an asymptotically decreasing trend. This change suggested that the contribution of labor--intensive industries to GDP growth was diminishing. Comparatively, the share of secondary industries in gross output value exhibited two slight upswings around 1993 and 2006, but it stayed relatively stable during the whole examined period.

FIGURE 1. The trend of change of gross output value of labor-intensive industries, secondary industries, trade openness and growth rate of GDP



Note: The value amounts in this figure are all real values after deflating the influences of price fluctuations.

Sources: *China Statistical Yearbook*, (1987-2009), Beijing: China Statistics Press; *The New China Statistics Fifty Years Assembly*, 1999, Beijing: China Statistics Press.

Based on the above observations, we would like to test two hypotheses:

H1. Economic growth and trade openness are positively correlated, i.e., economic growth stimulates trade openness while trade openness fosters economic growth.

H2. Both, economic growth and trade openness are unfavorable to the development of labor-intensive industries, while the development of labor-intensive industries is unfavorable to both economic growth and trade openness.

For the purpose of investigating the changes of China's labor-intensive export industries in the context trade openness and GDP growth, we develop empirical models. Besides the three variables above-mentioned, we introduce control variables so as to reflect the real connection between different variables and to increase the robustness and validity of our empirical models. Specifically, we use trade openness, economic growth and the share of labor-intensive industries as dependent variables. For each empirical model, only one of the three is selected as the dependent variable, the other two, together with the control variables, are used as the independent variables. In this paper, the real GDP per capita, technological progress, the share of the secondary industries in gross output value, total employment, investment rate are all used as control variables. The empirical models are constructed as follows:

$$L\_STR_t = a_0 + a_1 TR\_OPEN_t + a_2 P\_GDP_t + \gamma x + \varepsilon_{1t} \quad (1)$$

$$P\_GDP_t = \phi_0 + \phi_1 L\_STR_t + \phi_2 TR\_OPEN_t + \gamma x_t + \varepsilon_{2t} \quad (2)$$

$$TR\_OPEN_t = \psi_0 + \psi_1 P\_GDP_t + \psi_2 L\_STR_t + \gamma x_t + \varepsilon_{3t} \quad (3)$$

Where, x_t denotes the control variables, and the symbols, economic interpretations and statistical properties of all these variables are listed in the following Table 1 and Table 2.

TABLE 1. The construction of variables and their specification

variables		symbols	specification
Share of labor-intensive industries in gross output value		L_STR	measured by the proportion in gross output value of labor--intensive industries of the manufacturing sectors including the State-owned Industrial Enterprises and the Industrial Enterprises above the Designated Size[3]
Real per capita GDP		P_GDP	deflated by the 1978 price level in order to measure the real economic growth
Trade openness		TR_ OPEN	measured by the ratio of total volume of import and export trade over GDP
control variables	Technological progress	TEC	measured by the number of patent applications
control variables	Proportion of the secondary industries in gross output value	SEC	measured by the proportion of gross output value of the secondary industry to GDP to reflect the industrial structure at the levels of the primary-secondary- tertiary industries
control variables	Total employment	WORK	to measure the effect of changes of numbers of the employed persons on the structure of labor-intensive industries
control variables	Investment rate	INV	measured by the share of total fixed capital investment to GDP

Source: own elaboration.

TABLE 2. Statistical properties

	L_STR	P_GDP	TR_ OPEN	WORK	INV	SEC	TEC
Mean	0.186007	3.264424	0.407113	4.83325	39.05833	45.5507	5.046904
Median	0.183261	3.242845	0.363084	4.846506	37.7	46.0906	4.968954
Maximum	0.231261	3.811123	0.668217	4.892067	47.7	48.92187	5.943302
Minimum	0.149557	2.847576	0.244575	4.709965	34.8	41.34065	4.136086
Std. Dev.	0.025233	0.307443	0.136082	0.054052	3.445592	1.99011	0.498838
Skewness	0.077745	0.232715	0.759347	−1.10979	0.706253	−0.54455	0.138379
Kurtosis	1.819461	1.85166	2.315272	3.137616	2.624951	2.406867	2.139081
Jarque-Bera	1.417849	1.535311	2.775285	4.945485	2.135836	1.537949	0.817776
Probability	0.492173	0.4641	0.249663	0.084353	0.343723	0.463488	0.664389
Observations	24	24	24	24	24	24	24

Sources: *China Statistical Yearbook*, 1987-2009, Beijing: China Statistics Press; *The New China Statistics Fifty Years Assembly*, 1999, Beijing: China Statistics Press.

The reasons why we choose these variables and the ways how we define them are as follows:

L_STR indicates the proportion of labor-intensive industries, measured by the proportion in gross output value of the State-owned Industrial Enterprises and the Industrial Enterprises above the Designated Size[4] in China's labor-intensive industries of manufacturing sectors. In this paper, we use the words *proportion*, *share*, *structural change* or *development* alternatively to express the two connotations of this indicator: (1) The positions which these industries have taken in Chinese industrial structure; (2) To what extent these industries have developed. According to the *United Nations Standard International Trade Classification (SITC)*, we classify the products of labor-intensive industries of the manufacturing sector in China into seven categories, i.e. manufacture of textile, manufacture of wearing apparel, footwear and caps, manufacture of leather, fur, and feather and its products, processing of timbers and manufacture of furniture, manufacture of papermaking, manufacture of articles for culture, educational and sports activities, manufacture of non-metallic mineral products.[5]

P_GDP stands for the logarithm of real GDP per capita, deflated by the 1978 price level in order to measure economic growth and to prove whether the changes in incomes will lead to the structural changes of labor-intensive industries or not.

TR_OPEN measures trade openness. The total sum of import and export trade is divided by GDP to build this variable. Trade openness has produced far-reaching impacts on China's economic growth since 1978, and a pattern of export which is dominated by labor-intensive industries has gradually come into being. But, in Chinese economic circle, there still exists a debate on whether trade openness has benefited economic growth or whether it has stimulated labor-intensive industries to expand. In our paper, the variable of trade openness is included into the simultaneous equations so as to check whether it has caused impacts on both economic growth and industrial structure.

TEC is an indicator for technological progress. Technological progress is usually considered to be embodied by two kinds respectively, i.e., the increase in product varieties and the improvement in product qualities. Because of the difficulties with the data availability, we define technological progress as the increase in product varieties, measured by the number of patent applications each year. The reason why we include this variable into the regression model is that technological progress is one of the main sources of economic growth, and it also causes the variation in the utilization efficiency of productive factors in different industries, leading to transformation in industrial structure.

SEC represents the proportion of gross output value of the secondary industry to GDP. We adopt it to measure the change of industrial structure at the level of the primary, secondary and tertiary industries. We use this variable to probe into the influence of economic growth on industrial structure and to further observe whether economic growth is biased towards the development of labor-intensive industries. Similarly as we build the variable **L_STR**, we utilize the words *proportion*, *share*, *structural change* or *development* alternatively to express the positions and the level of development of the secondary industry. It is worth mentioning, that we use the share of secondary industries in gross output value as a similar proxy variable of the share of capital (technology)-intensive industries in gross output value, because the complete and detailed data on capital (technology)-intensive industries is unavailable.

WORK is the logarithm of total employment. We use it to calculate the effect of the variance of total number of the employed persons in labor-intensive industries. We add it into the model for two considerations. On the one hand, to add the extra variables into the equations of the share of labor-intensive industries can make the equations to be discerned. On the other hand, the increase of the employed workers in labor-intensive industries may strengthen the comparative advantage of labor factor if the newly employed workers supply their effective labor, and furthermore, it gives impetus to the expansion of labor-intensive industries.

INV expresses the investment rate, denoted by the share of total fixed capital investment to GDP. There are also two reasons for introducing this variable into the empirical model. One reason is that without this extra variable, the economic growth equation cannot be discerned. Another reason is based on the fact that China's high rate of economic growth is, to a great extent, driven by high rate of fixed capital investment.

Since the data we collect from the above-mentioned seven categories of labor-intensive industries are incomplete, in order to meet the requirement of date completeness, we have to choose the time series data during the period of 1986-2010 as analysis samples. We construct the above variables based on the data which are sorted out from *China Statistical Yearbook* of each year and *The New China Statistics Fifty Years Assembly.*

Econometric Analysis and Testing

The Simultaneous Equations Models

When we build up the simultaneous equations models, we focus on the simultaneity problem. If the simultaneity problem arises, the OLS estimation will reveal inconsistency estimators. Correspondingly, we need adopt the Two-stage Least Square (TSLS) estimation and the Instrumental Variable (IV) estimation. If the simultaneity problem does not arise, we can use the OLS method to get consistent and efficient estimates. At the beginning, we apply Hausman Test to decide whether the simultaneity problem appears. According to the results, Hausman Test shows that there exists simultaneity among the empirical equations (1), (2) and (3). Therefore, we utilize the TSLS method to estimate the models.

When using the TSLS estimation, we develop our regression analysis using factors that have made influence on the share of labor-intensive industries (L_STR). Since trade openness and economic growth are highly correlated, they do not enter the equation simultaneously. The regression results are presented in Table 3.

TABLE 3. The results of L_STR (TLS)

Sample interval: 1986-2009, 24 samples					
variables	symbols	Model(1)	Model(2)	Model(3)	Model(4)
constant	C	0.385589***	0.245716***	−3.346345***	−3.451977***
Trade openness	TR_ OPEN	——	−0.1445824***	——	−0.051633**
Economic growth	P_GDP	−0.060841***	——	−0.024662*	——
Technological progress	TEC	——	——	−0.115029**	−0.120398***
The share of gross output value of secondary industries to GDP	SEC	——	——	——	——
Total employment	WORK	——	——	0.843504***	0.856541***
Investment rate	INV	——	——	0.002984**	0.003246***
R^2		0.481011	0.412579	0.904674	0.892090
Adjusted R^2		0.456297	0.384607	0.878195	0.869372
DW statistics		0.439838	0.576124	1.499242	1.371070
F statistics		20.33023	17.13765	34.1651	39.26828

Note: ***, **, * means the estimators are significant at the levels of 1%, 5%, 10%, respectively.

Source: own elaboration.

In Table 3, we show that in the Benchmark Model 1 and Benchmark Model 2, trade openness and economic growth respectively have significantly negative effects on the proportion of labor-intensive industries. On the one hand, for many years, China's foreign trade has mainly relied on export of the low value-added labor-intensive products. This kind of trade pattern of labor-intensive industries means that when trade openness increases and export grows, the added value from export will decrease, which will be further explained below. So, the increase of trade openness is harmful to the expansion of labor-intensive industries. On the other hand, economic growth in China is seemingly detrimental to the development of labor-intensive industries, too.

Economic growth in China tends to reduce the share of labor-intensive industries in the manufacturing sector. This result can be attributed to the following factors. Firstly, GDP growth tends to raise the income level. According to the law of marginal propensity to consume, when GDP per capita goes up, the demand for consumer goods of high quality will rise while the demand for those of low quality will fall. Since in China, the goods made by labor-intensive industries are basically low-grade consumer goods, economic growth will probably result in two opposite effects at the same time: it causes an increase in the income level while it leads to an accompanying reduction in demand for labor-intensive goods. Whether economic growth has pushed labor-intensive industries forward or not depends on which effect dominates another. Secondly, economic growth will accelerate capital accumulation, and enhance the proportions of capital as factor endowment. Consequently, economic growth shifts comparative advantage to the capital-intensive industries, and the resultant structural adjustment within the manufacturing sector causes a decline of the share of labor-intensive industries. Thirdly, economic growth usually is consistent with a high level of technological progress and diffusion, and the cost of utility of new technologies is hence reduced. Moreover, the advanced technologies are more often applied to the high value-added capital-intensive or technology-intensive industries while less frequently to the low value-added labor-intensive industries. That is an important reason why technological progress often generates advances in the high-tech industries while producing negative effects in labor-intensive industries, decreasing the share of China's labor-intensive industries in the manufacturing sector.

In the next step we add the control variables into the benchmark models and remove those insignificant variables. Our regression results (see Model 3 and Model 4) show that the coefficients of trade openness and economic growth are significant, which means the empirical models are robust, but the effects made by trade openness and economic growth respectively on the proportion of labor-intensive industries have been reduced. This means that, on the one hand, there is a certain correlation between our control variables and trade openness or between control variables and economic growth; on the other hand, the regression results of control variables demonstrate that the coefficients of technological progress in labor-intensive industries are significantly negative. It follows that in China, technological progress is generally not conducive to the development of labor-intensive industries. Similarly, the significantly positive coefficients of total employment suggest that the increase in total number of employed persons facilitates labor-intensive industries to expand.

This result has verified the inference of comparative advantage theory. It confirms that labor as a factor endowment still plays an important role in promoting economic growth in China. The coefficient of investment rate in labor-intensive industries is significantly positive which supports widely accepted views in the Chinese literature that a large amount of capital input is still one of main driving factor to promote China's economic growth.

Table 4 presents the regression results when economic growth is used as an independent variable. Here we recognize that the results are generally consistent with those in Table 3. Since trade openness and the share of labor-intensive industries are highly correlated, they need a separate regression models. The results indicate that the influences from both of them on economic growth are highly significant: trade openness makes positive effects on economic growth while the share of labor-intensive industries is detriment to economic growth (see Model 5 and Model 6).

Since China carried out the strategy of opening-up in early 1980s, foreign trade had been an important engine for economic growth. The labor-intensive industries, which depended on a large quantity of cheap rural labor, have made significant contributions to China's economic growth. But, there exists a heated debate on the role of labor-intensive industries: some research results have testified that the unduly large share of labor-intensive industries in the manufacturing sector certainly will impede sustainable development in China. As compared to the products of capital (technology)-intensive industries, labor--intensive products are usually both cheap and low value-added. The more these industries get expanded, the less they have contributed to China's GDP growth. Therefore, if the share of labor-intensive industries is rising, they will occupy a large amount of resources (which should have been used in the capital(technology-intensive industries) and only produce a large number of the low value-added products. If this process continues, it will hamper transformation and development in China.

TABLE 4. The results of P_GDP (TLS)

Sample interval: 1986-2009, 24 samples					
variables	symbol	Model(5)	Model(6)	Model(7)	Model(8)
constant	C	2.359093***	4.819207***	3.679901*	0.101196
Share of labor-intensive industries	L_STR	——	−8.267201***	——	−1.442904**
Trade openness	TR_OPEN	2.231135***	——	−0.050580	——
Technological progress	TEC	——	——	0.673117***	0.522376***
The share of secondary industries in gross product	SEC	——	——	2.219538**	0.019607**
Total employment	WORK	——	——	−2.192388**	——
Investment rate	INV	——	——	——	——
R^2		0.705459	0.481055	0.982969	0.985971
Adjusted R^2		0.691433	0.456344	0.979383	0.983017
DW statistics		0.613722	0.241582	0.693659	0.885728
F statistics		59.77632	15.77807	274.1524	333.8297

Note: ***, **, * means the estimators are significant at the levels of 1%, 5%, 10%, respectively.

Source: own elaboration.

In Table 4, after adding the control variables and removing the insignificant variables (see Model 7 and Model 8), we discover that the negative effect of share of labor-intensive industries on economic growth still remains significant, but the effect of trade openness on economic growth is insignificant, which reveals that a considerable correlation exists between trade openness and the control variables. Among the control variables, both technological progress and the share of secondary industries have significantly positive effects on economic growth. The significantly positive coefficients of the technological progress in Model 7 and Model 8 suggest that, technological progress fosters economic growth by enhancing the production efficiency in labor-intensive industries. Similarly, the coefficients of the share of secondary industries in Model 7 and Model 8 are significantly positive. This overall regression results imply that there is still room for China's manufacturing sectors (which include capital and technology intensive industries) to expand.

Table 5 exhibits the regression results where trade openness is treated as an independent variable. In the Benchmark Model 9 and Benchmark Model 10 of Table 5, we find that economic growth has positive effects on trade openness while the development of labor--intensive industries has negative impact on trade openness. Intuitively, high economic growth should have a positive effect on trade openness because not only does high growth lead to the expansion of export, but also to the increase of import (such as machinery and intermediate goods). Generally speaking, an open and rapidly growing economy requires a larger degree of trade dependency.

There arises a question: Why the development of China's labor-intensive industries has negative effects on trade openness? China's labor-intensive industrial structure was formed in early 1980s when the developed countries and the East Asian economies transferred some capital (technology)-intensive industries into China. At that time, China had just started out export-oriented development strategy. This round of global industrial transfer was accepted by China that sought capital and technology. An outward pattern of economic development of labor-intensive industries with typical Chinese characteristics of "processing given material, assembling provided components, order against samples, and compensation trade" was taking shape. The first round of China's industrial transformation was a correct choice for it completed a change from the planning-dominated, capital-intensive heavy industries to the market-oriented, labor-intensive light industries for exports. Since then, China's labor-intensive export industries gradually formed their strong comparative advantages. From mid-1980s to mid-1990s, these industries fueled trade expansion, giving big impetus to GDP growth.

But, circumstances changed overtime as the drawbacks of labor-intensive industries gradually revealed. In 1980s and 1990s, when FDI and multinational corporations poured into China, bringing capital and technology to supplement China's cheap labor, transferring mainly the low-end productive links, generating low value-added and demanding large inputs of labor. The resulting problem faced by China today is that it relies on labor--intensive export industries with low-added value. This implies that the more goods these industries produce, the less the value-added will be as compared to the costs input, and the larger scale these industries have reached, the more unfavorable to trade openness these industries will be. Because the share of labor-intensive industries is measured by their proportion in gross output value taken by these industries, it means that the more open the economy is, the less benefit China will gain.

Models 11 and 12 add control variables on the basis of benchmark models. The results of these two models demonstrate that the coefficients of the share of labor-intensive industries and economic growth remain significant, which verifies the robustness of the empirical models. Table 5 also shows that both the share of secondary industries and total employment are positively related to trade openness. The important policy implications of our findings are interpreted below.

TABLE 5. The results of TR_OPEN (TLS)

Sample interval: 1986-2009, 24 samples					
variables	symbol	Model(9)	Model(10)	Model(11)	Model(12)
constant	C	1.085699***	−0.827022***	−5.680130***	−0.827022***
Share of labor-intensive industries	L_STR	−3.614298***	——	−2.322232***	——
Economic growth	P_GDP	——	0.378035***	——	0.378035***
Technological progress	TEC	——	——	——	——
The share of secondary industries in gross product	SEC	——	——	0.016714*	——
Total employment	WORK	——	——	1.191304**	——
Investment rate	INV	——	——	——	——
R^2		0.422104	0.727129	0.796197	0.727129
Adjusted R^2		0.394585	0.714135	0.765627	0.714135
DW statistics		0.508916	0.649598	0.839514	0.649598
F statistics		13.47265	54.54590	26.04470	54.54590

Note: ***, **, * means the estimators are significant at the levels of 1%, 5%, 10%, respectively.

Source: own elaboration.

The VAR Model

The above results in the models of simultaneous equations only depict the statistical relationships between trade openness, the share of labor-intensive industries and economic growth, but they do not reflect how these variables interact one another. In fact, the interaction between the trade openness, the share of labor-intensive industries and economic growth has somewhat embodied in the above regression equations. In order to overcome the shortcomings of a single equation and express the interactions between the three variables, we apply VAR model for an in-depth analysis. A VAR (q) is specified as follows:

$$y_t = A_t y_{t-1} + \ldots + A_p y_{t-p} + Bx_i + \varepsilon_t \quad (4)$$

In Equation (4), y_t is an unstable I (1) series of m dimensions, and x_t is exogenous variables vector of d dimensions, ε_t denotes random disturbance vector. Since VAR model requires the data series of variables to be stable, we perform ADF unit root testing. We find that all the data series of the above three variables are unstable, but the first order difference form of the data series of the variables turns out to be stable at the significance level of 5% (see Table 6). Therefore, in this paper, we adopt the first order difference form. In the meanwhile, being limited to the samples, we need to determine the proper lag order q, Five kinds of tests are applied in this paper, namely LR test, Final Prediction Error (FPE) test, AIC criterion, SC criterion and HQ criterion. According to the results, we select 4 as the proper lag order (see Table 7).

TABLE 6. Data stationarity test

variable	testing model	statistics	1% critical value	5% critical value	10% critical value
P_GDP	(0,0,1)	1.027729	−3.7667	−3.0038	−2.6417
dP_GDP	(c,t,1)	−2.748144	−3.7856	−3.0114	−2.6457
L_STR	(0,0,1)	−1.986449	−4.4415	−3.2535	−3.2602
dL_STR	(c,t,1)	−4.416301	−4.4691	−3.6454	−3.2602
TR_OPEN	(0,0,1)	−2.118370	−4.4415	−3.6330	−3.2535
dTR_OPEN	(c,t,1)	−1.657507	−2.6819	−1.9583	−1.6242

Note: (c, t, k) stands for the situation where the constant, the trend term and the lag phase of variables are included in the testing models, and here the lag order is determined when AIC or SC is minimized.

Source: own elaboration.

TABLE 7. The determination of lag order

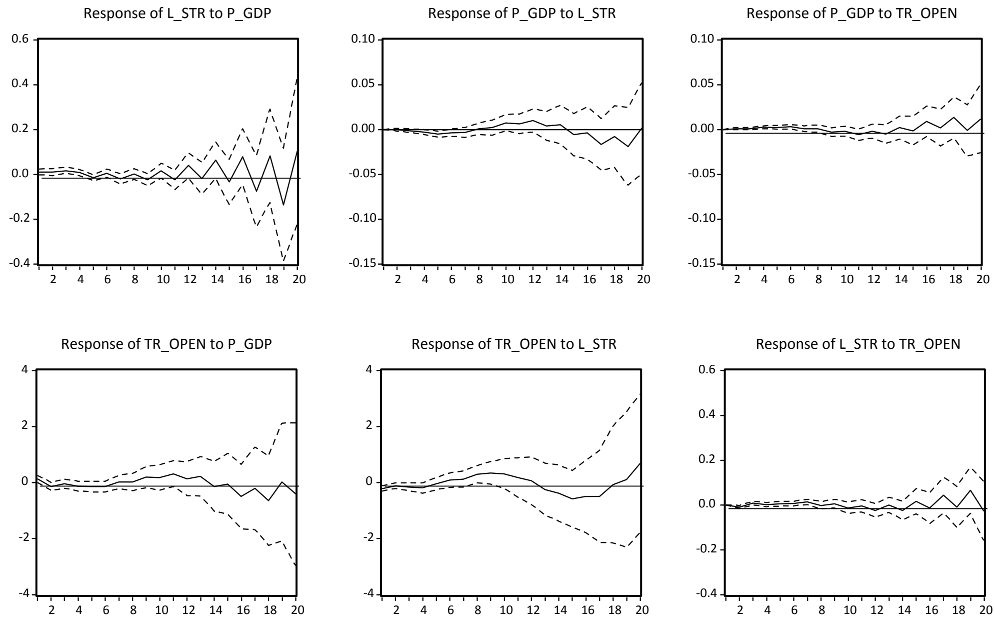
Lag	LogL	LR	FPE	AIC	SC	HQ
0	25.03970	NA	1.97e-05	−2.319969	−2.170847	−2.294731
1	86.73962	97.42092	7.84e-08	−7.867329	−7.270841	−7.766379
2	93.62448	8.696662	1.07e-07	−7.644682	−6.600828	−7.468021
3	115.1534	20.39578	3.65e-08	−8.963511	−7.472292	−8.711137
4	146.0250	19.49788*	6.43e-09*	−11.26579*	−9.327203*	−10.93770*

Note: * represents the corresponding lag order determined by a certain criterion.

Source: own elaboration.

Since the impulse response function can be used to mirror the interactions between the variables, we describe the impulse response function of lag order 4 in Figure 2.

FIGURE 2. The impulse response function of VAR (4) model of lag order 4.



Note: The impulse response functions in Figure 2 are illustrated by using EVIEWS 6.0.

Source: own elaboration.

From the illustrations of the impulse response function of VAR model, we derive three conclusions: (1) The response of the share of labor-intensive industrials to economic growth is gradually augmented with time, and the effect of such a response is cyclical. The response of economic growth to the share of labor-intensive industries is negative at the beginning, and it shifts to be positive after lagging for 8 periods, and it turns negative again after the 14th lag period. (2) The response of economic growth to trade openness is insignificant at the beginning, but it comes into effect with time. The response of trade openness to economic growth is negative at the start, and it becomes positive after the 8th lag period, then it comes back to be negative. (3) The response of trade openness to the share of labor-intensive industries is somewhat complicated. It is negative at first, then positive after the 6th lag period, negative again after the 12th lag period and finally back to be positive after the 18th lag period. The response of the share of labor-intensive industries to trade openness is insignificant at the start. Although it augments as time goes on, it remains trivial.

In addition, the results of variance decomposition procedure of VAR (4) provide another way to interpret how the variables and their influencing factors affect one another (see Table 8). (1) The effect of the share of labor-intensive industries on economic growth is hysteretic and it begins to have significant effect at about the 3rd lag period. Afterwards, such an effect gradually increases and it reaches maximum at the 12th lag period, then it begins to diminish. Economic growth has a substantial influence on the share of labor-intensive industries at the very beginning, and such an effect increases with time. However, the effect of economic growth on the share of labor-intensive industries is larger than that of the latter on the former. (2) The effect of trade openness on economic growth is hysteretic. It begins to produce significant influence at the 2nd lag period, and it keeps rising until it reaches maximum at about the 16th lag period, then it decreases. At the start, economic growth has brought a great shock on trade openness, then the effect of such a shock remains rather stable. But, the effect of economic growth on trade openness is larger than that of the latter on the former. (3) The effect of trade openness on the share of labor-intensive products is lagging behind. It becomes relevant at the 2nd lag period, then it stabilizes. At the same time, the share of labor-intensive industries has an effect on trade openness from the very beginning, which remains stable through the examined period. But, the effect of the share of labor-intensive industries on trade openness is larger than that of the latter on the former.

TABLE 8. Variance decomposition procedure of VAR (4)

period	P_GDP		L_STR		TR_OPEN	
	L_STR	TR_OPEN	P_GDP	TR_OPEN	P_GDP	L_STR
1	0.000000	0.000000	12.12360	0.000000	18.12673	53.33620
2	0.736671	2.524000	15.41316	7.585936	29.58682	46.78464
3	10.13116	3.476184	28.26006	9.585630	23.88897	53.75903
4	21.55419	13.97561	31.01071	9.173827	24.17892	55.00773
6	41.20793	15.62714	32.40026	8.637636	35.12524	47.35233
8	37.59443	11.90671	37.17694	12.00439	24.03286	56.73900
10	46.38240	13.24816	47.82965	13.39463	21.98225	59.36249
12	52.19986	15.06158	51.09006	14.51974	30.61818	52.56697
14	40.72647	14.62298	58.43751	12.55647	27.24355	53.56747
16	29.60029	16.06189	65.49722	9.674468	26.12838	55.31483
18	28.84583	15.40767	64.48480	9.918722	34.94684	49.91247
19	36.41413	12.83608	70.20958	12.75432	34.09480	49.04272
20	24.65543	11.89548	67.37200	10.85550	32.40707	52.54445

Note: The results of variance decomposition procedure are performed by EVIEWS 6.0.

Source: own elaboration.

Conclusions and Policy Implications

In this paper, we consider China's industrial transformation and analyze empirical data for the period 1986-2008 to better account for why labor-intensive export industries had once played their roles as China's engines of growth. We rely on empirical models to examine and test the systematic co-relationship between the development of labor-intensive industries and other variables. The goal is to account for the factors behind the vicissitude of China's labor-intensive export industries.

In the introductory section, we discuss two strands of Chinese literature concerning the vicissitude of China's labor-intensive industries; one upholding the theory that China should continue to develop labor-intensive industries and the other urging China to adjust its industrial structure and turn it to more capital (technology)-intensive industries. Based on our findings, we argue that the second theory is better supported. Based on our empirical results, we conclude that:

(1) In the period when the labor-intensive export industries were forming, the strong comparative advantage rooted in abundant and cheap rural labor has promoted China's foreign trade and economic growth. But, over time, China's labor-intensive industries which gain low value-added face limits as engines of export-led growth. By contrast to the traditional inter-industry trade pattern, the intra-industry or intra-product trade patterns created newly established global patterns of vertically specialized division of labor at different levels of value-added chains. They have caused the trade originating from low value added sectors to contribute less to growth relative to more capital-intensive, high value added sectors. The empirical results of our models reveal that further development of labor-intensive industries has negative effects on both trade openness and economic growth. Based on Figure 1, the share of low value-added labor-intensive industries in gross output value began to decline since 1995. Even if we extend the data series to the present, the declining trend for these industries remains. We argue that global recession and rising trade protectionism is likely to further reduce its share.

(2) The development of China's labor-intensive industries has a tendency to excessively expand. For over more than 30 years, China followed an export-oriented strategy where the numerical export targets were set up and the enterprises, no matter public or private, are encouraged to actively participate in the competition for export. In the circumstance of an economic transition, in which some vestiges of the traditional planning economy remain, this process evoked by the export-led development strategy easily induces the labor-intensive industries to expand. In addition, since the major export competition instrument implemented by firms in labor-intensive industries is the low price, it encourages an easy solution – reliance on cheap labor instead of costly investment enhancing technologies and capital and improving quality of products. In consequence, the low-added value in exports of labor-intensive products makes these industries less competitive and

leads to inefficient use of resources. These two reasons demonstrate that the heyday of China's labor-intensive export industries has gone forever and China urgently needs another industrial transformation to move from labor-intensive export industries into more capital (technology)-intensive industries

China's industrial structure has undergone a major restructuring, as capital (technology)-intensive industries have increased their share in output and exports since mid-1990s, and the total capital stock have increased supporting that process. Based on the literature, some Chinese economists argue that a few China's capital (technology)-intensive industries, such as IT industry, office work and communication equipment, machinery and transportation equipment etc., have built up their preliminary international competitiveness. The regression results in our paper show that the coefficients of the share of secondary industries are significantly positive, which at least imply that there is still a vast space for China to further develop its capital-and-technology-intensive industries.

China's goal for its second industrial upgrading, that is to scale down the labor-intensive industries, while to scale up the capital (technology)-intensive industries will likely alter the present outward pattern of economic development. Consequently the pertinent question is how to further upgrade the capital (technology)-intensive industries. Under current international division of labor, which is characterized by vertical specialization, China has two ways to enhance its capital (technology)-intensive industries: Firstly, promote capital (technology)-intensive industries with competitive advantage to escalate along the value-added chains and try to connect their production with the higher-end links relating to R&D or the global distribution network so as to complete the industrial upgrading. Secondly, cultivate the ability of self-reliance innovation of these industries, and make every effort to foster own core technology and core competitiveness. This self--reliance innovation in China is well displayed by the example of swift development of high-speed train.

Due to the characteristics which are peculiar to the capital (technology)-intensive industries, such as externalities, indivisibility of capital equipment, scale effects, asymmetrical information, technological market deviating from perfect competition, social overhead capital aroused by structural upgrading, match of human capital to accumulation of physical capital and industrial upgrading etc., Chinese government should find the right fields in which its intervention plays indispensable roles of coordinating investment activities and tackling externalities and other market failures. Of course, the necessary premise of government intervention is that in China, the further market-oriented reforms should be carried forward so as to let market play decisive role in allocation of resources. Only on this basis, can the government intervention be effective.

Although China's labor-intensive industries have their weakness of gaining too less added value, which has crippled their ability to prop up healthy and sustainable development, we must confess, from another angle, the labor-intensive industries are still making a considerable contribution to create the opportunities for employment and maintain social stability. For such a country with so large a population as China, to heighten the rate of employment is a long-run target of a macroeconomic policy. It is worth mentioning that quite a number of labor-intensive enterprises are private-owned. During the transitional period, to maintain enough private firms will prepare a good circumstance in which the market-oriented reforms will be more effectively put into effect.

At present, the government's policy orientation is to scale down and reshuffle the labor-intensive industries, not to shut down these industries abruptly. In the process of second industrial transformation, while the dominant position for export industries will be gradually substituted by the capital (technology)-intensive industries, there still exist great potentialities for the labor-intensive industries to develop. For those industries that still have latent international competitiveness, such as textile and apparel etc., the government should induce them to seek a strategy of "famous-brand" and turn "price advantage" into "brand advantage" and "distribution channel advantage". At the same time, R&D should be encouraged, workers should be trained on the job and human capital should be cultivated and its stock should be motivated into use in order to ameliorate productive efficiency and to raise the value-added of labor-intensive products.

We are aware of the limitations of the current study. First of all, we have not introduced the variable of human capital into the econometric models. It is easy to adopt the data of labor-intensive industries as a whole, but it is difficult for us to find an approach to differentiate the human capital in China's labor-intensive industries from the high-qualified human capital at some production links in capital (technology)-intensive industries. Another limitation is that we expect China's capital (technology)-intensive industries to dominate in the economy, but in this paper we have not analyzed the relative positions of the capital (technology)-intensive industries in Chinese economy as compared to that of the labor-intensive industries. In addition, we used the share of secondary industries as a proxy variable of the share of capital (technology)-intensive industries. These two limitations of our study do point to an important research direction on our agenda in the future.

Notes

[1] The authors acknowledge the financial support of the project *A Study on the Transformation of China's Outward Pattern of Economic Development* (13JJD790021) given by the Ministry of Education, P.R. China.

[2] A hypothesis that refers to the importance of impacts of changes of industrial structure on economic growth stresses that in the process of industrialization, due to the different levels of productivity and the

different rates of productivity growth, when the productive factors flow from the sectors with low levels of productivity or low rates of productivity growth to the sectors with high levels of productivity or high rates of productivity growth, the aggregate productivity growth will be accelerated. This explanation based on the contribution made by the changes of industrial structure which is initiated by factors flow on productivity growth is called the "Structural Bonus Hypothesis". The "Structural burden hypothesis" expresses the reversed meaning. The feature that the change of industrial structure plays an important role on economic growth is more protruding in developing countries than in industrialized countries has been accepted as one of the "stylized facts". See M.P. Timmer and A. Szirmai, (2000), Productivity Growth in Asian Manufacturing: The Structural Bonus Hypothesis Examined, *Structural Change and Economic Dynamics*, Vol. 11, pp. 371–392.

[3] The Industrial Enterprises above the Designated Size denote all the state-owned industrial enterprises and the non-state-owned industrial enterprises in China whose yearly gross output value reaches 5 million yuan or above 5 million yuan (in 2011, the State Statistics Bureau adjusted this requirement up to 20 million yuan or above 20 million yuan).

[4] Because of lacking the data of gross output value of manufacturing sector in 2004, we adopt the share of labor-intensive industries in gross sale value of manufacturing sector as a substitute.

[5] Including the industries that need more intensive input of labor, such as glass and glass products, non-refractory pottery and porcelain products, refractory pottery and porcelain products (porcelain bricks), sintered clay bricks, tiles and other building products, the stones used as building and fitting-up materials, grinding materials (diamond), asbestos etc.

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