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An Empirical Study on Technological Sophistication of China Imports

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ABSTRACT

This paper calculates technological sophistication of Chinese manufacturing industries imports during 2002-2012, the results show that technological sophistication of Chinese imports has an upward trend. We find positive relation between economic development and Technological Sophistication of Imports, negative relation between capital intensity and Technological Sophistication of Imports, negative relation between wage and Technological Sophistication of Imports. And the effect has difference between developed country and developing country. We also found that China's imports from the developing countries are more applicable and easier for absorption; companies are more inclined to choose the most suitable product imports, rather than high-tech products.

Keywords: Technological Sophistication of Imports; export Sophistication; ASEAN; EU

1. Introduction

China is the biggest country of export and second biggest country of import in the world, and it will become the first biggest import country in the years to come, therefore, more and more studies pay more attention to China trade quality, the related studies normally focus on export quality, whereas fewer on import quality. As Muller ever said the interest of foreign trade lies not in export but in import, this article has made a special study on China trade quality from the perspective of import, it is of important significance to optimize the import trade structure and promote the sustainable and steady economic growth of China.

2. Summary of Literature

North-south trade model given by Flam and Helpman (1987) considers the two types of countries in the North and South has big disparity in technological standards, which has caused the northern countries can produce the high quality products, and the southern countries export the low-quality products[1]. Schott (2004) discovered the mutual overlapping among the products from

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developed and developing countries, but the products have vertical disparity: prices of products from developing countries are obviously lower than that from developed countries, namely the developed countries have exported products of higher unit value (higher quality)[2]. The study shows that the products from the countries of different economic development standards are of differentiated import quality; the products from developed countries enjoy high quality whereas products from developing countries are of low quality. It is consistent with comparative advantages and mutual demanding theory. Are there any differences in product quality and affecting elements for those imported from developed and developing countries? This article intends to compare the differences and rule.

Most of the studies on China trade are mainly focused on export, e.g. export trade structure, quality and trade influence and etc. Take the export trade quality as an example, the studies are: Marvasi (2013) discovers in his studies that China exports as well as imports products of high technological complexity, and the import technical sophistication has exceeded the exported products, the gap between the two is reduced year by year [3]. Du and Wang (2007) established the technical indices to test the products, and discovered in their case studies that the technical structure for China export trade has never exceeded the average standards of the developing countries from 1980 to 2003[4].

In contrast with the "prosperity" in export trade research, the studies on import trade are very rare. The domestic studies on import trade are mainly of two schools. The studies of Coe et Helpman(1995), Coe et al.(1997), Keller(2000)as well as Eaton and Kortun (1999) prove that the international trade and int'l R&D spillover has played an important part in the improvement of the domestic technological standards and productivity of a country[5-8], most of the national literature studies pay more attention to the influence of import upon productivity, refer to the studies and works of Gao and Wang (2010), Qian (2011)[9-10]. The import trade studies have paid partial attention to the influence of import upon export performances, such as the work done by Tian and Yu (2013) and Gao (2013)[11-12]. Academic studies on China import quality are at initial stage, the relevant work done by Zhu and Feng (2011) discovered that the China import technical complexity is constantly upgraded, the import structure is mainly the finished products of hi/mid-technology, and also insist that China should enlarge the quota import of energy resources and resource products, optimize the import trade structure [13]. Shi (2015), with the employment of the micro data research from China Customs Office, discovers that China import quality is in optimized trend, apart from the textiles and furniture, the remaining industries import quality is increasing, the processing trade import quality is higher than the general trade [14]. Li and Cai (2013) studied the transformation of import nature and enlargement of import strategy [15].

Since there are quite fewer studies on import quality in China, the author intends to analyze the China import trade quality and its regional difference from this perspective. The articles are divided into 3 parts, first part is the measurement of the China import technological complexity in 2002-2012; second part analyzes the factors affecting China import technical complexity based on evidences provided; third part, as represented by 15 countries from EC developed world, 5 countries from ASEAN as delegates of developing countries, the author made realistic analysis and comparison to the influential factors upon the technical complexity of import from both developed and developing countries, finally a conclusion is made.

3. Measurement of China import quality

3.1Creation of import quality indices

The methods on trade quality research are mainly as follows: (1) Product price. According to Fontagné et al (2008) and Schott (2004), the export prices for the two types of products are different due to the different stage development in two types of countries:

the developing countries mainly exported the low-end products with low price range, the developed countries exported the high-end products with high price range [16, 2]. Hu (2013) uses $r = \frac{p_c}{p_w}$ of which " P_s is the export price of a given country for a given product, P_w is the world average export price, when we determine the China export quality, we found the export quality is upgraded after entry into WTO but still remains low. [17] (2) Product technical sophistication. According to the comparative advantage theory from Ricardo, Hausman et al (2007) thinks the technical content will be higher if most of the products are exported by rich countries, sitting at the upper end of international labor specialization chain; when export is mostly done by the poor countries, then the technical content will be lower, sitting at the lower end of the int'l labor specialization chain, thus the indices to measure the technical complexity of export products is created [18]. (3) Indices of similarity. Tang and Zhang (2009) compared the similarity indices of export structure between the developing countries and developed countries, by means of mathematical expression, $ESI_{i,t} = \sum_{j=1}^{n} Min[S_{i,j,t}, S_{r,j,t}]$ of which S represents the percentage of a certain commodity in total amount of export, subscript i denotes developing countries, r denotes reference countries, j means export commodities, t shows the year; the calculation shows the international labor specialization positions of 40 developing countries [19]. The product technical complexity has perfectly reflected the technical content of products, and can precisely reflect the trade quality, therefore the article here chooses technical complexity (sophistication) as the index to measure the import trade quality.

Hausman et al (2007) created the index PRODY to measure the technical complexity of export product based on Ricardo theory of comparative advantage, the calculation equation is:

$$PRODY_{\mathrm{i}} = \sum_j \frac{(x_{ji}/X_j)}{\sum_j (x_{ji}/X_j)} Y_j = \sum_j \frac{RCA_{ji}}{\sum_j RCA_j} \quad (1)$$

denotes the technical complexity of product i, i refers to a certain product, j refers to a certain export country, x_{ji} means the export amount of product i in Country j, X_j namely the gross export value, Y_j refer to the per capita revenue in country j, (x_{ji}/X_j) denotes the proportion of export of product i in gross export of country j, RCA_{ji} denotes the comparative advantage indices of product i in Country j. You can see that the index is actually the weighted average of per capita GDP for certain product made by all countries, its weight is the revealed comparative advantage index of that product by all countries, using the comparative advantage index as the weight can efficiently remove the deviation caused by the different sizes of all countries. Apparently if the hi-income countries export a certain product more intensively, its technical complexity will be higher.

Since the import and export are the different perspectives of the same matter, the import complexity index $IMPY_j$ of country j is built based on the export technical complexity, using Marvasi (2013) methodology, the import product complexity of commodity i in a certain country is:

$$IMPY_j = \sum_i (\frac{m_{ij}}{M_j}) PRODY_i \quad (2)$$

Of which m_{ij} denotes the import value of product i in country j, M_j denotes the import value of product i in country j, $PRODY_i$ refers to the technical complexity of product type i. you can see that the import complexity index is the weighted average of technical complexity, weight is import of product i in the gross import value of country j [3] . Zhu and Feng (2011) point out that this calculation method may probably over estimate the function of big country, and neglect the export product of comparative advantage in small country[13].

This article uses equation (2) to calculate the technical complexity of import after China's Access into WTO. It has used the import and export data of 4632 HS6 (2002) commodities in 142 countries in 2002-2012, the trade data is taken from the COMTRADE Database of the United Nations, the per

capita income uses GDP data adjusted by purchasing power parity, the original data are from WDI database of the World Bank, the calculation is done using the unchangeable price in 2002, unit U.S. Dollars.

3.2 Measurement of China's import quality and regional comparison

This article uses equation (2) to calculate the China import technical complexity in 2002-2012. Since the import quality from countries of different economic development stage may be variable, together with the previous analysis here, we make separate calculation on import technical complexity of EU and ASEAN. Why we choose these two regions are: first, the EU and ASEAN are the dynamic market of big economic size in the world as well as the important trading partners of China. EU is the biggest and well developed integrated economic organization of the world, the biggest trade partner of China, the 2nd largest import market; ASEAN is the rapidest region for China trade development, the third biggest trade partner of China, China-ASEAN is the third biggest free trade zone in the world. Secondly, most of the member countries of European Union are developed countries, whereas most member countries of ASEAN are developing countries, the two regions are very representative, and will be helpful in making further analysis of import complexity deviations from countries of different economic development stages, thus to explore the China import quality status quo and problems existed.

China import trade technical complexity is showing the upward trend as a whole, as in Table 1, the max annual increase margin of gross import complexity is up to over 10%. The reasons for overall upward going trend of import technical complexity are due to two probable reasons: on the one hand, the rapid economic development of China has increased the demands on products of a higher technological standards, incl. two levels both in consumption and investment demands. On the other hand, according to the mutual demands theory from Linder, the increase of China national citizens' income has upgraded the demands on products of more complexity of foreign countries, the domestic enterprises have increased capital investment in relevant fields for the import of machinery so as to satisfy the high-tier demands. Secondly as China actively joins the division of labor in the global value chain, the development of processed trade has brought a number of imports of intermediate products of high complexity, which has increased the import complexity of China as well. In table 1, we have given the imported products technical complexity of 15 developed countries of EU, ASEAN and 5 developing countries from ASEAN. If we look from all different regions, the China overall import complexity from EU, ASEAN and 15 countries of EU and 5 countries of ASEAN is going upwards. The technical import complexity from EU after 2005 is even upgraded in a quicker speed, and it has exceeded the import complexity from ASEAN. The China import complexity from 15 European countries is higher than that from 5 countries of ASEAN, the deviation degree is very obvious. Look from the import complexity of these specific countries (see Fig. 1 and Fig. 2), the average value from 15 countries of EU have all exceeded 25500 USD except Greece, value of Austria and Belgium is less than 24500 USD, then the rest 12 countries average value is all in the range of 24500-25500 USD. And the mean value for complexity from ASEAN countries falls in the range of 22000-24000 USD, obviously lower than the previous value. It means that the import complexity from developed countries is higher than from developing countries, it is consistent to the relevant theory.

Actual analysis for the real evidences that affecting the China import complexity factors: comparison between EU and ASEAN

4. Model and real case analysis

According to descriptions in previous passages and studies from other economists in the past, the mutual demanding theory thinks the income standards of a country will affect its consumption demands

Table 1 China import technical complexity in 2002-2012 (Unit: USD)

Year	Gross import technical complexity	EU import complexity	ASEAN import complexity	Import complexity from 15 EU countries	Import complexity from 5 ASEAN countries
2002	19755.143	19980.24	19315.017	19984.484	19318.757
2005	20945.244	18898.011	19334.515	18892.798	19365.987
2009	25633.836	25926.517	23787.56	26097.906	23748.714
2012	28945.265	28692.847	26845.215	28815.489	26574.215
Mean value	24451.59	23993.19	23427.504	24026.08	23365.698

Data source: COMTRADE database, WDI database, as calculated by the author.

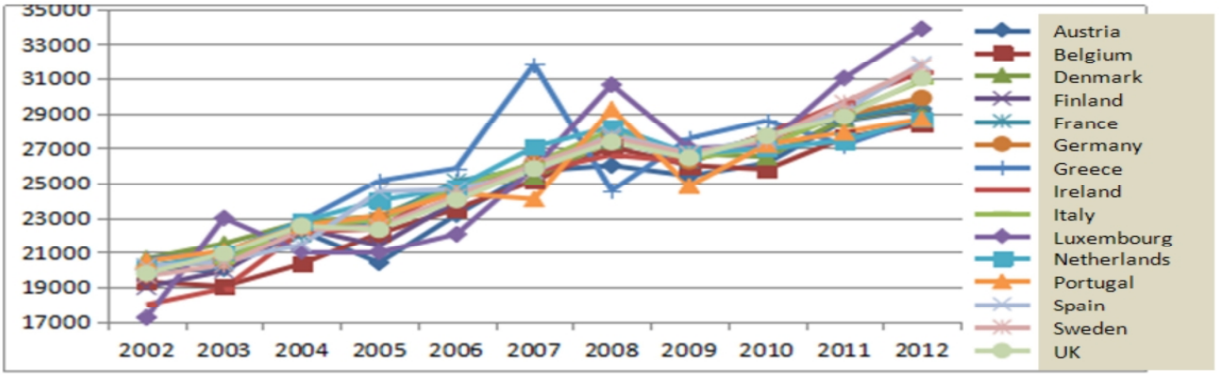

Fig. 1 Import complexity from 15 EU countries in 2002-2012 (Unit: USD)

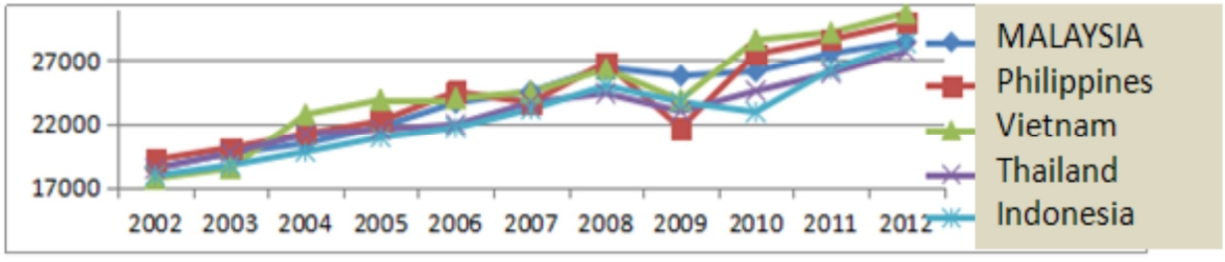

Fig. 2 Import complexity from 5 ASEAN countries in 2002-2012 (Unit: USD)

Data source: COMTRADE database, WDI database, as calculated by the author.

further affecting its import constituents, namely the economic development standards of the originating country will affect the import quality, so the articles uses the import complexity as the variable to explain many, economic development standards (per capita national income) is used as the variable to explain to provide argumentative evidences for relevant theories and studies. The selection of control variables are combined with relevant theoretical studies and real cases: comparative advantage theory and H-0 theory think that the comparative advantages of country and key element endowments will decide the import product structure and import quality, so the China factor endowment may affect the import complexity. The import complexity is used as the variable factor for explanation by integrating relevant theories and real case studies, per capita GDP is also the explanatory variable, intensity of capital, human

resources capital, vertical specialization of labor are the variables for control, the real case model in this article is as follows:

$$impy = c + \alpha_1 gdp + \alpha_2 wage + \alpha_3 cap + c \quad (3)$$

Of which impy is the explained variable, denotes the import quality, with the import complexity as its acting variable; gdp is the explanatory variable, denoting the per capita GDP of China, the original data are from the database of WDI of World Bank, adjusted by unchangeable price of 2002; the production elements mainly contain capital and labor force, cap denotes capital endowment, calculation methods are (physical capital/no. of employees in manufacturing industry), physical capital uses algorithm from Zhang Jun (2004) namely the fixed capital net value surplus substitute[20], the original data from "China Statistical Yearbook", Unit: 100 million RMB Yuan, adjusted according to the unchangeable price fixed asset investment price index in 2002, the original data of price index come from China Research Net, no. of employees in manufacturing industries is from "China Labor Force Statistical Yearbook", Unit: 1000 persons; wage denotes labor force, calculation method is (total amount of wage/no. of employees of manufacturing industry), the original data for total amount of wage come from "China Labor Force Statistical Yearbook", adjusted by the unchangeable consumers' price index of 2002; vss denotes China's standards in participating in vertical professional labor dividing, according to the calculation methods of Hummels (2001) [23], together with the processing methods of Ping [22], the original data are from table of investment production output of 2007 and UN COMTRADE Database. All the data are logarithms except vss data.

About the time sequence data, in order to avoid spurious regression, the stability test has to be done first, all the variables after tested by ADF unit root test all rejects the original pseudo assumption in 5% confidence interval, so the original sequence are not stationary series; we make further ADF unit root testing to first order difference of all series, all first order difference all shows obvious stability around 5% standards, the I (1) procedure is satisfied. Co integration test shows, there is co integration relations among the first order difference, denoting the long term balance relations among the variables . Consider that the GDP may have certain interior growing performance, so we choose the delay term as its instrumental variable, the Hausman testing results are: chi2=0.58, p=0.9653, accepting the assumptions that all variables for explanation are exogenous, it means no endogenous model set up here. OLS regression results are listed in column (1) of Table 2, we made further test to the classical assumption of OLS. White different variance results show chi2=7.57, p=0.1817, accepting the former assumption from same variance, no different variance exists. The relevant series inspection D-W tests results show D-W=2.97, the original assumption is rejected, which means the first order sequence correlation exists; then a further test is done to check if the high-order sequence correlation exist, we use Breusch-Godfrey to check 2nd order sequence correlation, results shows p=0.3118, it accepts that the former assumption namely the 2nd order correlation does not exist. In order to solve the sequence correlation problems, we made Newey robust estimation, results seen in column (2) of Table 2. In order to see the reasonableness of regression results, Self correlation of test residuals, shows Q=3.6161, p=0.0572, in 5% confidence level, the residual series does not have autocorrelation stationary series; in addition, Engel Granger test results show that residual difference statistical magnitude -4.816,p=0.0001 residual difference is also the stationary series, which all denotes that the regression results are reasonable.

We look from the regression results of the affecting factors of China overall import complexity, the per capita national citizen income, physical capital intensity and labor force factors all apparently affect the China import technical complexity, whereas the vertical labor dividing degree influence upon the china import complexity is not obvious. When the per capita GDP coefficient is above 1%, it means apparent positive value, it shows that per capita

income has obvious positive influence upon the import complexity. On the one hand, China economy is at take-off stage of economic development, the demands on advanced production machinery and equipment of certain technical complexity are increased; on the other hand, the increase of people's income has caused the further increase of products of further complexity. The Physical capital density (cap) reflecting the capital factor is obviously negative value around 1% standards, meaning the Physical capital density has apparent negative influence upon the China import complexity. The newly built plant buildings, purchase of most up-dated machinery & equipment, has enhanced the corporate production capacity, productivity and technological standards for hi-end products, thus lead to the substituting effects of imported commodities; another hand, the improvement of production capacity for the intermediate products has extended the complete domestic production, which has partially replaced certain import of the mid-end products. Labor force wage proves to be negative value at the levels above 10% standards, shows that consumption labor power cost of China population bonus is increased, which has obviously the negative influence upon China import product complexity, the probable reasons can be firstly that the enterprises tend to employ the imported machines to replace the man power due to the increase of labor power cost, secondly it is due to the long term implementation of import substitute strategy. Which shows that the vertical labor division vss is positive but not sharp in the global value chain labor division, participating the global value chain can promote the China import complexity, which has proved the fact that China manufacturing industry is at the low-end segment of international labor power distribution.

Table 2 Affecting Elements to China Import Technical Complexity

	China as a whole		15 EU countries		5 ASEAN countries	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	NEWEY	OLS	NEWEY	OLS	NEWEY
gdp	1.394764***	1.394764***	3.535*	3.535*	5.604149*	5.604149**
	(0.3629553)	(0.3288988)	(1.282132)	(1.043476)	(1.840827)	(1.83993)
cap	-0.2008248***	-0.2008248***	0.212589*	0.212589*	-0.3387368*	-0.3387368**
	(0.0776613)	(0.050253)	(0.076841)	(0.0624461)	(0.1352725)	(0.098053)
wage	-0.2623071*	-0.2623071*	-0.2047148	-0.2047148	-0.228046	-0.228046
	(0.123017)	(0.09959)	(0.1933799)	(0.0904583)	(0.2473414)	(0.194082)
vss	3.312165	3.312165	4.683741	4.683741	6.80609*	6.80609*
	(2.109137)	(2.059247)	(4.114032)	(3.888863)	(2.706134)	(2.950621)
con	1.693043*	1.693043***	-2.46373*	-2.46373*	-3.16296*	-3.16296*
	(0.837013)	(0.39195)	(0.48579)	(0.90501)	(1.26187)	(1.2453)
R^2	0.9823		0.909		0.8573	
F	49.909	85.199	11.36	48.17	7.51	48.72
D-W	1.97		1.87		1.99	

Note: "*", "**" and "***" respectively shows the obvious change in standards at 10%, 5% and 1%.

5. Comparative analysis of EU and ASEAN real cases

Based on the analysis in previous passages and initial testing in statistics, there is import quality disparity to China from countries of different economic development stages. We take the 5 ASEAN countries as the representatives from developing regions, 15 EU countries representing the industrial world, to analyze the real case disparity. We still use equation (3) as the regression formula, different from the regression of all samples as a whole, the meaning of variables for explanation has changed. We choose the weighted average GDP from the import resource country as the explanatory variable, original data still come from WDI database of the World Bank, the all country population data are from the Conference Board Total Economy Database. From the previous inspection procedures of China overall import complexity regression, we know that the inspection display model does not have the abnormal Different variance, however there is first order sequential correlation, choose Newey stability estimation. Column (3) of Table 2 are the results from common OLS regression of EU import complexity, Column (3) of Table 2 are the results from Newey stability estimation. Column (5) and (6) are regression results from ASEAN on import complexity. The stability testing of Newey results residual difference all shows the residual difference are in stability series, the regression results are rational. From the previous statistical analysis, we discover that 2005 is the cut-off point for complexity both in EU 15 countries and ASEAN 5 countries, however, the chow testing results do not show any structural mutation.

The regression results from 15 EU countries show, the estimate coefficient for economic development standards of the 15 EU countries (GDP) prove to be positive around 10% level, which is consistent to the comparative advantage theory. Different from the regression for China as a whole, the estimate coefficient for physical capital density (cap) is positive around 10% level, which denotes China import substitute to the future EU hi-tech products are weak, it means the big gap between China and developed countries in productivity, technological standards of hi-end products. Obviously the influence of labor power upon the import technical complexity is negative. The coefficient reflecting China participating the proportion of vertical division of labor (VSS) in global value chain is positive but not so sharp, which may be probably associated with the Sino-Europe trade features: EU has fewer restriction and control on technology export comparing with other developed countries, therefore EU is the biggest import origin for technology, technology trade takes an important position in Sino-Europe trade. The absorption of advanced technology of EU made China can partially produce intermediate products to replace the imported products, which has undermined the influence of China to participate the global value chain upon the import complexity from EU.

The regression results of 5 ASEAN countries show the coefficient of import origin countries with GDP proves to be positive around 10% level. The coefficient of physical capital density (cap) is negative around 1% level, and the absolute value is greater than that of regression as a whole, which denotes that China has a strong import substituting on the technical products from ASEAN. According to the intermediate technical theory of (Schumacher, E.F.) and technical theory of Reddy, A., restricted by China technical standards and absorbing capability in current stage, the enterprise tends to choose the most suitable products and equipments, the suitability to China and its digesting and absorbing imitating & innovating capability are even much stronger. Different from the regression of integrated China samples, the vertical specialization of 5 ASEAN countries (vss) is positive and very sharp. China and 5 ASEAN countries are all members of ASEAN production network, Indermit Gill (2008) thinks that in East Asia production network, Indonesia and Malaysia and other countries provide parts and components and intermediate products for China

and Vietnam and other countries in the region[23], which has strengthened the influence of vertical specialization upon the import complexity.

6. Conclusions

The article has calculated the China import technical sophistication in 2002-2012, discovers that China sophistication of import is in upgrading status. Through the comparison of sophistication of import technology to China from both developed and developing countries, we found the technology is more sophisticated from 15 EU countries than that from 5 ASEAN countries. The real cases analysis shows the consequences affecting China import technology sophistication factors shows: (1) China economic development standards have positive influence upon the import technology sophistication, meanwhile, the economic standards of the source countries for the technology has the obvious positive influence upon the import complicatedness. The influence from 15 EU countries is smaller than that of 5 ASEAN countries. Which denotes that China has high suitability, digestive and absorbing and innovative capabilities to the import from the latter. (2) Take it as a whole, we think the physical capital density has negative influence upon the import complicatedness to China. The influence from 15 EU developed countries is positive, meaning China has a weaker substitute towards import from developed countries. (3) Labor force has negative influence upon the complicatedness of import. (4) Vertical specialization has positive influence to china import complexity but not so conspicuous, since China and 5 ASEAN countries are all members of East Asia production network, which has made the vertical specialization has positive influence upon the import from their countries. Namely there exist differences in the affecting factors to import complicatedness from developed and developing countries.

Hips of the article: the evidence results from the actual cases of this paper shows that due to the restriction of existing standards and absorbing capability in current stage of China. China has a much stronger digestive, absorptive and innovative capabilities on import technology from 5 ASEAN countries. This conclusion is in accordance with intermediate technical theory and adaptive technical theory, namely enterprises in developing countries tend to import the most suitable products instead of the products of the highest technological content. Therefore, we need to actively strengthen the collaboration with ASEAN countries on the one hand, deepen the participation degree in East Asia production network, and import the updated technology, products and machinery that can be imitated, improved and innovated based digestion and absorption of technology; on the other hand, EU are the important cooperation partners for China in the future.

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