# Airfreight and International Trade: Evidence from Japanese Export

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## 1. Introduction: Airport Infrastructure Development

According to trade data from Japan, the share of air-shipped products' value out of the total exports of Japan was about 30% in 2007. The rest of the products exported have to be shipped by sea in the case of Japan. Interestingly, Hummels (2001) observed similar results among US exports. The importance of air freight in international trade or international logistics has not been discussed so often in the literatures of international trade, compared with the discussion in the literatures of transportation economics or transportation engineering so far. As seen in previous transportation economics' research, Matsumoto (2005), Grosche et al. (2007) analysed empirically the role of airfreight in determining the air carriage flows, such as passengers, cargo, between countries using models similar to the gravity type equation. The determinants of volume of the flows of air transportation are the important research issue, since transportation infrastructure investment would be necessary to spend in order to expand its transportation capacity in case of shortage of the capacity.

The Japanese government says that the two Tokyo airports, Narita and Haneda airport, have been close to their capacity limits. Narita airport has been designed and opened for international air transportation network since the 1970s, and Haneda airport has been used mainly for domestic air transportation. These two airports have been segregated in usage as follows: Narita is the international hub-airport, whereas Haneda is the domestic hub-airport. However, with the current re-expansion investment of Haneda airport[1], Japanese government will set international air-route in Haneda airport in the second half of 2010, since Haneda is

[1] This re-expansion will install 4th runway to Hanae airport. This runway is expected to increase Haneda's runway capacity for takeoffs and landings from 296,000 to 407,000 per year.

closer to the central Tokyo and Narita cannot open for 24 hours a day. Passengers will save their total transit time to foreign countries with the flights from Haneda than Narita. Installing new air routes would affect trade costs with foreign countries in that it would reduce transit time.

#Table 1#

The development of transportation infrastructure in China has expanded drastically since advancing the reforms and open-door policies of the early 1990s. Table 1 shows the achievement of each transportation mode's development in China in terms of the established route length, compared with the 1990 level. According to this result, the highway and the domestic air route network have been expanded its length about 3.5 fold and 6 fold respectively in the period between 1990 and 2007. The international air route network has also been expanded by a factor of 6 during the same period. In its recent economic growth, China has developed every transportation mode quickly, and the air route network was the most expanded among transport modes in this period.

Japan and China have been developing their domestic and international air traffic capacity. We will consider the significance of such air traffic infrastructure investments in terms of international air cargo usage. This paper analyses determinants of the frequency of airfreight usage in Japanese exports across importing countries and products using gravity model. The reminder of this paper is as follows. Section 2 describes some statistical evidence of Japanese export shipped by aircraft in 2007. Section 3 describes the theoretical background of the empirical model employed in this paper, considering difference in trade costs among varieties in same product category. Section 4 provides the empirical results on the determinants of the ratio of airfreight usage in Japanese export.

## 2. Some evidences of Air shipment in Japan

As seen in table 2, Narita airport is the largest international trading port among all Japanese international trading ports, seaports and airports, in terms of value of trade from 2007. You can surmise that airports are currently one of the important infrastructures to trade with foreign countries.

#Table 2#

As mentioned before, the export value shipped by aircraft is about 30% of the total export in Japan and the US. We use the trade data taken from the Ministry of Finance in Japan. This data[2] is classified with the Japanese 9 digit HS code[3] in 2007, and contains transportation mode information, indicating air or ship. The total number of products exported from Japan to the world is about 150,000. This is the total number of each country's imported products from Japan across all importing countries. 86,265 products out of all exported products were transported by aircraft from Japan to foreign countries in 2007. This means that aircraft currently carries more than half of Japanese exported products. At the same time, this also implies that some of the products are difficult or impossible to be transported by air.

#Figure1#

Since aircraft generally cannot carry heavy and large cargo, unlike cargo ship, we could expect that the products shipped by air may share certain characteristics, such as light and high value-added products, fresh foods, flowers and so on. Hummels (2001) [4]and Nordas et al. (2006) discussed the possibility of trade cost differences among traded products, considering the difference in each product's opportunity cost of transit-time. They define products which require the exporter or importer to save transit time as "time-sensitive products." In order to verify their idea, we will measure the frequency of airfreight usage by calculating the ratio of export value shipped by aircraft with total export value in each HS-9 product. We describe it as the air shipment ratio (hereafter denoted by AR). We consider higher AR products as the time sensitive products.

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[2] The Trade Statistics of Japan, Ministry of Finance, Japan. It is available from http://www.customs.go.jp/toukei/srch/indexe.htm.

[3] The first 6-digit of this Japanese 9-digit HS code is based on HS2007 code. The last 3-digit of it is Japanese original code.

[4] He estimates the tariff equivalent per day in transit to 0.8%. This indicates that for 20 days transit it would be nearly tariff ratio of 16%.

In case AR is equal to 1, it indicates that the products are exported by exclusively aircraft. The number of the products exclusively shipped by air (AR=1, exclusively air-shipped product) was 30,756 in 2007. It means about 20% of the total exported products and about 2.2% of the total exported value in Japan were exclusively shipped by air. Figure 1 shows the distribution of AR in Japanese export products. According to these results, exports of both exclusively sea-shipped product (AR=O) and exclusively air-shipped product (AR=1) are major in Japanese export, where as the other AR products (0<AR<1) are relatively minor. This result implies that some transactions have to be done be either aircraft or ship. Even though the transportation cost of airfreight is much higher than that of shipping, some exporters clearly prefer to ship their products by aircraft[5]. It may be motivated by transit-time saving.

#Table 3#

Table 3 shows the results of the two measured indexes of frequency of airfreight usage, AR ratio and AR average in export from Japan by product category in BEC (Broad Economic Categories) classification in order to consider a difference among product characteristics. The BEC classification has the following product category: Parts & Components, Processed Goods, Material Goods, and Consumer goods. As previous study, such as Harrigan and Venables(2005) discussed, we expect parts & components are shipped by faster transportation modes. AR ratio is the ratio of the number of exclusively air-shipped products out of the total number of each BEC category. And, AR average is the average of each product's AR in a BEC category.

The result of the AR ratio shows that Consumer goods and Material Goods are shipped by air relatively more often than the others. As for the result of average AR of each BEC product category, Parts & Components and Consumer Goods have relatively higher shares, 34.5% and 35.51% respectively. This indicates that certain BEC product categories, such as P&C, Consumer Goods and Material Products, are

5 Transportation quality is another important determinant of transport mode choice, especially for fragile products, quick-rusting products. They are exclusively shipped by aircrafts, not by ships, rails, or tracks.

different in that those products are frequently shipped by aircraft.

#Table 4 and 5 #

Table 4 shows top 30 countries that intensively imported Japanese products by aircraft in 2007. Monaco is the most intensive airfreight user in Japanese export. Nearly 90% of the total number of the imported products and more than 95% of the import in value are shipped by aircraft from Japan to Monaco. Other intensive airfreight user countries are Andorra, Bosnia and Herzegovina, Switzerland, and Costa Rica as shown in Table 4. Table 5 also shows top 30 countries in terms of the ratio of exclusively air-shipped product to the total number of exported product in 2007. Monaco, Andorra, and Bosnia and Herzegovina are ranked in top 10 in both Table 4 and 5. It shows that relatively smaller and farther economies tend to be placed high in both ranking.

If there were no airline route to those intensive airfreight user countries from Japan, it would be expected that the volume of Japanese export to the countries would be reduced by substantial amount and the number of the imported products, especially the intensively air-shipped products, from Japan to the countries would be decreased. In contrast, setting new airline route and increase of freight frequency would cause trade creation effects. This may imply public spending on the airport development in Japan cause positive economic effect to Japanese economy.

## 3. Theory

Gravity models have been usual and powerful analysis tool to analyse the volume of aggregate trade flows between trading partners, considering trade costs, or trade barriers. However, the gravity models are disadvantageous in that those models cannot analyse bilateral trade flows sector by sector. As indicated in section 2, the frequency of airfreight usage of each product was different among product categories in the case of Japanese export. It may imply different trade costs for the products within the same product category. In order to analyse the determinants of air shipment flows from Japan to destination countries, we need the theoretical model which can consider the determinants of disaggregate trade volume between countries. Chaney (2008) developed an improved gravity model which can analyse the volume of disaggregate trade flows by sector between countries. His model is based on international trade model with firm-heterogeneity developed by Helpman, Melitz and Yeaple (2004). We will apply the Chaney's improved gravity model to the analysis of airfreight frequency in Japanese export. The Chaney model would be summarized as follows.

Assuming that N asymmetric countries exist in economy and they produce goods with only one production factor, labour. There are two different types of goods in terms of degree of product differentiation, homogenous goods (sector 0) and differentiated goods (sector H). The differentiated goods sector H has subsectors h, and then this subsector has ω varieties. Under consumer's utility maximising assumption, consumers choose to buy a set of homogenous goods 0 and differentiated good H with the elasticity of substitution between sectors (and also between varieties in sector h). The homogenous good 0 is produced with constant returns to scale technology, and can be traded freely. There are two types of trade costs, a variable trade cost and a fixed trade cost. The Variable trade cost is assumed to be a usual iceberg type of transportation cost ($\tau_{ij}$). Exporting firms to country j have to pay the entrance fixed trade cost ($f_{ij}$). All countries have same technology and preference. With the above basic setting and the firm heterogeneity setting he derives the following gravity equation (1).

Total exports (f.o.b.) $X^h_{ij}$ in sector h from country i to country j are given by

equation (1)

$$X_{ij}^{h} = \mu_h \times \frac{Y_i \times Y_j}{Y} \times \left(\frac{w_i \tau_{ij}^{h}}{\theta_j^{h}}\right)^{-\gamma_h} \times \left(f_{ij}^{h}\right)^{-[\gamma_h/(\sigma_h-1)-1]},$$

where $Y_i$ is exporter's output, $Y_j$ is importer's output, Y is world output, $w_i$ is worker's productivity in export country, and $\theta_j^h$ is the measure of importer's remoteness from the rest of the world.

One of the Chaney type gravity model's advantages is that this model has two different trade costs, variable trade cost and fixed trade cost. The fixed trade cost depends on the magnitude of entry costs to foreign market, and it is potentially different among sectors. We will extend this sector (h) level fixed trade costs into variety ($\omega$) level trade costs. We define each variety, $\omega$, in sector h faces different fixed trade costs, since some of the producers would be subject to use a different transportation mode within a same sector. For example, one producer usually ships its own product to foreign consumers by rail. But, for a certain reason, such as just-in-time production, lean inventory, the foreign consumer need to receive the product by a certain deadline. Then, the consumer asks the producer to ship it by the faster transportation mode than usual. Therefore, the concerning product faces a different transport cost than usual transaction. Hence, the fixed trade cost may not be always same across varieties in the same sector h, because of necessity of timely delivery.

We assume there are two possible transportation modes, airfreight and shipping, for producers. When the producers have to ship their products by air to destination markets, they will pay $f_{ij}^{hw^A}$, which is higher than $f_{ij}^{h}$. Only time-sensitive producers can afford to pay $f_{ij}^{hw^A}$, and export their product to country j by air. The varieties shipped by air are denoted as $\omega^A$, and their export value is $X^{hA}_{ij}$.,

equation(2)

$$X_{ij}^{hA} = \mu_h \times \frac{Y_i \times Y_j}{Y} \times \left(\frac{w_i \tau_{ij}^h}{\theta_j^h}\right)^{-\gamma_h} \times \left(f_{ij}^{hw^A}\right)^{-[\gamma_h/(\sigma_h - 1) - 1]}.$$

If all varieties have the same fixed trade cost within sector h, then this model falls to the Cheney model. All producers in sector h ship their products by same transportation mode, either ship or air, and the export value in sector h is $X^h_{ij}$. If not, some of the varieties might be shipped by different transportation modes, and the export value in sector h would be no long same as $X^h_{ij}$.

# 4. Empirical model and Results

## Empirical model

We will estimate the determinants of export volume from Japan to destination countries with respect to difference in the frequency of airfreight usage among exported products, based on the above theoretical model. We use the following three dependent variables: total export value for the first model, export value shipped by air for the second model, and air shipment share in sector h for the third model. For the purpose of estimation, exporter's explanatory variables, GDP and worker's productivity wage, are omitted in the empirical model, since we have only one exporter, Japan. We also use a proxy variable for remoteness and dummy variable for fixed trade cost. We expect that larger market size and higher remoteness of destination country increase the export value from Japan, and longer geographical distance from Japan decreases the export value. In addition, time-sensitiveness of exported product increases air-shipped export value, whereas it decreases sea-shipped export value. This means time-sensitiveness of exported product increases air shipment ratio.

(1) The first model: Total export value in sector h to country j ($EX_{ij}^{h}$)

$$EX_{ij}^{h} = c + \beta_1 \ln SGP_j + \beta_2 \ln \mathrm{Re}\,moteness_j + \beta_3 \ln Dist_{ij} + \beta_4 TS\_Dummy + \varepsilon$$

(2) The second model: Air shipped export value in sector h to country j ($EX_{ij}^{hA}$)

$$EX_{ij}^{hA} = c + \beta_1 \ln SGP_j + \beta_2 \ln \mathrm{Re}\,moteness_j + \beta_3 \ln Dist_{ij} + \beta_4 TS\_Dummy + \varepsilon$$

(3) The third model: Air Shipment Ratio in h sector ($EX_{ij}^{hA} / EX_{ij}^{h}$)

$$EX_{ij}^{hA} / EX_{ij}^{h} = c + \beta_1 \ln SGP_j + \beta_2 \ln \mathrm{Re}\,moteness_j + \beta_3 \ln Dist_{ij} + \beta_4 TS\_Dummy + \varepsilon$$

Explanatory Variables:

| Variable Name | Definition of Variables | Expected Sign |
|---|---|---|
| lnSGDP | Share of country j's GDP to the world GDP: Market Size | + |
| lnDIST | Great Circle Distance from Japan to country j: Proxy for variable trade cost | - |
| lnRM | Log of Country j's Remoteness | + |
| TS_Dummy | Time-sensitive product dummy:<br>Intensively air-shipped product=1<br>Intensively sea-shipped product=0 | |
| D_PC | Parts & Components BEC Product Dummy | + |
| D_CG | Capital Goods BEC Product Dummy | - |
| D_MG | Material Goods BEC Product Dummy | - |
| D_Con | Consumer Goods BEC Product Dummy | + |
| D_PG | Processed Goods BEC Product Dummy | - |

## Results of Estimations

We estimate the above empirical model using OLS. Table 6 shows the results of those estimations. The first models estimate total export value of each product with BEC product dummies variables. And, the second models estimate the export value shipped by air. Then, the third models estimate the air shipment ratio of each product.

All three models' results indicate that all explanatory variables are statistically significant at 5%. The first models show high R-squared (around 0.8), compared to the other models. Market Size and Remoteness have expected positive sign in all three models. Distance, proxy for variable trade cost, has expected negative sign in the first and second model, while it has significant positive sign in the third model. That is, high variable trade cost reduces export values in total and air shipped, but increases the frequency of air shipment in the case of Japanese export. The time-sensitive product dummy variables are statistically significant. The results of those confirm that the products categorised as parts& components and capital goods are more intensively shipped by air to the destinations in terms of value, compared to the other products in BEC classification. In addition, the result s of the third models indicate that parts & components and consumer goods are more frequently shipped by air from Japan to farther destination countries.

#Table 6#

## 5. Conclusion

Japan and China has been conducting their air transportation infrastructure improvement recently. As indicated in section 2, airfreight service is an important transportation mode for international trade in Japan, because most of the products exported from Japan to some small economies, especially Monaco, Andorra, Luxemburg, were intensively shipped by air, and some products, such as parts & components, consumer products, and material products were frequently shipped by air to destination countries. It is about 30% of the total export value in 2007 that shipped to foreign countries by air in Japan. And, More than 50% of the total number of exported products from Japan can be shipped by air. In addition, the value of export exclusively shipped by air is account for about 2.2% of the total Japanese export value. Following the Chaney's gravity model, we estimated the determinants of the frequency of air shipment in Japanese export using 9-digit HS trade data. The results of the estimations support the Chaney's model. According to the estimation results of the extended Chaney model to consider fixed trade cost difference in the same product, the time-sensitive products, such as parts & components and consumer goods tend to be shipped more frequently by air to the farther countries from Japan.

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Table 1　 Index of Length of Transportation Routes in China

（Year1990 value=100）

| Year | Rails | Highways | Waterways | Domestic Civil Aviation route | International Civil Aviation route |
|---|---|---|---|---|---|
| 1991 | 99.8 | 101.2 | 100.5 | 110.3 | 106.6 |
| 1992 | 100.3 | 102.8 | 100.5 | 165.1 | 182.1 |
| 1993 | 101.2 | 105.4 | 100.9 | 189.6 | 167.5 |
| 1994 | 101.9 | 108.7 | 101.0 | 206.3 | 211.5 |
| 1995 | 107.8 | 112.5 | 101.3 | 222.8 | 209.3 |
| 1996 | 112.1 | 115.3 | 101.5 | 230.2 | 232.2 |
| 1997 | 114.0 | 119.3 | 100.5 | 281.2 | 303.1 |
| 1998 | 114.7 | 124.3 | 101.0 | 297.1 | 303.1 |
| 1999 | 116.4 | 131.4 | 106.7 | 300.4 | 314.5 |
| 2000 | 118.7 | 136.4 | 109.2 | 296.5 | 305.5 |
| 2001 | 121.0 | 165.1 | 111.3 | 306.6 | 310.6 |
| 2002 | 124.2 | 171.7 | 111.4 | 323.1 | 345.3 |
| 2003 | 126.1 | 176.0 | 113.6 | 345.2 | 429.9 |
| 2004 | 128.5 | 181.9 | 112.9 | 404.4 | 537.4 |
| 2005 | 130.3 | 325.3 | 112.9 | 394.3 | 514.4 |
| 2006 | 133.1 | 336.2 | 113.0 | 417.0 | 580.6 |
| 2007 | 134.7 | 348.5 | 113.1 | 462.3 | 629.5 |

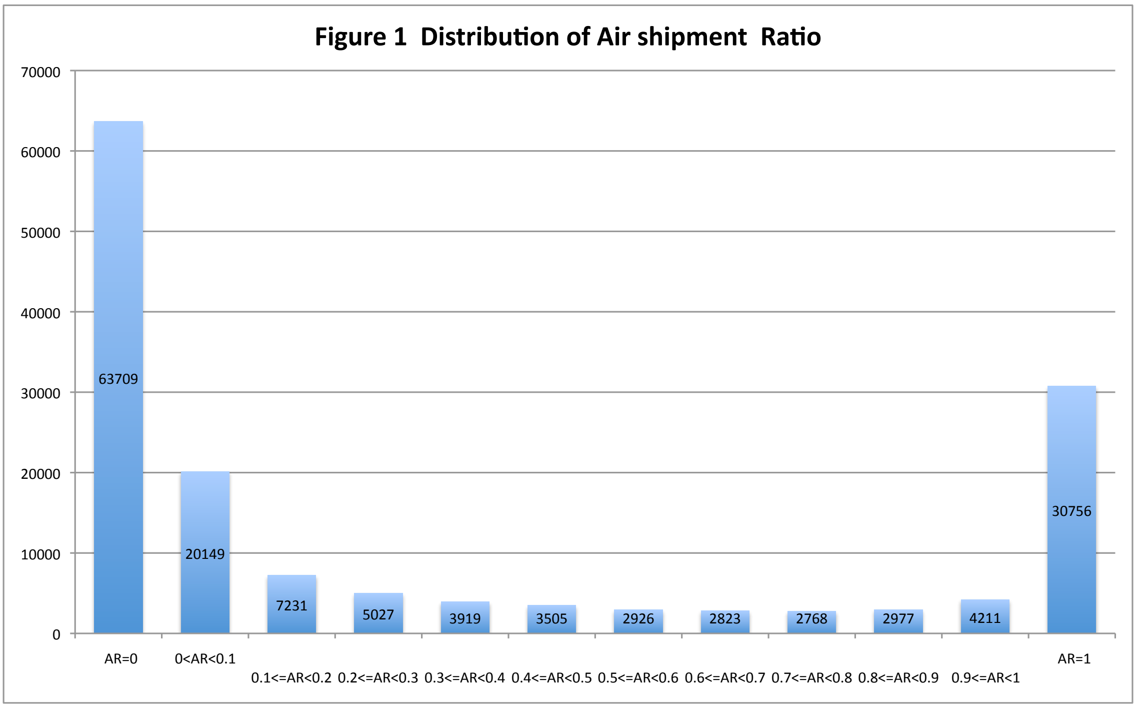
Source： China Statistical Yearbook, various issues, National Bureau of Statistics of China

**Table2: Trading Port Ranking by Transaction Value in Japan,2008**

（Unit：Million Yen，%）

| Rank | Port | Export Value | Share | Port | Import Value | Share | Port | Trade Value | Share |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Narita Airport | 11,208,563 | 13.8 | Narita Airport | 11,366,825 | 14.4 | Narita Airport | 22,575,388 | 14.1 |
| 2 | Nagoya | 11,083,130 | 13.7 | Tokyo | 8,009,108 | 10.1 | Nagoya | 16,360,172 | 10.2 |
| 3 | Yokohama | 8,695,587 | 10.7 | Nagoya | 5,277,042 | 6.7 | Tokyo | 13,378,389 | 8.4 |
| 4 | Kobe | 6,107,770 | 7.5 | Chiba | 5,158,983 | 6.5 | Yokohama | 12,994,469 | 8.1 |
| 5 | Tokyo | 5,369,281 | 6.6 | Yokohama | 4,298,882 | 5.4 | Kobe | 9,180,391 | 5.7 |
| 6 | Kansai Airport | 4,634,026 | 5.7 | Osaka | 4,131,405 | 5.2 | Osaka | 7,620,933 | 4.8 |
| 7 | Osaka | 3,489,529 | 4.3 | Kawasaki | 3,160,907 | 4.0 | Kansai Airport | 7,453,956 | 4.7 |
| 8 | Mikawa | 2,937,482 | 3.6 | Kobe | 3,072,621 | 3.9 | Chiba | 6,852,051 | 4.3 |
| 9 | Shimizu | 1,952,719 | 2.4 | Kansai Airport | 2,819,930 | 3.6 | Kawasaki | 4,695,182 | 2.9 |
| 10 | Chiba | 1,693,068 | 2.1 | Mizushima | 2,298,340 | 2.9 | Mizushima | 3,682,746 | 2.3 |

Source: Japan Customs, http://www.customs.go.jp/




Source: Author's calculation

Table 3: Two indexes of Frequency of airfireight usage, AR ratio and Average

| | BEC Classification Category | | | | |
|---|---|---|---|---|---|
| | P&C | Capital goods | Processed Goods | Material Goods | Consumption Goods |
| AR=1 No. Product | 4 | 10 | 23 | 17 | 62 |
| No.Products in product category | 420 | 601 | 847 | 402 | 1223 |
| AR Ratio(No. AR=1 Prod./No.Prod.) | 0.95% | 1.66% | 2.72% | 4.23% | 5.07% |
| Average AR | 34.50% | 15.98% | 16.72% | 16.09% | 35.51% |

Source: Author's calculation

Table 4 Air shipment Ratio by Destination country

| Ranking | Destination Country | Air Shipment Ratio |
|---|---|---|
| 1 | Monaco | 97.08% |
| 2 | Andorra | 82.75% |
| 3 | Bosnia and Herzegovina | 68.88% |
| 4 | Switzerland | 64.40% |
| 5 | Costa Rica | 56.33% |
| 6 | Slovakia | 56.12% |
| 7 | Hong Kong | 55.17% |
| 8 | Puerto Rico (USA) | 55.04% |
| 9 | Singapore | 50.36% |
| 10 | Philippines | 49.54% |
| 11 | Germany | 48.19% |
| 12 | Hungary | 46.41% |
| 13 | Taiwan | 46.36% |
| 14 | Ireland | 44.50% |
| 15 | Niue Islands (NZ) | 44.36% |
| 16 | Malaysia | 43.89% |
| 17 | Finland | 40.79% |
| 18 | Sweden | 39.32% |
| 19 | Belarus | 34.19% |
| 20 | People's Republic of China | 32.14% |
| 21 | Luxembourg | 32.03% |
| 22 | The West Bank and Gaza Strip | 31.73% |
| 23 | Denmark | 31.14% |
| 24 | Republic of Korea | 30.29% |
| 25 | Estonia | 29.83% |
| 26 | Czech Republic | 29.02% |
| 27 | France | 29.01% |
| 28 | United Kingdom | 28.38% |
| 29 | Netherlands | 27.32% |
| 30 | Thailand | 26.82% |

Source: MOF , Author's calculation

Table 5 AR1 Ratio by Destination Country

| Ranking | Destination Country | No. of Export Products | No. of AR1 Product | AR1 Ratio |
|---|---|---|---|---|
| 1 | Monaco | 31 | 27 | 87.10% |
| 2 | Gibraltar (UK) | 42 | 31 | 73.81% |
| 3 | The West Bank and Gaza Strip | 15 | 11 | 73.33% |
| 4 | Andorra | 21 | 15 | 71.43% |
| 5 | Belarus | 125 | 88 | 70.40% |
| 6 | Moldova | 51 | 32 | 62.75% |
| 7 | Bosnia and Herzegovina | 26 | 16 | 61.54% |
| 8 | Cayman islands (UK) | 59 | 35 | 59.32% |
| 9 | Luxembourg | 210 | 117 | 55.71% |
| 10 | Croatia | 235 | 129 | 54.89% |
| 11 | Serbia | 267 | 146 | 54.68% |
| 12 | Austria | 998 | 533 | 53.41% |
| 13 | US Virgin Islands | 27 | 14 | 51.85% |
| 14 | Lithuania | 279 | 143 | 51.25% |
| 15 | Uzbekistan | 190 | 97 | 51.05% |
| 16 | Armenia | 36 | 18 | 50.00% |
| 17 | Slovenia | 325 | 162 | 49.85% |
| 18 | Zambia | 136 | 67 | 49.26% |
| 19 | Romania | 504 | 245 | 48.61% |
| 20 | Switzerland | 1508 | 720 | 47.75% |
| 21 | Bermuda (UK) | 80 | 37 | 46.25% |
| 22 | Azerbaijan | 221 | 101 | 45.70% |
| 23 | Malta | 272 | 124 | 45.59% |
| 24 | Netherlands Antilles | 185 | 84 | 45.41% |
| 25 | Bulgaria | 395 | 177 | 44.81% |
| 26 | Former Yugoslav Republic of Macedonia | 56 | 25 | 44.64% |
| 27 | Denmark | 963 | 428 | 44.44% |
| 28 | Ireland | 786 | 347 | 44.15% |
| 29 | Liberia | 223 | 96 | 43.05% |
| 30 | Niue Islands (NZ) | 7 | 3 | 42.86% |
| | Average of all countries | | | 25.67% |

Source: MOF , Author's calculation

Table6 Estimation Results

| | First model : Total export value | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| | lnex | lnex | lnex | lnex | lnex | lnex |
| lnSGDP | 4.537 | 4.544 | 4.562 | 4.429 | 4.555 | 6.116 |
| | (10.70)** | (10.71)** | (10.76)** | (10.42)** | (10.74)** | (14.44)** |
| lnRemoteness | 0.911 | 0.912 | 0.911 | 0.911 | 0.91 | 0.908 |
| | (569.10)** | (569.40)** | (568.63)** | (567.88)** | (565.08)** | (568.96)** |
| lndist | -1.161 | -1.165 | -1.167 | -1.167 | -1.167 | -1.146 |
| | (246.09)** | (247.82)** | (249.02)** | (249.32)** | (249.40)** | (244.23)** |
| D_PC | -0.098 | | | | | |
| | (11.39)** | | | | | |
| D_CG | | -0.04 | | | | |
| | | (4.64)** | | | | |
| D_MG | | | 0.137 | | | |
| | | | (5.18)** | | | |
| D_Con | | | | 0.049 | | |
| | | | | (5.20)** | | |
| D_PG | | | | | 0.123 | |
| | | | | | (10.99)** | |
| AR1_D | | | | | | -0.271 |
| | | | | | | (37.49)** |
| Constant | 10.787 | 10.809 | 10.821 | 10.828 | 10.852 | 10.755 |
| | (186.40)** | (186.71)** | (187.19)** | (187.29)** | (187.60)** | (187.00)** |
| Observations | 121280 | 121280 | 121280 | 121280 | 121280 | 121280 |
| R-squared | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 |

| | Second Model: Export value shipped by air | | | | | |
|---|---|---|---|---|---|---|
| | 7 | 8 | 9 | 10 | 11 | 12 |
| | lnaex | lnaex | lnaex | lnaex | lnaex | lnaex |
| lnSGDP | 3.425 | 2.966 | 2.968 | 6.248 | 2.934 | 9.181 |
| | (2.89)** | (2.48)* | (2.48)* | (5.26)** | (2.46)* | (7.80)** |
| lnRemoteness | 0.345 | 0.336 | 0.337 | 0.349 | 0.34 | 0.271 |
| | (69.44)** | (67.35)** | (67.53)** | (70.42)** | (67.72)** | (53.55)** |
| lndist | -0.527 | -0.481 | -0.473 | -0.493 | -0.473 | -0.342 |
| | (39.80)** | (36.25)** | (35.80)** | (37.62)** | (35.74)** | (25.93)** |
| D_PC | 0.704 | | | | | |
| | (31.90)** | | | | | |
| D_CG | | 0.211 | | | | |
| | | (8.11)** | | | | |
| D_MG | | | -0.66 | | | |
| | | | (7.06)** | | | |
| D_Con | | | | -0.987 | | |
| | | | | (37.32)** | | |
| D_PG | | | | | -0.232 | |
| | | | | | (6.91)** | |
| AR1_D | | | | | | -0.953 |
| | | | | | | (53.16)** |
| Constant | 5.44 | 5.314 | 5.255 | 5.249 | 5.207 | 5.807 |
| | (32.08)** | (31.12)** | (30.79)** | (31.05)** | (30.47)** | (34.63)** |
| Observations | 69037 | 69037 | 69037 | 69037 | 69037 | 69037 |
| R-squared | 0.12 | 0.1 | 0.1 | 0.12 | 0.1 | 0.14 |

| | Third Model: Air shipment ratio | | | | | |
|---|---|---|---|---|---|---|
| | 13 | 14 | 15 | 16 | 17 | 18 |
| | AirRate | AirRate | AirRate | AirRate | AirRate | AirRate |
| lnSGDP | 6.919 | 6.826 | 6.885 | 6.742 | 6.893 | 2.099 |
| | (39.34)** | (38.74)** | (39.02)** | (38.14)** | (39.12)** | (19.60)** |
| lnRemoteness | 0.005 | 0.005 | 0.005 | 0.004 | 0.006 | 0.017 |
| | (7.98)** | (7.34)** | (7.42)** | (6.36)** | (9.19)** | (41.73)** |
| lndist | 0.06 | 0.071 | 0.067 | 0.067 | 0.067 | 0.0000 |
| | (30.65)** | (36.37)** | (34.24)** | (34.63)** | (34.42)** | (0.150 |
| D_PC | 0.105 | | | | | |
| | (29.45)** | | | | | |
| D_CG | | -0.075 | | | | |
| | | (20.87)** | | | | |
| D_MG | | | -0.07 | | | |
| | | | (6.36)** | | | |
| D_Con | | | | 0.047 | | |
| | | | | (12.06)** | | |
| D_PG | | | | | -0.09 | |
| | | | | | (19.22)** | |
| AR1_D | | | | | | 0.841 |
| | | | | | | (459.38)** |
| Constant | -0.384 | -0.449 | -0.421 | -0.417 | -0.443 | -0.21 |
| | (15.99)** | (18.67)** | (17.52)** | (17.36)** | (18.44)** | (14.46)** |
| Observations | 121280 | 121280 | 121280 | 121280 | 121280 | 121280 |
| R-squared | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.65 |

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%