# 中央研究院經濟所學術研討論文
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**Theory and Empirical Evidence**

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# On the Determinant of Trading Hub in East and Southeast Asia: Theory and Empirical Evidence[1]

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## Abstract

Based on the existing hubness measure in the trade literature, we developed two modified trading-hub index in two directions, export-destination and import-source. Then we demonstrate the stylized fact of China-and-Japan's double trading-hub, especially in export-destination sense, in East Asia since the early 1990s. After showing the dynamics of the twin-hub, more specifically the rising China-hub and shrinking Japan-hub, theoretical explanations, such as the home-market effect (HME), FDI and technology advantage etc. are provided. Finally, a panel data ranged from 1993 to 2014 of thirteen economies, including eleven economies in East Asia, USA and EU as a whole, are established to conduct empirical tests. In general, the empirical results support the role of HME, FDI and technology advantage for making a trading-hub, in terms of export-destination and/or import-sources.

JEL Classification Codes: F14, F15
*Keywords:* Double Trading-Hub, Export Destination Hub, Import-Source Hub, Home-market effect, Technology Advantage

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## 1. Introduction

Right after its successful industrialization after World War II, Japan has been the leading economy in the East Asia (EA). In the recent decades, especially after the Asian financial crisis in 1997, China began to rise as an important player in the world economy, beginning as the major export country in the conventional sectors like footwear, textile and consumer electronics, and in the modern information and communication technology (ICT) industries. In the era of superabundance regional trade agreements (RTA) either in bilateral free trade agreement (FTA) or multi-lateral FTA, seemingly triggered by the formation of North American FTA (NAFTA) 1994, China also plays an active role in signing FTA with its trade partners around the world, especially in EA.

Based on the proliferation of regionalism, in East Asia especially after the 1997's Asian financial crisis, Baldwin (2004, 2009) depicted the phenomenon that China and Japan are the two most FTA-involved economies, and named the pattern as the bicycle model for East Asian integration[1], or alternatively hub-and-spoke pattern.[2] Accordingly, the so-called double-hub of Japan and China in the East Asia has been illustrated on the base of FTA relation, and an index of hubness measure, basically based on the intensity of relative export dependency of the spoke on hub, was developed. Several papers adopted the measure to study the likely candidate for trading hubs under FTA-relation, e.g. Chen (2006), Chen and De Lombaerde (2014), and de Vall (2016).

In this paper, we argue that the FTA-induced hub may not be consistent with the de facto trading hub in the real world, simply due to the commonly observed noodle bowl effect (Baldwin 2004) and the implicit non-tariff barrier between FTA members. In fact, an empirical study using gravity model by Kimura et al. (2006) find no significant effect of FTA numbers on bilateral trade volume.

[1] It is also called bicycle model in East Asian integration. Chow (2010) extended the FTA-hub model by including USA to make into a tri-cycle model.

[2] The hub is defined as the nation which holds the largest numbers of FTA membership, and is surrounded by those spoke nations that have signed FTA with the hub only. In fact the hub-and-spoke pattern in trade was raised initially in Kowalczyk and Wonnacott (1992) and Wannacott (1996). See de Vaal (2016) for the development of the literatures on the concept.

Then, we illustrate the stylized fact of asymmetric trade dependency upon China and Japan beginning early 1990s for the EA countries, USA and EU. After modifying the Baldwin's HM index from bilateral base to a country-specific index, and extending into two types of trading hub, export-destination hub (XH) and import-source hub (MH), we apply the index to re-display the trading hub for East Asian economies. As will be clear, we show that in fact the trading hubs are different in terms of export-destination and import-source. Theoretical explanations are addressed and empirical test follows.

The rest of this paper is organized as following. Section 2 illustrates the stylized facts of trade position of Japan and China. Theoretical factors, like domestic market size, FDI and technology advantage etc., for fostering trading hubs of export-destination and import-source are addressed in Section 3. In Section 4, we conduct empirical analysis and Section 5 concludes.

## 2. Stylized Facts of Trade position of Japan and China

In general, to sign a FTA or not is driven by not only economic concerns but also many other non-economic political and even military factors. Despite the main purpose of acquiring lower trade barrier to its member countries, a country located as the star-shape center of FTAs, FTA-hub, does not necessarily become a de facto trading hub. In reality, being a trading hub should be determined under market mechanism in the international trade markets. The inconsistency between FTA-hub and de facto trading hub among East Asia will be shown below. More specifically, we first single out the countries that hold most of the membership of the RTAs encompassing the East Asia and Pacific Rims. Then, using the bilateral trade data, we illustrate the stylized facts of the two trading hubs of China and Japan beginning in the early 1990s, and the corresponding trend of rising China-hub and declining Japan-hub.

### 2.1 FTA-hub in East Asia

Due to the bandwagon effect of signing FTAs in the last decades, there are overabundant of FTAs, be it bilateral or multi-lateral. According to WTO statistics, the registered and approved FTA accumulated to 250 in 2017, of which about 150 are related to East Asia. In fact, due to so-called Spaghetti bowl effect, the preferential tariff under FTA may not contribute significant trade to the member countries, as empirically shown in Kimura et al. (2006).

There is an inconsistent mapping between the policy-determined FTA-hub and market-determined trading hub. The FTA-hub countries may not necessarily have higher volume of trade and trade share than the others. Take East Asia as an example. Figure 1 shows the mapping of member countries of the most important regional trade agreements (RTA). As can be seen clearly, the four most FTA-attended countries include Singapore, Malaysia, Vietnam and Brunei. By definition, the four are FTA-hub, and countries like US, India and Taiwan, Hong Kong etc. are spokes for having the least FTA memberships. The four FTA-hubs are not only member countries of ASEAN, but also involve the other RTA of RCEP, TPP and later of CPTPP, not to mention the most popular APEC. However, their trade positions are far below that of China and Japan, the twin-hubs in EA, as to be illustrated in the followings.

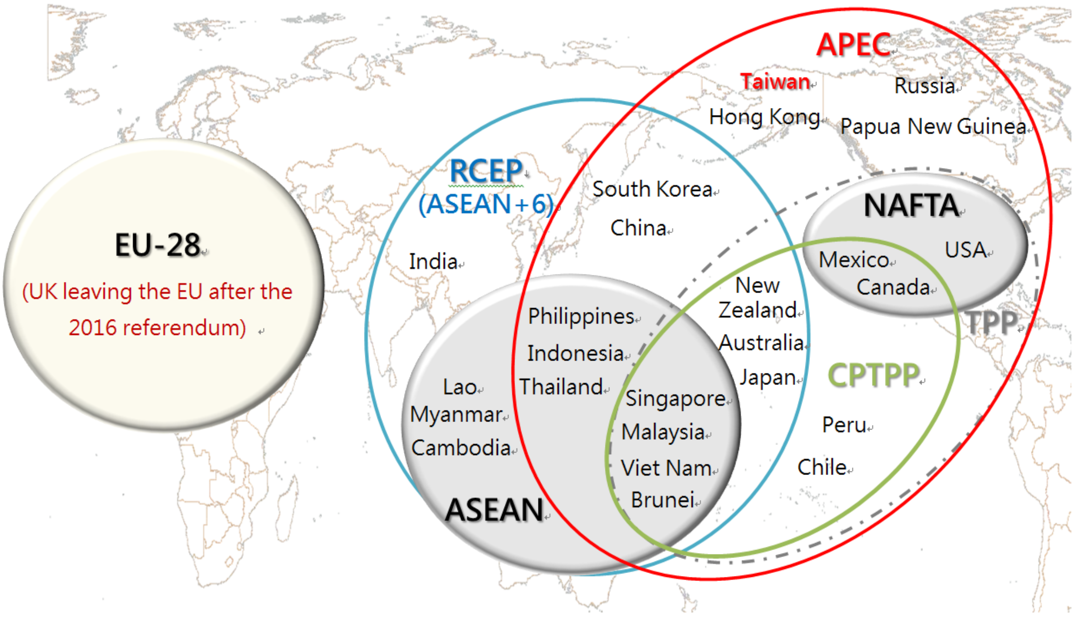



**Figure 1 Major RTAs surrounding East Asia (2017)**

2.2 De facto trading hubs of China and Japan

The trade dependency on China and Japan for countries/region in East Asia and its two major trading partners of USA and EU are illustrated in Figure 2 and Figure 3 respectively.

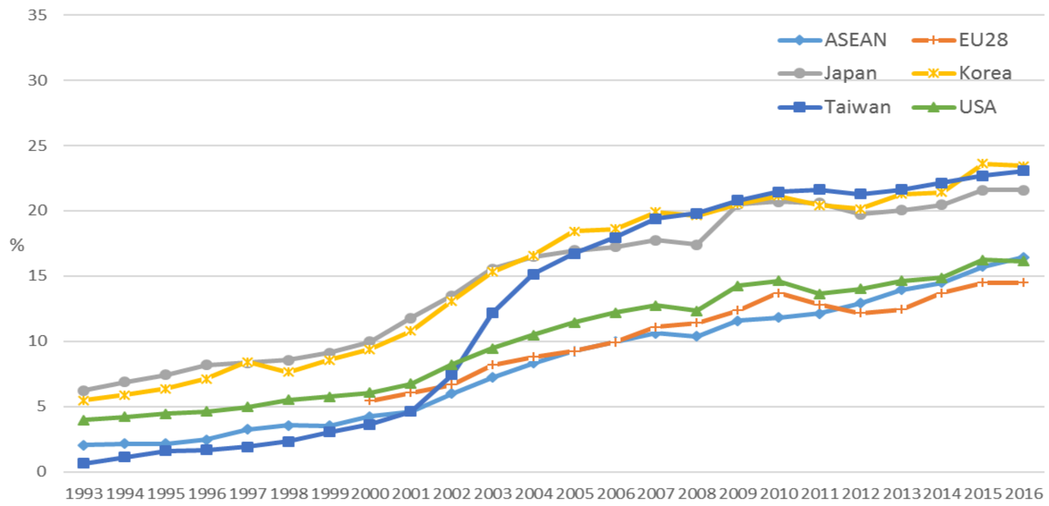
<u>China-hub</u>

Figure 2A display the ratio of VOT (volume of trade, defined as the value of export plus value of import) with China to its total VOT for all the China's trade partners. As shown clearly, there appears a rising trend of trade share with China since early 1990s. In addition, the trend became even more significant after 2001, when China became a member of WTO. The trends then split into two groups, EA group of Japan, Korea and Taiwan, and the others as a group. The EA group of Japan, Korea and Taiwan surfaced up dramatically. In the year of 2004 its trade share with China for each of the three in EA group accounted for more than 15%, while the others remained bellowed 10%. Taiwan was once having the lowest VOT share with China in early 1990s, began to surf up dramatically since 2001 and surpassed all the others after 2007 having the highest trade ratio with China. In sum, Figure 2A shows if there is a China-hub, then the main spokes are those three neighboring countries of Taiwan, Korea and Japan.

Similarly, if we explore the corresponding trend of export share and import share, as shown in Figure 2B and 2C respectively, a similar rising trend appears. In addition, we can observe a more diversified trend in export share than the import share. As shown in Figure 2B, in the most recent decades Taiwan and Korea have more than 25 % export share to China, followed by Japan around 15% to 20%. ASEAN takes the 3rd place, and followed by EU, then USA.

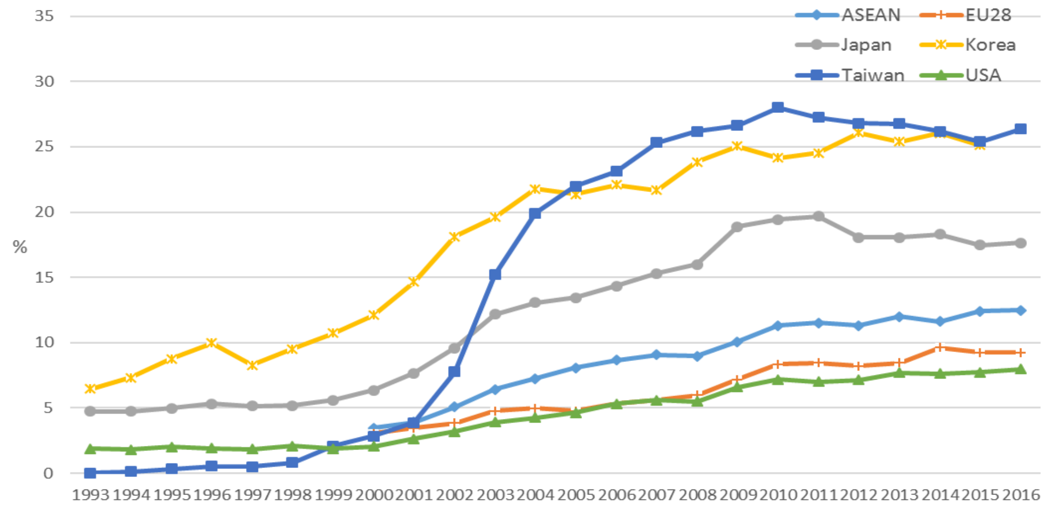
As to the import share dependency on China, Figure 2C shows us a relatively stable rising trend since early 1990s and increasing faster after 2001, among which Japan remained as the top and out-weighed the other economies.

By comparing the export and import dependency of USA and EU on China, as shown in Figure 2B and Figure 2C, we can easily find that the import dependency far outweighed the corresponding export dependency for the two economies.



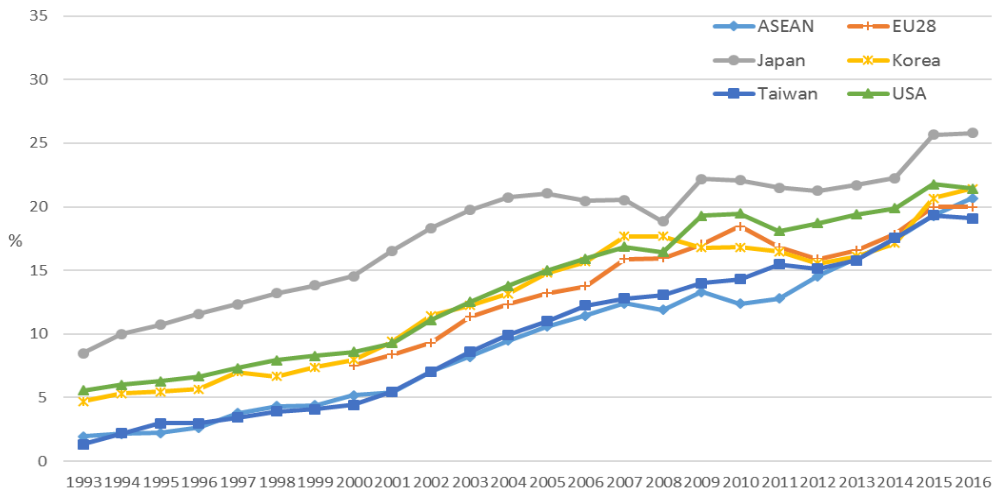

Source: UN Comtrade, ASEANstats

**Figure 2A The ratio of trade with China to its total trade**




Source: UN Comtrade, ASEANstats

**Figure 2B The ratio of exports to China to its total exports**




Source: UN Comtrade, ASEANstats

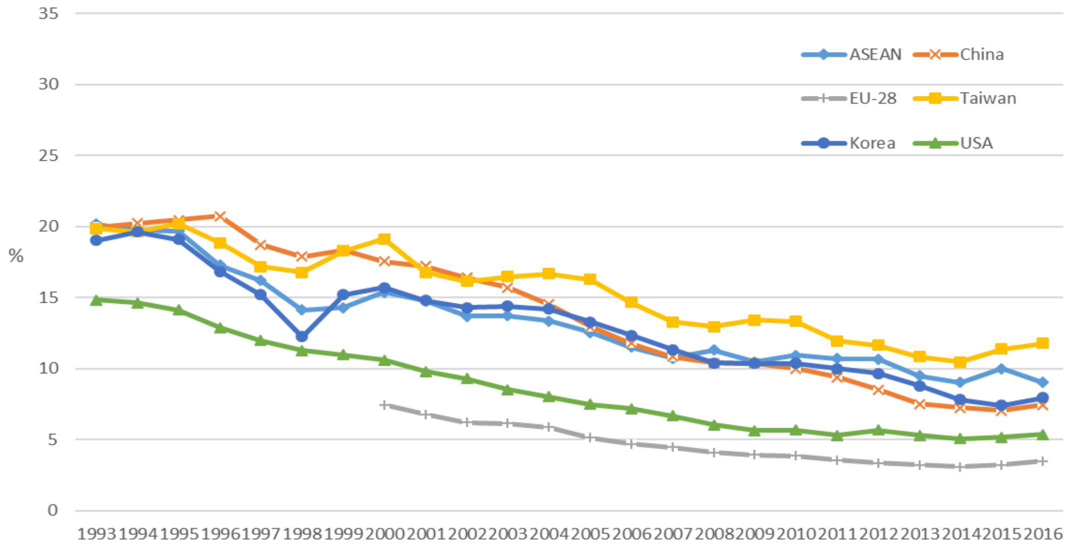
**Figure 2C The ratio of imports from China to its total imports**

Japan-hub

Similarly, we illustrate the VOT share, export share and import share on Japan for those economies, respectively in Figure 3A, 3B and 3C. A first glimpse finds us that the trade dependency on Japan, whatever measured by VOT, export or import, has been declining over the last decades. Among the partners, USA and EU have the lowest trade share with Japan. On the contrary Taiwan followed by ASEAN and Korea are the top three.

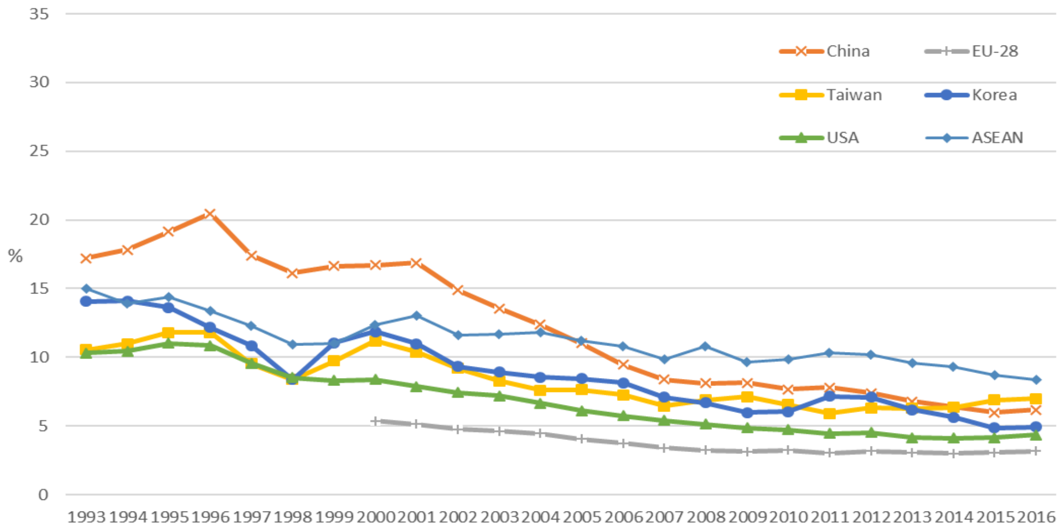
The downward trend of trade share with Japan can also be observed for both the import and export share. Figure 3B of export share shows that China had far outweighed others in the export share till 2004, then dropped quickly to a lower level of third place behind ASEAN and Taiwan. On the contrary, ASEAN's export share rises to the first position and significantly above all the others'. As shall be explored in the next section, in term of export-destination hub, Japan-hub is more important than China-hub for ASEAN, a phenomenon already identified in Huang et al. (2017).

As to the import share from Japan, we observed more diversified degree of dependency from Figure 3C than that of the export dependency. Taiwan has the highest import share from Japan, remaining a persist level of 5% beyond that of the 2nd high of Korea in the last decades, indicating the importance of Japan as Taiwan's major import-source. Furthermore, despite the declining trend, the dependent import ratio is quite high, as compared with the import dependency on China.



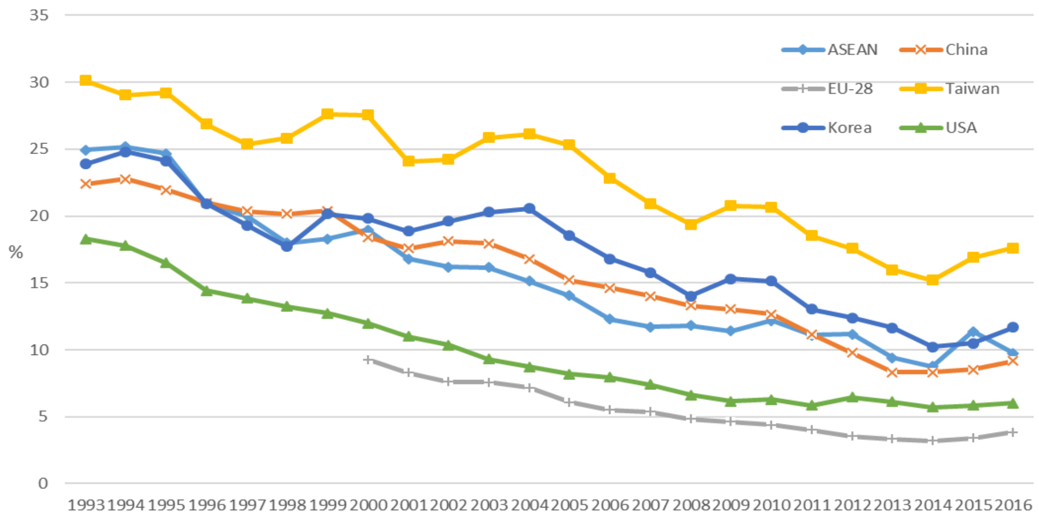

Source: UN Comtrade, ASEANstats

**Figure 3A The ratio of trade with Japan to its total trade**




Source: UN Comtrade, ASEANstats

**Figure 3B The ratio of exports to Japan to its total exports**




Source: UN Comtrade, ASEANstats

**Figure 3C The ratio of imports from Japan to its total imports**

## 3. Trading Hubs: Theory and the hubness measure

### 3.1 Theory

By the directions of trade flows, there are two types of hub, one export-destination hub, the other import-source hub. The export-destination hub refers to a country that is the major export destination for most of the other countries in the region. Statistically, the trading hub country imports a significant large share of the total export of each country in the region. On the contrary, each of the export countries holds a relatively small share of the hub's market. For example, being a major assembly hub in the downstream production, a country should be the major export destination of all the upstream goods from other countries, and thus reflected in trade flow data as a export-destination hub in the industry. On the other hand, the export-destination hub country should also be a major import-source for all the countries importing the assembled final products.

On the contrary, an import-source hub refers to a country, on which a large number of country rely as the major import source. Statistically, the country's export should count for a great share of the import volume of the import countries. In addition to the above-mentioned case of final assembly hub, a country of the major producer of the parts or components due to technology advantage would be the major export country of the products, that is, an import-source hub.

The formation of trading hubs can be attributed to the following factors: geographical location of being a transportation hub, manufacturing assembly base, technological advantage, and home market effect (HME).

Firstly, a country geographically located as a transport hub should naturally become a trading-hub, simply because of its transport cost advantage. Theoretically in a three-region model, as in Krugman (1993), the pivotal country B becomes the trading hub, simply because a direct trade between country A and C cost more transportation costs than indirectly trade by transferring through country B. A simple calculation can illustrate the point. The total trade volume of country B will be inflated due to the addition of redirect trade flow between Countries A and C. Let $X_{ij}$ denote the exports from country i to country j. The trade redirected center country B will have extra redirect trade volume: $X_{AC}+X_{CA}$. The total world trade will have double counting of $X_{AC}+X_{CA}$.

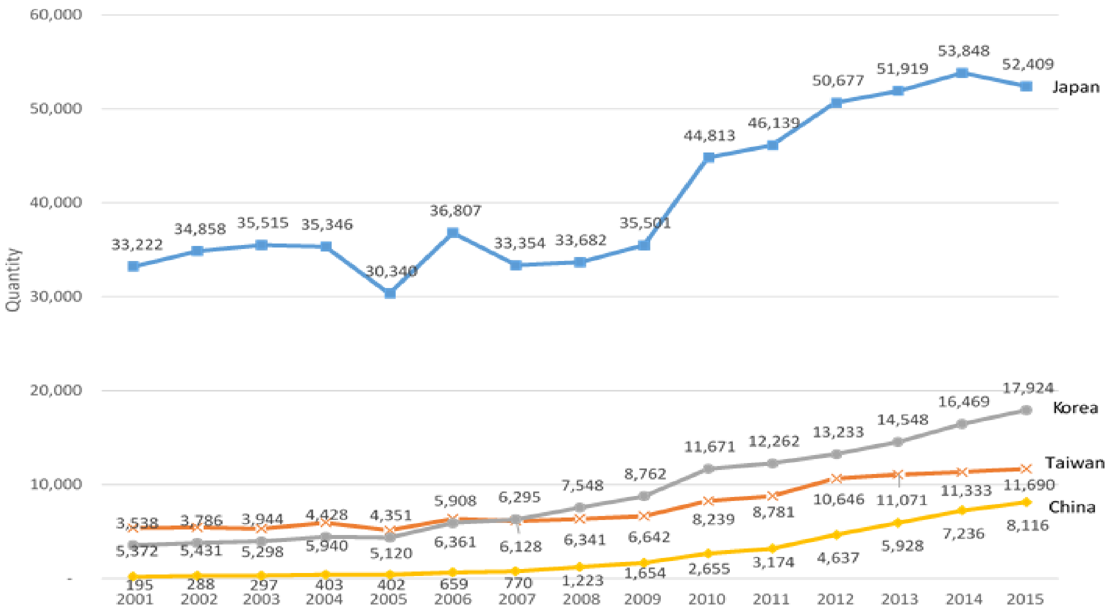
Secondly, being an assembly base for a given industry can be another possible reason to become a trade hub. In the case of vertical specialization of international trade, namely global production chain (GPC) or production value chain (PVC), the lower-end production process is mostly labor-intensive. Thus, a country with abundant labor and low wage rate, has comparative advantage in becoming the assembly base for the downstream production. And inward FDI from abroad in this sector will enhance the likelihood of being the assembly hub. As such, a country's population size is a positive determinant for being an assembly hub, or export-destination hub for the upstream products, and on the other hand as a determinant for the import-source hub for the finished final goods.

In reality, a manufacturing assembly base is most likely to be created when a country opens up to trade and FDI with cheap labor, such as occurred to Taiwan, South Korea, Hong Kong and Singapore (the Four Dragons) in the 1970s and 1980s. These countries became the manufacturing assembly base for Japanese products. They imported parts and components from Japan and re-assembled them as the final products to re-export to the US and European markets.

Compared to a transportation hub, the manufacturing assembly base country can benefit from the value added by the process of assembling. However, the role of country size is also important. The domestic market scales of the Four Dragons are small, and only focus on the manufacturing assembly of Japan's labor-intensive or low-tech-intensive sunset industries. Thus they failed to become the trade hubs in the 1970s and 80s. That is, country size matters for being a trading-hub. In contrast, with a huge amount of cheap labor and its gradual opening to world economy, China has replaced the Four Dragons the main labor-intensive manufacturing assembly base in East Asia since its open-door policy in 1979. Unlike the Four Dragons in the 1970s and 1980s, China's domestic market is big enough to attract tremendous export volume to China and re-export to the world market after assembly. China has become a trading hub in Asia and has been called the world's manufacturing factory. As such, GDP and/or population size is a key driving force for being a trading hub, either in terms of export-destination or import-source.

Technological advantage can also enable a country to become a trade hub. In contrast to China’s trade role based on the opening up of its market and its manufacturing reassembly center, Japan has maintained its trade importance in Asia because of its rapid industrial development and technological advantage, as reflected in Figure 4 which shows Japan’s superior status in terms of patent rights in East Asia. Even after Japan transferred its sunset industry and manufacturing process to the Four Dragons and China via foreign direct investment, it still holds some trade advantages, such as the supplies of manufacturing equipment, key parts and components in the upstream technology-intensive industry exports. In sum, Japan has its trading hub status based on its technological lead and advantages in the production and export of the key parts and components in the upstream industry. The manufacturing firms in the Four Dragons, the Four Tigers and China rely on these imports of upstream key parts components and equipment from Japan for their downstream production. The technological-advantage-based trading hub status of Japan shall be reflected in the East Asian countries’ import- dependence trade statistics.

Last but not the least factor for becoming a trading hub is due to the conventional Home-market Effect (HME) in the literature, initially raised by Krugman (1979,1980). According to the HME, a country with bigger domestic market can be benefitted from larger output in the IRTS manufacturing sectors, because of lower average cost than in other small country. As a result, a big economy tends to hold more than proportional share of the world market. As such, GDP is a positive determinants for becoming a major export country, or import-source hub in the IRTS manufacturing goods.




Note: Utility patents (i.e., "patents for invention") .
Source: US Pantent and Trademark Office: Patent Counts By Country, State, and Year Utility Patents (December 2015)
(https://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utlh.htm)

**Figure 4 Number of Patents registered in US Patent Bureau by country**

3.2 Hubness Measure for Export-Destination and Import-Source

In this section, we introduce the index to measure the intensity of a country (say *h*) to be an export-destination hub ($XH_h$) for a region, modified in Huang et al (2017) based on the bilateral hubness measure ($HM_{ih}$) in Baldwin (2004). By the same approach, we develop an import-source hub for country *h* ($MH_h$). Then, we apply the two index to the case of EA regional trade, to show the likely positions of China and Japan as the regional trading hub, in the sensed of export-destination and import-source.

<u>Export-destination hub:</u>

Let $HM_{oh}$ denotes the "hub-ness' importance of a hub country to country o, which is defined by Baldwin as below: `

$$HM_{oh} = (X_{oh} / \sum_j X_{oj}) \times (1 - (X_{oh} / \sum_i X_{ih})) = S^x_{oh} \cdot (1 - S^m_{oh}), \qquad (1)$$

where $X_{ij}$ denotes the exports from country *i* to country *j*, $S^x_{oh}$ the export share of country o to country h, $S^m_{oh}$ the import share of h from country *o*. Obviously, 0 < $HM_{oh}$ <1, and higher $HM_{oh}$ implies higher degree of export dependency of country o on country h.[3] Based on the $HM_{oh}$, the weighted HM 'hub-ness' Index of h in region r , denoted as $XH_{\cdot h}^{R}$, is computed as below:[4]

$$XH_{\cdot h}^{R} = \sum_{o \in R} \{HM_{oh} \cdot [X_{oh} \Big/ \sum_{i \in R} x_{ih}]\} \quad (2)$$

Import-Source hub ( $MH_{\cdot h}^{R}$)

By symmetric, the $MH_{\cdot h}^{R}$ index to represent the degree of import-source hub-ness for country *h* in the region *r*, can be derived as below:

$$HM_{oh}^{M} = (X_{oh} \Big/ \sum_j X_{jh}) \times (1 - (X_{oh} \Big/ \sum_i X_{oi})) = S_{oh}^{m} \cdot (1 - S_{oh}^{x}) \quad (3)$$

$$MH_{\cdot h}^{R} = \sum_{o \in R} MH_{oh}^{M} (X_{ho} / X_{.h}) \quad (4)$$

Obviously, we have 0 < $MH_{\cdot h}^{R}$ <1, the higher the value the more important country *h* as the regional import-source trading hub.

3.2.1 Export-Destination Hub in East Asia

Applying the measure of export-destination hub to the East Asia region, we can observe the long-term trend of being a trading hub for each economy in the region. Since US and EU are well-known important trade partner to EA, we also compute the corresponding index by considering into the US and EU market.

The export destination hub index from 1993 to 2016 are reported in Figure 5, where US and EU are excluded in the calculation for the upper panel of Figure 5A, but included in the lower panel 5B. Similarly, the import-source hubs for each country in the underlying region are reported in Figure 6A, and 6B.

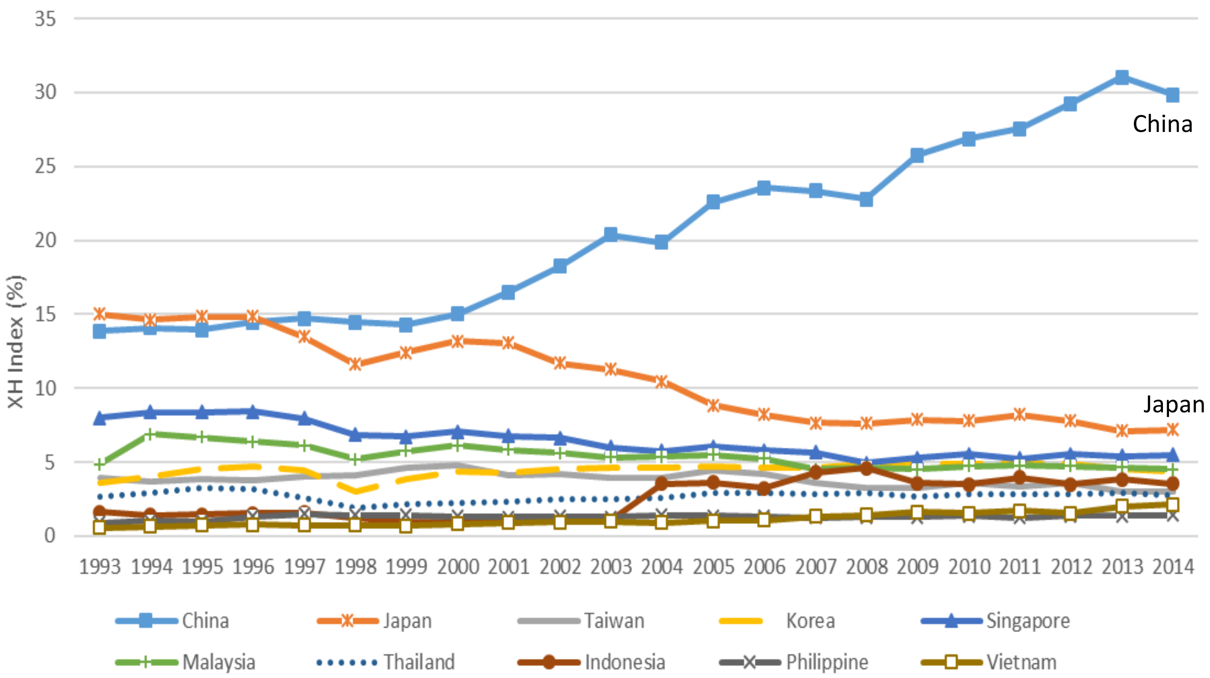
Clearly, as to the aspect of export-destination, Figure 5A depicts the emerging of double hubs regime in the East Asia, since early 1990s. The Japan and China's index far outweighed all the other countries in the region. Furthermore, in the beginning of early 1990s, Japan as a conventional trading hub for East Asia, its export

[3] Baldwin (2004, 2006) linked the o and h countries with the HM value exceeding 0.5 to illustrate a wheel-like picture with hub and spoke.
[4] See Huang et al. (2017) for the corresponding spoke-ness index of the 'spoke' economy.

destination hub index slightly outweighed that of China. However, after 1997, the China index began to surpass Japan, and surfing up in contrast with the declining path of Japan's index.

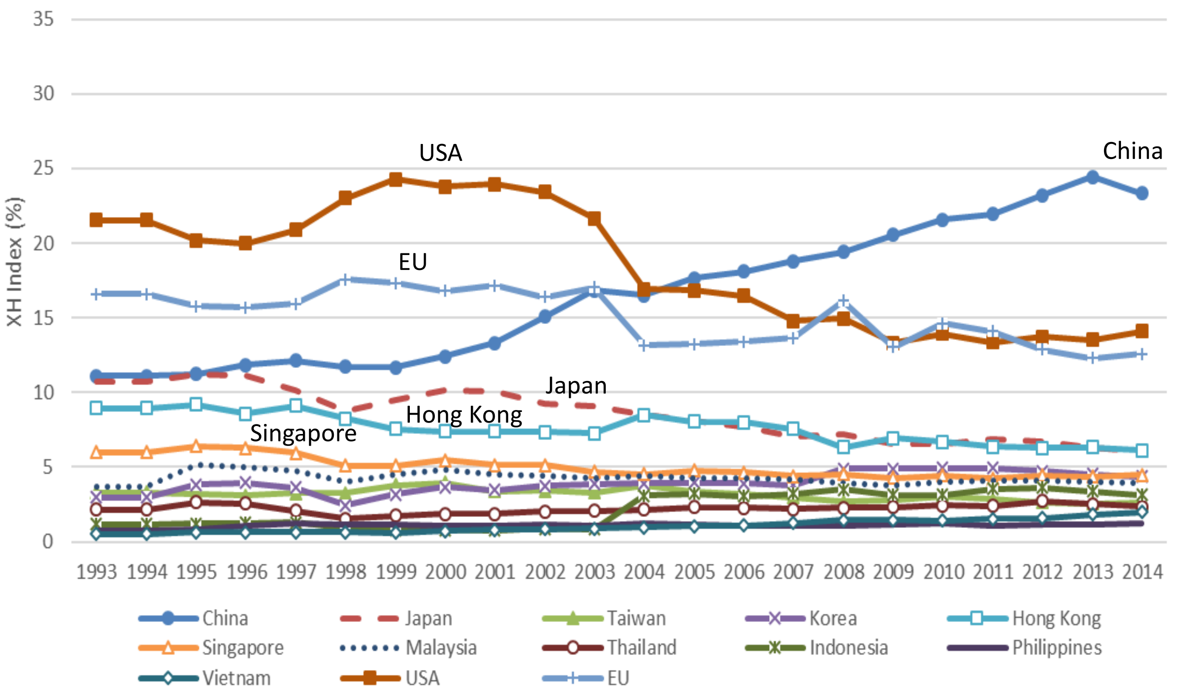
In sum, a double export-destination hubs of Japan and China appears in the early 1990s, with a dynamics path of rising China and declining Japan. In recent years, the Japan hub index has almost melded into others, leaving China as the sole hub.

Should we include US and EU into calculation, the phenomenon of Japan's losing its export-destination hub position become clearer, as shown in Figure 5B. In the figure, we observe that during the 1990s USA and EU have far outweighed the EA's double-hub of China and Japan. With declining of USA- and EU-hub position, the rising China-hub finally caught up with the EU in 2003 than USA in 2004 and continued to surfing up. After 2005, declining trend continued for USA- and EU-hub. However, the USA and EU-hub still remains in the $2^{nd}$ and $3^{rd}$ position behind China-hub, and significantly outweighed all the others including Japan, Hong Kong and Singapore. That is, China, USA and EU are the top three export-destination hub for the East Asia as a whole.




Source: UN Comtrade

**Figure 5A Export Destination Hub (XH index)**




Source: UN Comtrade

**Figure 5B Export Destination Hub (XH index of Total Trade, East Asia, USA & EU**

### 3.2.2 Import-Source Hub of EA and with EU and USA

As to the import-source hub, Figure 6A depicts that without considering EU and USA, the hubs of Japan, Hong Kong and Singapore took the top three positions in 1990s and early 2000s. China-hub emerged in the aftermath of Asian financial turmoil of 1997, and continued to rise to surpass Singapore in 2001, then Hong Kong in 2003 and Japan in 2005. In the aftermath of world financial crisis of 2008, China become the outstanding hub and continued to rise, in contrast with the declining of other hubs of Singapore and Japan.

Should we include USA and EU into calculation, we can observe from Figure 6B that in the years before 2003, USA-hub far outweighed Japan and EU and Hong Kong. China-hub surpassed the USA, Japan and EU after 2003, and remains as the first significant hub far above the 2$^{nd}$ largest hub of EU. USA-hub melded into the same group of Japan and Singapore.

In sum, we have observed different dynamic path for the export-destination hub and the import-source hub. We now turn to empirical analysis to identify the likely determinants for the trading-hubs.

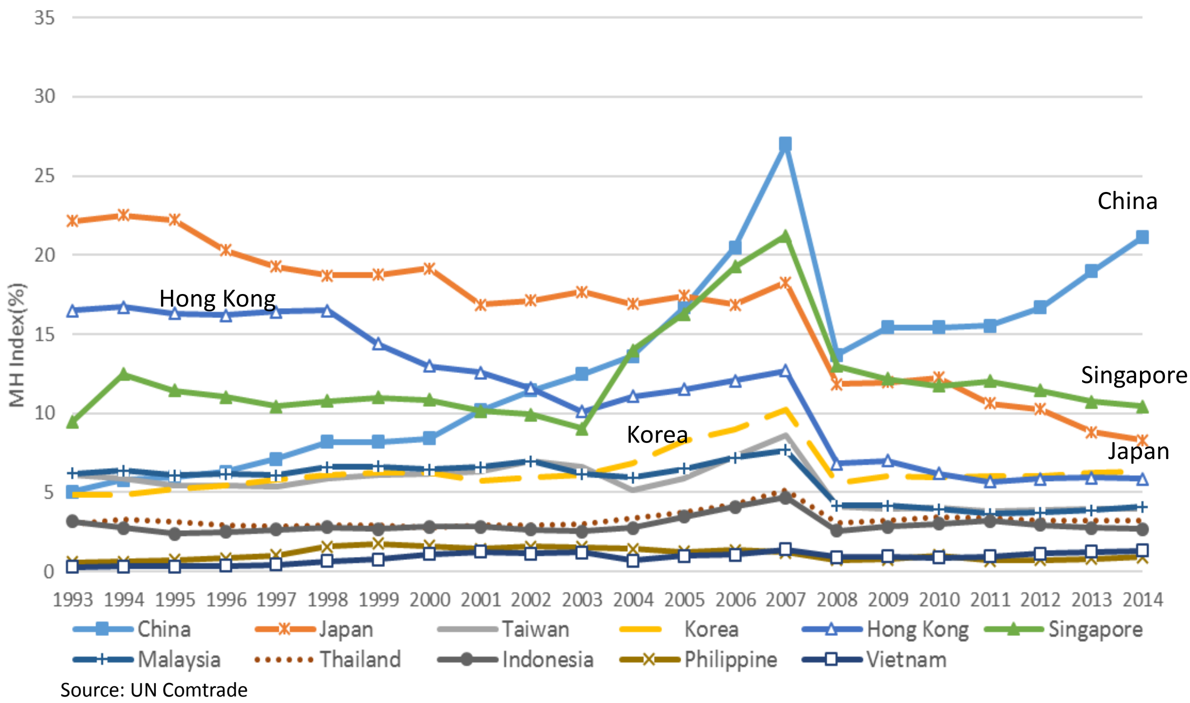



**Figure 6A Import-Source Hub (MH index of Total Trade, East Asia )**

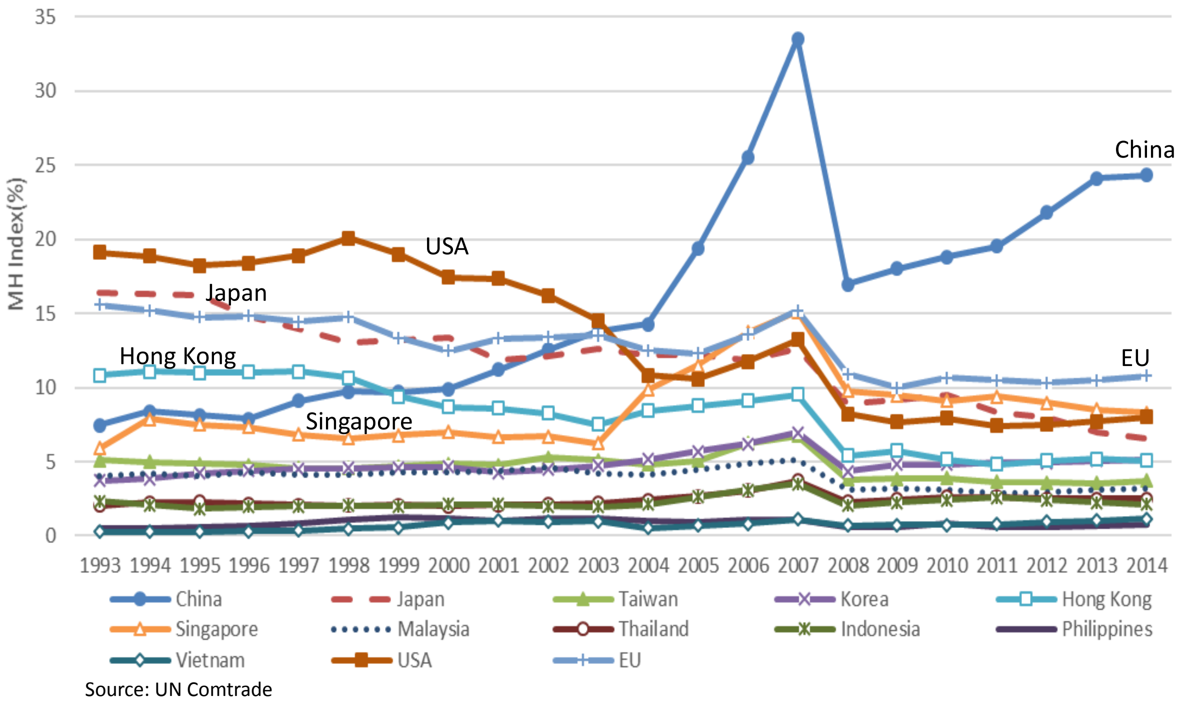



**Figure 6B Import-Source Hub (MH index of Total Trade, East Asia, USA & EU )**

## 4. Empirical Analysis

We now turn to conduct empirical analysis to identify the determinants for trading hubs. As addressed in the theory, there are two types of hubs, export-destination and import-source hub. The basic hub determinants include GDP, GNI per capita, the technology level represented by $PTN_{ic}$ (the numbers of patent holdings by sector and by country) and inward foreign direct investment ($FDI_i$) and outward FDI ($FDI_o$)

### 4.1 Empirical Model

**The basic model**

The basic models for XH and MH are designed as in Equation (5A), and (5B). Note that without losing the generality, we take log on the variables if needed, simply to scale down the value of the variables.

$$\ln XH_{it} = \alpha_1 + \beta_1 \ln GDP_{it} + \beta_2 \ln GNPPC_{it} + \beta_3 \ln PTN_{it} + \gamma_1 \ln FDIi_{it} + \gamma_2 \ln FDIo_{it} + \delta_C dCHN + \delta_U dUSA + \delta_E dEU + \varepsilon_{it} \quad (5A)$$

and

$$\ln MH_{it} = \alpha_1 + \beta_1 \ln GDP_{it} + \beta_2 \ln GNPPC_{it} + \beta_3 \ln PTN_{it} + \gamma_1 \ln FDIi_{it} + \gamma_2 \ln FDIo_{it} + \delta_C dCHN + \delta_U dUSA + \delta_E dEU + \varepsilon_{it} \quad (5B)$$

Clearly, in addition to the regular variables, we also include country/economy dummies of *dCHN* for China, *dUSA* for USA and *dEU* for EU. For example, *dCHN* equals one if the sample *i* refers to China, otherwise zero, so do *dUSA* and *dEU.*

The country-dummy design is to capture the other non-economic factors such as institutional and political regime, that may affect the formation of trading hubs, be it export-destination or import-source. For example, China's state capitalism can enhance the likelihood of becoming assembly hub for East Asia, or even 'a factory' for the world as a whole. On the contrary, some inherent institutional regime like democracy and socialism or social capitalism may lead USA and EU likely to consume and import most of the final goods around the world, making itself an export-destination hub. The three economy-dummies for China, USA and EU are selected into the model for its far surfaced lines of XH and MH index over fairly long years of the sample period, as shown in Figure 5B and Figure 6B.

**Extended Model**

In addition, the basic models are extended as designed in the following regression equations of 6A and 6B.

$$\begin{aligned}\ln XH_{it} = {} & \alpha_1 + \beta_1 \ln GDP_{it} + \beta_{1C} crCHNgdp_{it} + \beta_{1J} crJPNgdp_{it} + \beta_{1U} crUSAgdp_{it} + \beta_{1E} crEUgdp_{it} \\ & + \beta_2 \ln GNPPC_{it} + \beta_3 \ln PTN_{it} + \beta_{3C} crCHNptn_{it} + \beta_{3J} crJPNptn_{it} + \beta_{3U} crUSAptn_{it} \\ & + \beta_{3E} crEUptn_{it} + \gamma_1 \ln FDIi_{it} + \gamma_2 \ln FDIo_{it} + \varepsilon_{it}\end{aligned} \qquad (6A)$$

and

$$\begin{aligned}\ln MH_{it} = {} & \alpha_1 + \beta_1 \ln GDP_{it} + \beta_{1C} crCHNgdp_{it} + \beta_{1J} crJPNgdp_{it} + \beta_{1U} crUSAgdp_{it} + \beta_{1E} crEUgdp_{it} \\ & + \beta_2 \ln GNPPC_{it} + \beta_3 \ln PTN_{it} + \beta_{3C} crCHNptn_{it} + \beta_{3J} crJPNptn_{it} + \beta_{3U} crUSAptn_{it} \\ & + \beta_{3E} crEUptn_{it} + \gamma_1 \ln FDIi_{it} + \gamma_2 \ln FDIo_{it} + \varepsilon_{it}\end{aligned} \qquad (6B)$$

As can be seen in the last two equations, instead of applying a direct country/economy dummy for China, Japan, EU and USA, we create new variables such as *crCHNgdp* defined as *dCHN* times ln*GDP*, to identify whether there is a China-specific GDP effect. That is, we would like to test whether the positive GDP effect for China is above general level. By the same token, *crJPNgdp*, *crUSAgdp* and *crEUgdp* are designed for Japan, USA and EU.

By the same rational, cross variables of the country/economy dummy with technology level represented by *PTN* are created for *crCHNptn*, *crJPNptn*, *crUSAptn* and *crEUptn*. The design is to test whether the technology effects are country specific, since patents are diverse in terms of its technology content, ranged from simple and marginal improvement innovation to key or even creative destruction innovation. In this regard, the count of patent holdings for each country ($PTN_i$) may not reflect fully the real technology advantage. As a result, including only the variable $PTN_i$ can blur the effect of technology difference across countries. Under our design, we could test and identify the country-specific technology effect on being a trading hub, especially for import-source hub.

4.2 Data and Empirical Methodology

The data sources and main variables used in the studies are listed in Table 1. The sample ranges from 1993 to 2014 of 22 years, and covers thirteen economies, including eleven in the EA as shown in the trading-hub figures of Figure 5B and Figure 6B. Summary statistics are reported in Table 2. Obviously this is a panel data of 13 countries over 22 years. To conduct empirical analysis further, we have to identify a suitable regression model.

First of all, as displayed $XH_{it}$ and $MH_{it}$ over $t$, we find widely differential in the intercept. The result is also empirically supported under F-test with OLS-pooled data mode1 which rejects the hypothesis of no significant intercept difference. Accordingly, it should not be suitable of using the OLS on pooled sample. Then we move to search for suitable approach from the Panel data models. Then, we apply Panel model under the Hausman fixed effect. The empirical results failed to pass the Hausman test for the null of no heteroskedasticity, implying there are significant autoregressive (AR) and correlation between the dependent variables and the residuals. Accordingly, the generalized least square (GLS) approach is adopted throughout the paper.

**Table 1 Variable Lists and Data Sources**

| Variable | Description | Expected Sign on XH | Expected Sign on MH | Source |
|---|---|---|---|---|
| *Dependent variables* | | | | |
| XH | $HM_{\cdot h}^{R}=\sum_{o\in R}\{HM_{oh}\cdot[X_{oh}/\sum_{i\in R}x_{ih}]\}$ | | | UN Comtrade |
| MH | $HM_{\cdot h}^{MR}=\sum_{o\in R}HM_{oh}^{M}\cdot[X_{ho}/\sum_{o\in R}x_{ho}]=\sum_{o\in R}HM_{o.h}^{M}\cdot S_{h.o}^{R}$ | | | UN Comtrade |
| *Market Size* | | | | |
| GDP | GDP (Million US$) | + | + | WDI, DGBAS |
| GNIPC | GNI per capita, Atlas method (current US$) | + | + | WDI, DGBAS |
| Pop | Population, total (million) | + | + | WDI, MOI |
| *Tech.* | | | | |
| PTN | Patent Counts By Country, State, and Year | ○ | + | USPTO |
| FDIi | Foreign direct investment: Inward flows (million) | + | ○ | UNCTADsata |
| FDIo | Foreign direct investment: outward flows (million) | ○ | + | UNCTADsata |

* DGBAS: Directorate General of Budget, Accounting and Statistics, Executive Yuan, R.O.C.
MOI: Ministry of the Interior, Executive Yuan, R.O.C.
USPTO: US Pantent and Trademark Office.

**Table 2 Summary Statistics Total Trade**

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| XH | 286 | 6.86 | 6.14 | .51 | 24.45 |
| MH | 286 | 6.94 | 5.66 | .25 | 33.55 |
| GDP(Billion) | 286 | 2,767.53 | 4,750.08 | 13.18 | 19,100.00 |
| GNPPC | 286 | 16,714.10 | 15,742.44 | 170.00 | 55,720.00 |
| Pop(Million) | 286 | 211.96 | 338.82 | 3.00 | 1,364.00 |
| PTN | 286 | 12,315.17 | 25,091.46 | .00 | 144,621.00 |
| FDIi(Million) | 286 | 52,492.10 | 110,928.80 | -6,505.84 | 824,400.70 |
| FDIo(Million) | 286 | 62,409.20 | 143,438.10 | -140.00 | 1,216,458.00 |

* Note: Annual data range from 1993 to 2014, including 11 economies in EA (China, Hong Kong, Japan, South Korea, Taiwan, Singapore, Malaysia, Thailand, Philippines, Indonesia, Vietnam) plus EU and USA.

4.3 Empirical Results

The empirical results are reported in Table 3 for the basic model; Table 4 for the extended model. The major findings are listed below.

#### 4.3.1 GDP effect (+)

The basic model in Table 1 shows all the positive effect of GDP on the determination of trading-hub, be it export-destination or import-source, except the MH in model 3. In addition, we also find greater effect of the GDP on XH than on MH, as shown in Model 1 of 0.316 > 0.204 for the estimated coefficients of ln*GDP* on ln*XH* and ln*MH*. The same results can be found in Model 2 and Model 3.

That is, the country size is helpful in forming a trading hub, and even more so for the export-destination hub than for the import-source hub. The results empirically support the theoretical argument of big-market effect on becoming an assembly hub as well as a consumption hub.

In addition, the results of significantly positive coefficient of GDP in MH equation, also support that home market effect, that is, a country with bigger domestic market benefit from economic scale thus tend to earn more than proportional share of the world market, potential for import-source hub.

#### 4.3.2 GNP per capita effect (+)

GNP per capita, represented by variable ln*GNPPC*, represents a country's stage of development. In all the three models of Table 3, (i) we find all the corresponding estimated coefficient are significant. That is, a more advanced economy denoted by higher GNP per capita is more likely be a trading hub, be it export-destination hub or import-source hub. In addition (ii) by comparing the estimated coefficient between the equation of ln*XH* and ln*MH*, we find bigger effect of the GNP per capita on the ln*MH* than on ln*XH*, in all the three models.

As such, we may conclude that a more advance economy in terms of higher GNP per capita is more likely to develop into a trading hub, not just export-destination but also import-source hub. However, the likelihood of becoming an import-source hub is greater than becoming an export-destination.

#### 4.3.3 Technology Advantage and Import-source hub

The technology advantage is represented by the country-specific total number of patent holdings registered in the US Patent Office, i.e., variable ln*PTN*. Some meaningful results can be draw upon the estimated coefficient. Firstly, the estimated coefficients are not significant, in the equation of ln*XH*, but significantly positive in the equation of ln*MH* in model 1 and 2. Even in model 3 where country-dummy is considered, we find significant negative estimated coefficient for the variable for equation ln*XH*, but not significant for the equation of ln*MH*, indicating a 'greater' effect technology advantage on becoming an import-source hub.  Empirical results from model 4 and model 4 find us qualitatively similar evidence.

In sum, as theoretically expected, a country with higher technology level is more likely to become an import-source hub and less likely to be an export-destination hub.

(Country-specific patent effect) Model 5 in Table 4 considers the cross variable of country-dummy and the patent level in the regression. For example, *crCHNptn* is to capture whether China's patent holdings' effect on being a trading hub is above or below the average. The estimated coefficients of all the corresponding variables are positive and significant. In other words, the technology advantage in fostering a trading hub differs across countries. It seems that China's patent effect has the greatest effect on being a trading hub, and far outweighs the others of EU, USA and Japan. To some extent, this unusual result reveals the non-economy facto in developing a big country into trading hub.

4.3.4 FDI effect

The role of FDI in fostering a trading-hub is analyzed in the regression by considering inward FDI and outward FDI into the explanatory variables. As shown in Table 3, empirical results in model 2 indicate that both the inward and outward FDI are positively related to the forming of export-destination hub. However, to enhance the likely of being import-source hub, the effect of inward FDI is significant but not outward FDI. In addition, by comparing the effect on ln*XH* and ln*MH*, we also see that FDI affects more on the export-destination hub than on the import-source hub.

In model 3 where country dummies are included on the right hand side, the estimated coefficient of outward FDI remains positively significant for the export-destination hub (ln*XH* equation), and insignificant for the ln*MH*, qualitatively identical to the result for model 2. The results of higher and more significant effect of FDI on ln*XH* than on ln*MH* are also found in the extended model, model 4 and model 5 in Table 4.

Briefly speaking, we find that FDI, be it inward or outward, positively related to the formation of trading hub. And the effect on export-destination hub is higher than on the import-source hub.

4.3.5 Country-specific Effect

Country dummies of China, EU and USA are included in model 3. As a result, the GDP effect becomes insignificant for both types of trading hub, and the country-specific effect appears significantly to China, USA and EU. For being an export-destination hub, China-effect ranks the top $1^{st}$, followed by USA and then EU. For being an import-source hub, China-effect still ranks the top $1^{st}$, followed by EU than USA.

That is, the GDP-effect seems to be dominated by the big economies of China, USA and EU, among which China-effect always take the $1^{st}$ place for both the export-destination and import-source hub, and far above the USA- and EU-effect.

In addition, by the cross variable between country-dummy and GDP, we are able to identify the difference of GDP-effect of the four big economies of China, USA, EU and Japan. As shown in model 4, the GDP effects are positive for all the four economies, in which China ranked the largest, followed by USA, EU then Japan in both the export-destination hub and the import-source hub.

**Table 3 GLS Results for Basic Model (Total Trade)**

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | lnXH | lnMH | lnXH | lnMH | lnXH | lnMH |
| lnGDP | 0.316*** | 0.204*** | 0.236*** | 0.162*** | 0.0333 | -0.0168 |
| | (12.76) | (7.52) | (10.15) | (5.62) | (1.45) | (-0.56) |
| lnGNPPC | 0.165*** | 0.224*** | 0.0932** | 0.190*** | 0.403*** | 0.553*** |
| | (5.05) | (6.25) | (3.17) | (5.24) | (15.77) | (16.43) |
| lnPTN | 0.0134 | 0.0411*** | 0.0154 | 0.0452*** | -0.0141* | 0.0116 |
| | (1.36) | (3.80) | (1.55) | (3.68) | (-2.09) | (1.31) |
| lnFDIi | | | 0.112*** | 0.0617*** | 0.00847 | -0.0373* |
| | | | (7.81) | (3.46) | (0.70) | (-2.33) |
| lnFDIo | | | 0.0193* | 0.00524 | 0.0206*** | -0.000661 |
| | | | (2.53) | (0.55) | (3.92) | (-0.10) |
| dCHN | | | | | 2.104*** | 2.344*** |
| | | | | | (18.68) | (15.79) |
| dUSA | | | | | 0.894*** | 0.458** |
| | | | | | (8.26) | (3.21) |
| dEU | | | | | 0.851*** | 0.758*** |
| | | | | | (7.35) | (4.96) |
| Intercept | -4.228*** | -3.395*** | -3.706*** | -3.149*** | -3.002*** | -3.190*** |
| | (-10.99) | (-8.05) | (-10.99) | (-7.56) | (-10.13) | (-8.17) |
| *N* | 286 | 286 | 286 | 286 | 286 | 286 |
| *Wald chi2* | 650.8 | 576.77 | 971.96 | 626.11 | 2585.78 | 1546.86 |

Note: 1. Superscripts *, ** and *** denote significance level of 5%, 1% and 0.1%, respectively.
2. Numbers in parentheses are Z-value.

**Table 4 GLS results for Extended Model (Total Trade)**

| | Model 4 | | Model 5 | |
|---|---|---|---|---|
| | lnXH | lnMH | lnXH | lnMH |
| lnGDP | -0.104*** | -0.129** | -0.0945** | -0.119* |
| | (-3.33) | (-3.05) | (-2.58) | (-2.51) |
| crCHNgdp | 0.158*** | 0.171*** | | |
| | (19.92) | (15.94) | | |
| crJPNgdp | 0.0446*** | 0.0363*** | | |
| | (6.31) | (3.79) | | |
| crUSAgdp | 0.0842*** | 0.0517*** | | |
| | (10.51) | (4.76) | | |
| crEUgdp | 0.0806*** | 0.0694*** | | |
| | (9.68) | (6.15) | | |
| lnGNPPC | 0.362*** | 0.517*** | 0.287*** | 0.436*** |
| | (14.67) | (15.45) | (10.86) | (12.72) |
| lnPTN | -0.00218 | 0.0219* | 0.00720 | 0.0320*** |
| | (-0.33) | (2.42) | (0.96) | (3.29) |
| crCHNptn | | | 0.327*** | 0.356*** |
| | | | (15.73) | (13.18) |
| crJPNptn | | | 0.0708*** | 0.0589*** |
| | | | (5.83) | (3.74) |
| crUSAptn | | | 0.116*** | 0.0690*** |
| | | | (8.65) | (3.96) |
| crEUptn | | | 0.121*** | 0.102*** |
| | | | (7.74) | (5.04) |
| lnFDIi | 0.0270* | -0.0216 | 0.0462*** | -0.000939 |
| | (2.25) | (-1.33) | (3.47) | (-0.05) |
| lnFDIo | 0.0247*** | 0.00280 | 0.0263*** | 0.00448 |
| | (4.86) | (0.41) | (4.55) | (0.60) |
| Intercept | -1.221** | -1.715** | -0.872 | -1.337* |
| | (-3.11) | (-3.23) | (-1.88) | (-2.22) |
| *N* | 286 | 286 | 286 | 286 |
| *Wald chi2* | 2810.97 | 1583.89 | 2134.93 | 1308.58 |

Note: 1. Superscripts *, ** and *** denote significance level of 5%, 1% and 0.1%, respectively. 2. Numbers in parentheses are Z-value.

## 5 Concluding Remarks

This paper contributes to the trading hubness literature in several distinctive aspects. Firstly, we show that the conventional FTA-induced hub may not be consistent with the de facto trading hubs.

Secondly, two types of trading hubs, namely export-destination hub and import-source hub are raised, and the corresponding hubness-index of XH and MH are derived by extending the hubness measure of Baldwin (2004). Applying the index to East Asian economies plus USA and EU, we reconfirmed the existence of the twin-hub of China and Japan only in export-destination sense, but not significant in the import-source sense. However, we find that since 1990s the China hub has been rising while Japan-hub declining.

Empirical evidence, using GLS panel model on the data ranged from 1993 to 2014 for economies including eleven EA economies plus the twos of USA and EU, supports our theoretical arguments. That is, the major determinants for fostering trading hubs, include GDP or domestic market size, technology advantage and FDI. However, the intensity of the effect of these determinants on being an export-destination or import-source hub differs. More specifically, GDP and FDI help more for fostering an export-destination hub; on the contrary, the GNP per capita and technology level tends to contribute more on becoming an import-source hub. Some significant effects of country-specific dummies of China, Japan, USA and EU on becoming a trading hub are also found, implying the existence of non-economic determinants, like political regime, institutional intangible trade barriers etc. that may affect the appearance of current de facto trading hubs among East Asia.

By now we only apply our approach to total trade. Intuitively, there are industry specific factors that should affect the strength of the same determinant factors in shaping the trading hubs. Should we focus on different industries, the trading-hub pictures for industries featured by different capital- and technology- intensity, e.q. footwear and ICT, could be quite different. We reserve this for further studies.

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