The relationship between China and regional economic agreement in global value chain: An analysis based on gravity model

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Global value chain has become a new and dominant pattern of international division of labor in the world. Meanwhile, international cooperation has turned from multilateralism to regionalization. This paper intends to use gravity model to explore the connections between the two trajectories. As a political and economic major power in the world, China should set about employing a comprehensive, self-oriented and well-functioning strategy of regional economic integration, either out of considerations for its global and regional strategies or the need to transform economic development model. In the process of implementation, China should be selective in choosing partners, choosing competitive ones at different levels of the global value chain.

Keywords: global value chain, regional economic agreement, gravity model

1. Introduction

The world economy has been on two important trajectories in the past two decades: One is the emergence of a new pattern of world labor division that requires transnational corporations as a dominant force to divide their production process globally, which generates a global value chain that features globalization of production and value-added trade, with East Asia Prodution Network (WAPN) being the most complex. The other one is the regionalization of world trade, of which the most prominent manifestation is the greatly increasing number of free trade agreements, aka FTA. The regional economic integration in the Asia-Pacific is among the most complicated and varied. The coexistence of the two trajectories, as argued by some economists, means they are connected in one way or another, but there is insufficient research on their connection and development path.

Thanks to the growing cross-regional investment and the great decrease of trading costs because of the development of modern telecommunication and transportation, trade patterns have witnessed gigantic transformations in the past 20 years with

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an increasingly refined international division of labor and more international corporations make the process of production beyond the confinement of national economies. A "made by the world" tendency is taking shape through the global value chain. The Chinese mainland joined in the global value chain in 1980s through processing trade, and the last 30 years have seen China playing a significant role in this new international division of labor. But generally speaking, most Chinese manufacturing industries are still bogged down in the downstream of the global value chain, and this would put China in a disadvantaged position in the international division of labor.

After the failure of the Doha round of world trade talks, the World Trade Organization has fallen in decline in global trade. Major economies headed by the US have diverted to seek bilateral free trade cooperation. But with the transformation of trade forms, bilateral FTAs are not enough to address multilateral trade problems, and this is when large-scale regional economic integration is called for.

There is a vigorous advancement of regional economic integration in the Asia-Pacific, and the most promising game-changer is the US-led Trans-Pacific Partnership (TPP), in which there are many intense "behind the border" barriers. The US hopes that these terms embedded in the TPP could be fully applied in the WTO one day.

Although the prospects of this high-standard trade pact became quite unclear as the new US president Trump declared US withdrawal from TPP, the outcomes of TPP, i.e. clauses about requirements for regulation integration behind the border of the members, will continue to be the mainstream of future multilateral and bilateral mechanism, and will appear on the negotiating table of Sino-US Bilateral Investment Treaty (BIT), China-EU BIT, and China-Japan-South Korea FTA. Under these circumstances, as the world economy becomes increasingly integrated, it becomes essential for China, a rising power, to explore the connections and mutual effect between the global value chain and regional economic integration.

2. Literature review

The formation of the new international division of labor, which manifests itself in the global value chain, is highly in sync with the rising current of the regional economic integration. Many economists, after considerable empirical studies, argue that there must be an inevitable connection between them. But most studies mainly focus on the impetus given by vertical specialization to the formation of regional trade agreements, and the growing import of intermediate goods among economies as a result of more FTAs. There are few researches on their mutual effect, especially how regional trade agreement impacts the existent local production networks.

Baldwin (2006) is the first economist who has established the connection between

the production networks and the new regionalism, arguing that with the rise of "Factory Asia," this region will have bigger demand for deep trade agreements. Baldwin (2011) also pointed out that the rapid development of the international division of labor has given new impetus to more countries seeking new trade agreements. Those who share similar views with Baldwin include WTO (2011), Orefice and Rocha (2011).

As of today, empirical research based on the the integration of new regionalism and the international division of labor is a novelty, because there is no well-developed quantitative research on the global value chain. Dautin et al (2008) is the first one that tried to connect the two things. By tracking the source of trade in value added and the production sequence in different countries, he figures out the ratio of added value produced in and beyond an FTA. For example, 56% of trade in value added in the European Union is manufactured within the bloc, while the US and Asia account for 44% and 34% of trade in value added respectively. Johnson and Noguera (2010) follow the same path, and by using the input-output table, they examine the domestic value-added exports that were used for re-processing in foreign countries. Although the two articles have used innovative ways of thinking and research, they have not sorted out the relationship between an FTA and the arrangement of the global value chain.

Andras and Staiger (2011) build a two-country benchmark model and use the Nash equilibrium model to explore the relations between outsourcing and trade agreements. As a result, they find that the rapidly developing outsourcing mechanism would make the traditional WTO principles lose efficacy. The hold-up effects caused by outsourcing will prompt these countries to seek after more individualized and deeper trade agreements to reflect their specific demands. González (2012) and Baldwin (2007), on the basis of Taglione's gravity model (2011), takes trade policy as an independent endogenous variable as distance and income. They argue that FTA has a substantial impact on the imported intermediate products, whether these products are in the global value chain or the bilateral value chain. The conclusion has echoed the non-quantitative views shared by Yi (2003), Egger and Pfaffermayr (2005), and Chinn (2005), who believe that the removal of trade barriers will change the allocation of production sequence among signatories of trade agreements.

3. Analysis of China's relationship with regional economic agreements in global value chain by gravity model

3.1. The principle and application of gravity model

Gravity Equation (GE) is a commonly used empirical equation in international trade, and one of the most successful empirical equations in economics. Since 1960s

when it was first brought up, it has been proven effective in enormous spatial economic studies. It is flexible to be used to analyze the flow of commodities and other factors, and can be adjusted to meet the demand of researchers.

The GE stems from Isaac Newton's law of universal gravity, which states that a particle attracts every other particle in the universe using a force that is directly proportional to the product of their masses, and inversely proportional to the square of the distance between them. Tinbergen (1962) and Poyhonen (1963) were the first economists that introduced the theory into economics, arguing that two countries' trade volume is in direct proportion to their economic aggregate, and in inverse proportion to their physical distance. In detail, the exporters' economic aggregate reflect their potential supply, while the importers' economic aggregate indicates their potential demand, and the physical distance means cost of transportation, a barrier to bilateral trade.

The traditional GE can be written as:

$$X_{ij} = K \frac{Y_i^{\alpha} Y_j^{\beta}}{D_{ij}^{\delta}} \tag{1}$$

Then convert it to a logarithmic equation,

$$\ln X_{ij} = \ln K + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln D_{ij} + \varepsilon_{ij} \tag{2}$$

In this equation, α_i is a coefficient, Y_i is country i's GDP, and Y_j is country j's GDP. D_{ij} refers to the distance between i and j. ε_{ij} is an error term. We can use the coefficient to estimate the resilience caused by the trade flow on the economic aggravate of importers and exporters and their physical distance, which, to put it simply, shows how much influence these elements can make on the trade flow. The simplest GE is not the only equation. Without the consideration of theoretical framework, variables can be replaced and increased in order to describe more general trading forms.

The object of research on gravity model is the bilateral trade flow. We try to explain bilateral trade by introducing variables such as economic aggregate, physical distance, economic integration and trade barrier. The pattern is clear, and the explaining variables and independent variables are observable data. Since being brought up, the gravity model fits the data well, and the fitting parameters are focused in a small range, which means the model is highly applicable. However, it has also drawn a lot of doubts and criticisms, which usually target two aspects. First, they claim that the gravity model lacks theoretical foundation. But the truth is, after joint efforts by economists, especially Anderson (1979), Helpman and Krugman (1985), Bergstrand (1989) and Deardorff (1995), the theoretical foundation of the model has been well

established. Second, they have a problem with the construction method of the gravity model, raising doubts about the cross-sectional data analysis method. But with the development of panel data analysis method, which integrates panel data and time sequence, the overlooked country and time-specific effects have been addressed. (Egger, 2002)

The GE is an adaptive model, which can be deduced to some kind of gravity equations from different starting points and under various economic frameworks. The wide adaptability is both an advantage and limitation for the GE – the parameter relationship between the independent variables and explaining variables can be unfolded from the equation itself, but the causes and applied theories are hard to be distinguished.

3.2. Model setting

This paper has taken into consideration the elements that can drive and impede trade. If the physical distance is seen as partof the trade cost, then other variables can also be analyzed from the perspective of trade cost, after all, when building a value chain around the world, multinational enterprises mainly consider every way to reduce production cost. Trade agreement between two economies is mainly for the reduction of cost, so is their common language. When both of them can meet the parameter, we define them as 1; when not, 0. Thus, the gravity equation can be shown as below.

$$\ln TiPC\_Ex_{ij} = \alpha_0 + \alpha_1 \ln GDP_i + \alpha_2 \ln GDP_j + \alpha_3 \ln D_{ij} + \alpha_4 \ln MDI_{ij} + \alpha_5 RTA + \alpha_6 Language + \varepsilon_{ij} \quad (3)$$

$$\ln TiPC\_Im_{ij} = \alpha_0 + \alpha_1 \ln GDP_i + \alpha_2 \ln GDP_j + \alpha_3 \ln D_{ij} + \alpha_4 \ln MDI_{ij} + \alpha_5 RTA + \alpha_6 Language + \varepsilon_{ij} \quad (4)$$

$TiPC\_Ex_{ij}$ is short for Trade in Parts and Components Export, which indicates economy i's export of parts and components to economy j. $TiPC\_Im_{ij}$ is economy i's import of parts and components from economy j. As for economies that are on the global value chain, the depth of their trade connections, if observed statistically, is mainly reflected by the increase of their trade of intermediate commodities, parts and components. This paper will conduct regression calculation of the export of parts and components from i to j, and the import of parts andcomponents from j to i, in order to distinguish the differences between the import traffic and export traffic in every economy, so that their status quos on the global value chain can be differentiated.

Table 1
Definitions, expected symbols and theoretical explanations of explanatory variables

Explanatory variables	Definitions	Expected symbols	Theoretical explanations
*GDP*1	Export economy *i*'s GDP when calculating *TiPC_Ex*	+	It indicates the export supply of an export economy. The larger the economy is, the more export supply it can offer.
	Import economy *i*'s GDP while calculating *TiPC_Im*		It indicates the importdemand of an import economy. The larger the economy is, the more import it needs and the stronger processing and assembly capacity it will have.
*GDP*2	Import economy *j*'s GDP while calculating *TiPC_EX*	+	It indicates the import demand of an import economy. The larger the economy is, the more consumption of imported goods there will be.
	Export economy j's GDP when calculating *TiPC_Im*		It indicates the export supply of an export economy. The larger the economy is, the more export supply it can offer.
D_{ij}	Absolute distance between *i* and *j*	-	It indicates the cost of transportation, which is a significant impediment to trade.
MDI_{ij}	Bilateral direct investment between *i* and *j*, based on their investment stock in 1997	+	The volume of bilateral direct investment between an import and export economy reflects the trade volume of their multinational companies in the process of global arrangement. Since outsourcing is hard to be calculated, we use MDIij to show the connections between economies.
RTA	Whether *i* and *j* have a regional economic deal	+	Trade cost between two economies will be greatly reduced if they have bilateral RTA. The trade creation effect will boost bilateral trade volume.
Language	Whether *i* and *j* have a common language	+	Trade cost between two economies will be greatly reduced if they use a common language, and the bilateral trade volume will be boosted.

This paper uses panel data and chooses 15 economies as samples to research, including the Chinese mainland, Hong Kong, Taiwan, the US, Japan, South Korea, Australia, New Zealand, ASEAN,[1] India, Canada, Mexico, Chile, Peru and the EU.[2] China is building 20 free trade zones, which involve 34 countries and regions. China has already signed 14 FTAs with 22 countries and regions, including FTAs with Australia, South Korea, ASEAN, Singapore, Pakistan, New Zealand, Chile, Peru, Costa Rica, Iceland, Switzerland, Closer Economic Partnership Arrangement (CEPA) with Hong Kong and Macau, and Economic Cooperation Framework Agreement (ECFA) with Taiwan.[3]The paper's research spans 18 years from 1997 to 2014. The sample size of the paper is 84 and it acquires 1512 observations concerning the statistics of the import and export of components and parts. The statistics of the

[1] The ten-country bloc of ASEAN is regarded as an entire economy.
[2] The 25-country bloc of EU is seen as a complete economy.
[3] Source: http://fta. mofcom. cn.

components and parts and GDP statistics stem from UNCTAD STAT. The statistics of physical distance comes from a "distance calculator" on a website called indo.com. The statistics of bilateral direct investment is acquired from the statistics websites of different economies.

There are two ways to indicate individual effect, one is fixed effect model (FEM), and the other is random effect model (REM). FEM is usually applied for specific sample selection, while the REM is used to study the trade of a random selection of sample countries (Egger, 2002). This paper chose FEM, and the panel data is strongly balanced. By unit root test, the statistics are denied to have unit root hypothesis, meaning the statistics are smooth. But they have dummy variables. Thus, by adopting Inmaculada and Felicitas' two-stage regressive method (2003) to establish a FEM. The first step is to remove the constant variable of time on the basis of the original formula, and regress the explained variables. The second step is to subtract the individual effect as an explained variable to regress and analyze the effect of constant variable of time. The constant variables in this paper are distance (*D*), *RTA* and *Language*.

In detail, the two-stage model is shown as below.

The first step,

$$\ln TiPC\_Ex_{ij} = \alpha_0 + \alpha_1 \ln GDP_i + \alpha_2 \ln GDP_j + \alpha_3 \ln MDI_{ij} + \varepsilon_{ij} \tag{5}$$

The second step,

$$IE_{ij} = \beta_1 + \beta_2 \ln D_{ij} + \beta_3 RTA + \beta_4 Language + \mu_t \tag{6}$$

Equation (5) is an augmented gravity model without the constant variable of time. The IE_{ij} in the second step is the individual effect α_0 as a result of extracting the salvage value in the first step. The meanings of other explanatory variables are the same as above, and the way to deal with *TiPC_Im* is also the same.

3.3. The selection of components and parts

The Standard International Trade Classification, aka SITC Rev.3, published by the UN in 1980s, has distinguished the components and parts in global trade. According to the 1-quantile SITC, export commodities have been classified into ten categories, including food and living animals (SITC-0), beverages and tobacco (SITC-1), crude materials, excluding fuels (SITC-2), mineral fuels (SITC-3), animal and vegetable oils, fats and waxes (SITC-4), chemicals and related products (SITC-5), manufactured goods (SITC-6), machinery and transport equipment (SITC-7), miscellaneous manufactured articles (SICT-8), and commodities and transactions (SITC-9). Usually primary commodities in SITC-0 to SITC-4 are defined as resource-extensive products,

manufactured goods in SITC-6 and SITC-8 are regarded as labor-intensive products, products in SITC-5 and SITC-7 are capital-intensive products, and SITC-9 products are undefined.

Yeats (1999) is the first one who proposes to distinguish the trade of components and parts and the trade of manufactured goods. But Yeats' classification is based on SITC Rev.2, which doesn't strictly categorize the components and parts, and only selects 50 kinds of commodities for SITC-7. Arthukorala (2006)'s selection process is based on SITC Rev.3, and compared with Yeats, Authukorala has made the classification more inclusive: Any commodity that has "component" on their names will be included, and he has expanded the selection range to SITC-7 and SITC-8. Eventually, he has selected 225 components and parts out of 1217 5-quantile products, among which 168 are SITC-7 products, 57 are SITC-8 products. According to this paper's research purpose and the previous result of calculation about the global value chain, this paper uses the more extensive Arthukorala (2006)'s method to select the 225 components and parts.

3.4. Analysis of regression result

By using a two-stage method, table 2 estimates the result of the fixed effect augmented gravity model of China's export of components and parts. *R-sq* is the regression of the first-stage model, which is the degree of fitting of *GDP*1, *GDP*2 and *MDI*. *Adj R-sq* is the regression of the second-stage model, which is the modified degree of fitting of *D*, *RTA* and *Language*.

Table 2
The estimated result of the fixed effect augmented gravity model of export of components and parts

	Mainland China	
	Coefficient	Standard deviation
*GDP*1	0.5866***	0.0610
*GDP*2	1.0193***	0.1110
MDI	0.3897***	0.0360
R-sq	0.9496	
D	0.1147	0.0736
RTA	0.8567***	0.1521
Language	1.4570***	0.1979
Adj R-sq	0.3313	

Note: *, ** and *** represent the significance of 10%, 5% and 1% on the significance level, respectively.

First, from table 2, we can see that degree of fitting among explaining variables *GDP*1, *GDP*2 and *MDI* is as high as 94.96%, and the 1% coefficient is significant on

the significant level. China's GDP has a positive impact on the export of components and parts. *GDP*2, which indicates the scale of partner economy, has a bigger influence on the export of Chinese components and parts as expected, which means the scale of trading partners' market is, to a large extent, determines the export of Chinese components and parts.

The mutual direct investment, aka *MDI*, has a positive impact on China's export of components and parts, and the influence co-efficient is 0.3897. This means that 38.97% of China's export of components and parts are contributed by internal transactions of transnational corporations.

After the constant variable of time has been readjusted, *R-sq* has also changed, and China's degree of fitting is 33.13%. Meanwhile, the estimated coefficients of *RTA* and *Language* are significant on the 1% level of significance.

Distance does not make a prominent impact on China's export of components and parts, which means that the distinction of the Chinese market is strong enough to override the barriers of distance on trade. The regional economic integration has a positive impact on China's export of components and parts with an expected high influence coefficient of 0.8567. Specifically speaking, China has signed free trade deals with 6 out of the selected 15 Asia-Pacific economies. For example, the Chinese mainland has signed RTA with ASEAN and Hong Kong in 2003, which was a boost for the trade of components and parts that increased by 8 times as of 2014. *Language* has a positive impact on China's export of components and parts with a high influence coefficient of 1.4570. A common language can make the Chinese mainland, Hong Kong and Taiwan's participation in the global value chain in a cost-saving and efficiency-enhanced manner, and the mutual trade of components and parts among the three economies is prominently higher than other economies.

Table 3
The estimated result of the fixed effect augmented gravity model of export of components and parts

	Mainland China	
	Coefficient	Standard deviation
*GDP*1	-0.1655	0.1202
*GDP*2	1.0414***	0.2187
MDI	0.6328***	0.0709
R-sq	0.7419	
D	-1.2286***	0.0948
RTA	-0.1339	0.1958
Language	0.2456	0.2566
Adj R-sq	0.4911	

Note: *, ** and *** represent the significance of 10%, 5% and 1% on the significance level, respectively.

From Table 3, we can know that the degree of fitting of *GDP*1, *GDP*2 and *MDI*, which is 74.19%, is lower than the degree of fitting of the export statistics of components and parts. This means that in the global value chain, China's upstream economies are generalized on some specific countries such as the US, Japan and South Korea, so its general degree of fitting is a bit low.

The growth of Chinese GDP has an insignificant correlation with its import of components and parts, which means that China's import of components and parts has not increased along with the growth of Chinese GDP. This is because although the import of components and parts accounted for 0.3% of China's GDP in 1997, and the percentage only slightly increased to 0.34% in 2014, the increase was mainly contributed by a few economies, such as Taiwan, the US, Japan, South Korea, ASEAN and the EU, especially Taiwan, South Korea and ASEAN. In 18 years, China's import of components and parts from these three economies have increased by 26.3 times. China is in deficit with the three economies in the trade, as well as the US and Japan. As Figure 1 shows, China is at the downstream of these economies in the global value chain. It imports components and parts, on which it manufactures products and export them. China's export of components and parts has also increased dramatically, especially to Hong Kong, which has soared by 26.73 times in 18 years. This means China is moving upward in the global value chain.

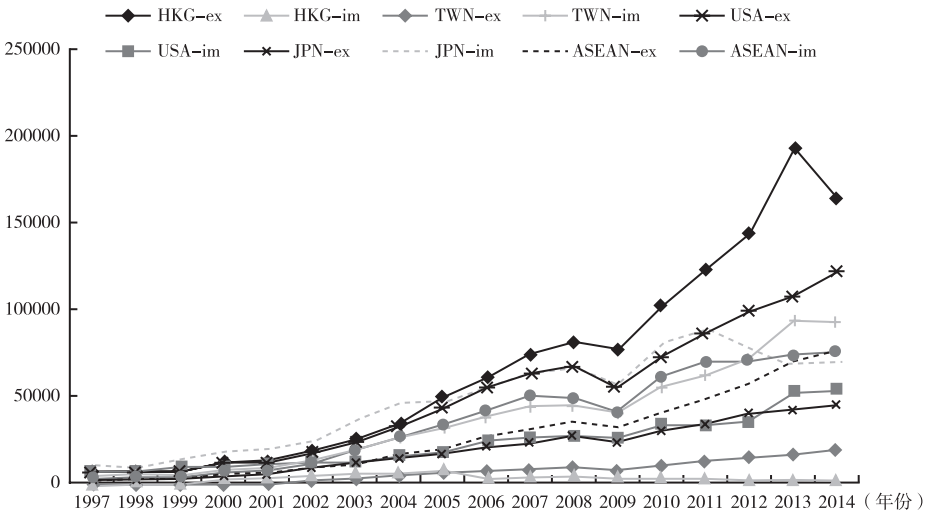

Figure 1. China's import and export of components and parts with major economies
Source: UNCTAD data base.

China's trading partners' GDP has a positive effect on the coefficient of its export of components and parts, being significant on the 1% level of significance with an expected high influence coefficient of 1.0414. This means the economic aggregate of a

country's trading partners is in a positive correlation with its export capacity.

MDI has an expectedly positive effect on China's import of components and parts, and the influence coefficient is 0.6328, which is higher than the influence coefficient of *MDI* to China's export of components and parts. This means China is prone to accept multinational corporations' orders, so the upstream economies in the global value chain have deeper influence on China.

In the regression result of the influence of constant variable of time to China's import of components and parts, the goodness of fit is 49.11%. *Distance* is an expectedly negative coefficient for China's import of components and parts, being significant on the 1% level of significance. Regional economic integration agreement does not a significant influence coefficient to China's import of components and parts, mainly because China has failed to sign regional economic integration agreements with upstream economies such as the US, Japan and the EU, despite the fact that China has accelerated its regional economic integration strategy during 1997 to 2014. But in the 18 years, the mainland's import of components and parts from Hong Kong and Taiwan has increased by 9.74 times. Thus, although the influence coefficient is not significant as expected, it fits well with the actual situation. China has signed FTA with South Korea and the negotiation for a three-party FTA between China, Japan and South Korea is underway. China and the US have resumed their talks over the BTA. These new developments, to some extent, can demonstrate the fact that when an economy, such as China, has assumed an irreplaceable position in the global value chain, it will boost the regional economic integration by connecting upstream and downstream economies.

The influence coefficient of *language* is unexpectedly insignificant to China's import of components and parts. Because China's upstream economies in the global value chain also include non-Chinese-speaking economies, such as the US, Japan and the EU. But as for other major trading partners, such as Hong Kong and Taiwan,[1] which speak Chinese, the coefficient fits into the actual situation.

4. Conclusion

This paper uses the gravity model to regress the trade of components and parts between China and major global economies. The results are basically in line with the expectations or facts. Besides the conclusions that the economic aggregate of trading partners have a significant impact on the trade of components and distance is still a barrier to the trade, there are four conclusions.

First, *MDI* between trading partners, reflects in multinational corporations' investment in China, contributes a lot to China's development in the global value chain.

[1] Hong Kong's export of components and parts to the mainland has been going down since 1997.

MDI's obvious influence in China shows that the multinational corporations play a big part in China's participation in the global value chain. 38.97% of China's exported components and parts come from internal orders of multinational corporations, while 63.28% of China's imported components and parts come from multinational corporations' orders.

Second, regional economic integration and the global value chain have mutual effects on each other, while China's involvement in the global value chain will boost upstream and downstream economies in regional economic integration. RTA has a positive influence on China's export of components and parts, which means the regional economic integration has played an active role in boosting China's export of components and parts. The regional economic integration does not have a significant influence on China's import of components and parts, mainly because China has not established RTA with upstream economies in the global value chain, including the US, Japan, the EU and South Korea, which means that China is still in a passive position in the global value chain. But China is making progress with South Korea, Japan and the US in terms of signing FTAs and engaging in other forms of economic cooperation, which means although China is still a downstream economy in the global value chain, with its considerable economic size and relatively perfect supporting facilities, its significance in global value chain is growing and its economic power has prompted the regional economic integration between China and upstream economies. But the process still needs time.

Third, a common language and a similar cultural background have a positive influence on China's participation in the global value chain, especially in terms of reducing cost and raising efficiency in export. Mainland China has participated in the distribution system of global value chain by undertaking processing trade from Hong Kong and Taiwan, which have played very important roles in the rapid development of Chinese economy.

Thus, generally speaking, in the international division of labor, economies, especially downstream economies in the global value chain, start from getting orders from upstream economies, manufacturing, processing and assembling components and parts, in which way they are engaged in the global value chain. The circulation of components and parts between economies is prominently reflected in trade statistics. During the regional economic integration, policies regarding tax reduction and opening-up of market and investment will boost the flow of production elements, change the production cost, and might change multinational corporations' list of suppliers, which will change the participants in the global value chain and further affect the form and distribution of global value chain. If some suppliers on the global value chain are irreplaceable, multinational corporations will lobby the government for a trade deal between the two economies in order to reduce cost and strengthen their integration and control of the global value chain.

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