Recent Development in Infrastructure and Its Impact on Agricultural and Non-agricultural Trade

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Abstract:

The main objective of this paper is to estimate the relationship between telecommunication and the volume of trade. More specifically, we estimate the effect of improved telecommunication on bilateral trade of agricultural and non-agricultural goods among the OECD countries in each year from 1997 to 2001. Our study revises the traditional gravity model by including variables representing the telecommunication infrastructure in exporting and importing countries to evaluate the effect of the recent development in the telecommunication infrastructure on bilateral trade of agricultural and non-agricultural goods among the OECD countries. The results indicate that per capita GDPs, geographical sizes, and telecommunication investments in both exporting and importing countries are significant and positively related to the value of bilateral trade between them. In agricultural trade, the investment in telecommunication in importing countries is more important than that of exporting countries.

Keywords: infrastructure, telecommunication investment, international trade

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1. Introduction

The improvement in infrastructure that occurred as a result of the recent revolution in information technology (IT), including the Internet and cellular mobile technology, has caused remarkable changes in the economic environment. Together with the development of the fixed network, access to information technology has expanded enormously within the Organization for Economic Co-operation and Development countries (OECD). While the number of Internet users was negligible in the early 1990s, by the beginning of 2002, the number of subscribers was more than 250 million and there were more than half a billion users of these subscriptions. Internet based companies, such as eBay, represent a new economic environment. eBay was launched in September of 1995 and has grown substantially for the last two years in a gross mechanic sale of a day. As of October, 2000, e-Bay recorded an average of 1.4 million visitors per day. There were 34.1 million active eBay members worldwide as of July 2003. Buyers and sellers on

eBay can negotiate their contracts through cyber space without the limitation of time and space[1].

The recent development of the telecommunication industries improves the environment of information infrastructure. The information technology (IT) revolution has enhanced economic activity and is an important factor in the recent acceleration of productivity growth. A fundamental question is: "Does IT accelerate the recent world globalization process and improve productivity?" IT could enlarge the volume of information flow, which accelerates productivity, but its impact on international trade has not ever been tested.

IT can increase the trade potential for both export and import countries. IT reduces entry costs in potential market and provides firms with greater freedom of entry and exit. On the other hand, importers can reduce search costs in the market. Thus, improved information flow makes markets more competitive and efficient by reducing transaction costs and employing the hysteresis effect.

The investment in telecommunication by a country is one of the factors affecting its info structure. Most previous studies have analyzed the total volume of trade as a function of changes in infrastructure without differentiating agricultural trade from

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[1] E-Commerce Success Story: eBay, Exclusive Interview with Kevin Purglove who was eBay spokesperson. (www.ecommerce.com, 01/04/00)

manufactured commodity trade. No literature has analyzed the role of IT in the international trade of agricultural goods.

Transportation infrastructure is generally considered a more important variable in agricultural trade because it connects production and consumption areas. Moreover, the transportation costs of agricultural commodities are much higher than those for non-agricultural commodities, relative to their prices of commodities. Since most agricultural goods are necessities, they may not be influenced by the commercial environment or education level of the workers. Although the prices of agricultural products are not influenced by the quality of a transportation infrastructure, the volume of agricultural trade may continuously increase because of growing population. Because the improvement of agricultural trade is considered as necessity or the result of population growth, improved telecommunication may have much stronger impact on non-agricultural trade than on agricultural trade. Actually, industrial goods are more competitive than agricultural goods so telecommunication in the marketing plays important role in non-agriculture.

The main objective of this study is to estimate the relationship between telecommunication environment in countries and the volume of trade. The study specifically focuses on estimating the effect of an improved telecommunication structure on bilateral trade. It differentiates agricultural from non-agricultural goods traded among

the OECD countries for each year from 1997 to 2001. The paper is organized by follows. Chapter 2 shows the model, data sources, and methodology to test this issue. In chapter 3, we present empirical results. The summary of this study is presented in chapter 4.

2. The model and data sources

A modified gravity-type model is developed for this study. This model has been extensively applied to identify factors affecting international trade flows from exporting countries to importing countries (Tinbergen, 1962; Anderson, 1979; Bergstrand 1985 and 1989). In a typical gravity model, the dependent variable is the bilateral trade value between two countries and independent variables are the incomes and sizes in both the exporting and importing countries and the distances between them.

This simple gravity equation relies only upon adding-up the constraints of a Cobb-Douglas expenditure system with an identical homothetic preferences function in each country. The basic empirical gravity equation is obtained by taking a natural logarithm as follows:

$$\ln X_{ij} = \alpha + \beta \cdot \ln Y_i + \gamma \cdot \ln Y_j + \delta \cdot \ln D_{ij} + \phi \ln Z_{ij} + \eta_{ij}, \qquad (1)$$

where $\alpha = (-\ln Y_w)$.

In general, the signs of β and γ are expected to be positive but not far from one (see Anderson, 1979). The sign of δ is expected to be negative because distance between countries negatively relates to trade volume between countries. In some studies,

economists use population or the area of countries instead of income as a proxy variable of the relative mass of countries, due to a potential endogeneity problem between income and trade (see Frenkel and Romer, 1999).

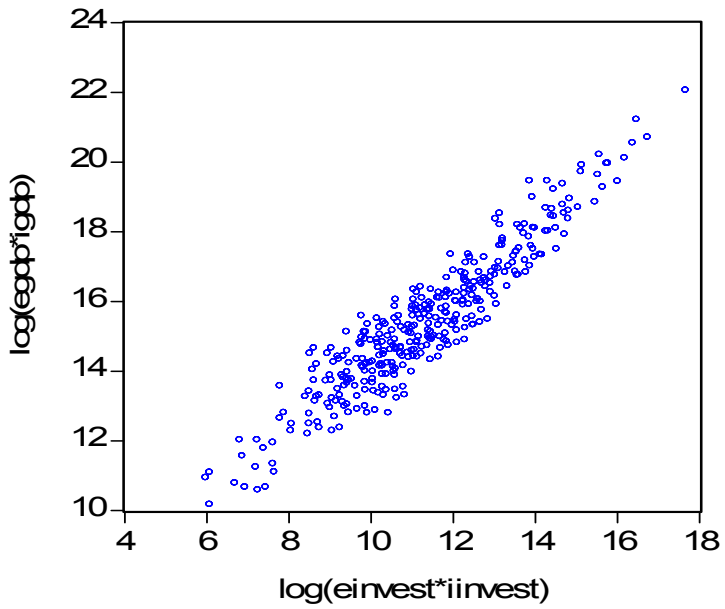

Figure1: Cross-Sectional Correlation between GDP and Telecommunication Investment (year 2000)

A statistical problem in estimating the gravity model is muti-collinearity between GDP and investment within the telecommunication industry. Larger countries in terms of GDP (or income) invest, in general, more in the telecommunication industry than small countries. This is especially true for developed countries.

Figure 1 shows a high degree of correlation between relative size of GDP and the public investment on telecommunication. To prevent the possibility of multi-collinearity,

the Equation (2) is modified by multipling population of two countries and dividing by population, as follows:

$$X_{ij} = \frac{Y_i\, Y_j}{Y^W P_i P_j D_{ij}} \cdot P_i P_j Z_{ij}\,, \qquad (2)$$

where Y_i / P_i represents per capita income in the i th country, (y_i), and Y_j / P_j, represents per capital income in the j th country, (y_j) . Since per capita income does not depend on a mass measurement of a country such as population, a potential multi-collinearity problem can be mitigated when we use other variables representing mass of a country. Equation (2) can be rewritten by taking logarithms in the both sides of the equation as:

$$\begin{aligned} &\ln(X_{ij}) = \alpha + \beta_1 \ln(y_i) + \beta_2 \ln(y_j) + \beta_3 \ln(P_i) + \beta_4 \ln(P_j) \\ &+ \beta_5 \ln(dist_{ij}) + \beta_6 \ln(Z_{ij}) + \eta_{ij} \end{aligned}\,, \qquad (3)$$

where y_i and y_j are per capita income of exporting country i and importing country j, respectively. P_i and P_j are population of countries i and j, respectively. Equation (3) has another multicollinearity problem between population and public investment in the internet. Figure 2 shows a positive correlation between the two variables: a country with large population has more investment telecommunication than a country with a small population.

To prevent multi-collinearity problems, another variable representing geographical characteristics of an individual country is used (Frankel and Romer (1999)).

Following Frankel and Romer, a variable representing the size of county is used to represent geographical characteristics that affect international trade and are not related to income. As shown in Figure 3, the correlation between the size of country and investment in telecommunication is weak and does not encounter any major estimation problems.

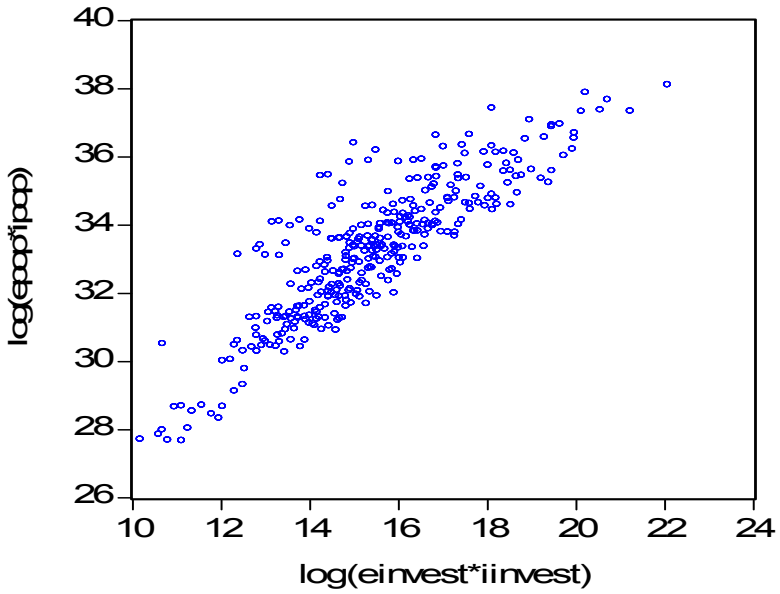

Figure 2: Cross-Sectional Correlation between Population and Telecommunication Investment Users (year 2000)

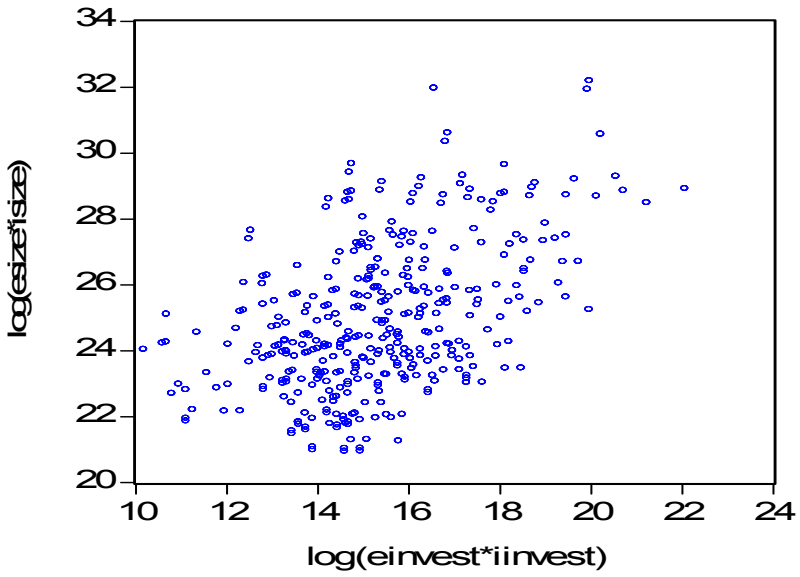

Figure 3: Cross-Sectional Correlation between Area (or Size) and Telecommunication Investment (year 2000)

The empirical model also includes several dummy variables representing regional and bilateral free trade agreements and common borders, in addition to public investment in telecommunication in country *i* and *j*.

$$\ln X_{ij} = \beta_0 + \beta_1 \ln(y_i) + \beta_2 \ln(y_j) + \beta_3 \ln(P_i) + \beta_4 \ln(P_j) + \beta_5 \ln(dist_{ij}) + \beta_6 D_{ij}^{LANG} + \beta_7 D_{ij}^{BORD} + \beta_8 D_{ij}^{EU} + \beta_9 D_{ij}^{NAFTA} + \gamma_1 \ln(TCI_i^k) + \gamma_2 \ln(TCI_j^k) + \varepsilon_{ij}' \quad (15)$$

where D_{ij}^{BORD} is a dummy variable representing a common border; D_{ij}^{LANG} is a dummy variable representing a common language; D_{ij}^{EU} is a dummy variable representing members of the European Union; and D_{ij}^{NAFTA} is a dummy variable representing NAFTA. Finally, TCI_i^k and TCI_j^k are proxy variables representing the telecommunication infrastructure of exporting and importing countries' respectively. In this paper, we use public investment in the telecommunication industry as the proxy for telecommunication infrastructure.

The coefficient of per capita GDP in the exporting country, β_1, is expected to have a positive sign because the exporter's income represents production capacity. On the other hand, the per capita GDP of an importing country represents its purchasing power. The coefficient of per capita income in importing country β_2 is therefore expected to be

positive. Secondly, the coefficients of the sizes of exporting and importing countries (β_3 and β_4) are expected to be positive because a larger country has more population than a small country. Population represents the labor force in produce and the producing country shows aggregated consumption in the importing country.

The distance between two countries is negatively related to trade volume between them; more trade occurs between countries with a short distance between them than a long distance. Thus, the coefficient of distance, β_5 , is expected to be negative.

Coefficients of common language, β_6 , and common border, β_7 , are expected to be positive. Common language between two countries helps them communicate and accordingly has a positive effect on trade. Common border means the distance between trading countries is small. Closer distance indicates the countries take advantage of trade because of cheaper transportation costs.

Recent regional or bilateral free trade agreements increase the trade volume through trade creation and trade diversion effects[2]. The trade creation effect is defined as an increase in trade volume through the replacement of domestic products with low-price imports from trading partners. The trade diversion effect is defined as an increase in trade volume through the replacement of imports from third countries with low-price imports from trading partners in the customs union. For these reasons, trade diversion and

[2]Koo,W. Won. and Kennedy, P.Lynn. International Trade: Application to Agriculture (pCh12-3)

creation effects, (the coefficients of NAFTA, β_8, and EU, β_9), are expected to be positive.

Coefficients of telecommunication proxy variables representing telecommunication infrastructure in the exporting and importing countries, γ_1 and γ_2, are expected to be positive. While the exporting country improves its productivity with enhanced infrastructure, importing countries increase their imports by lowering transaction costs and increasing their choices of goods.

The OECD countries that are considered in this study are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. The other countries, the Republic of Korea and the Republic of Slovakia, are dropped because of the unavailability of data related to infrastructure. Luxembourg is added to Belgium.

The OECD bilateral trade data set is taken from *International Trade by Commodities Statistics* publication (OECD, 1997-2001) and classified by one-digit standard international trade code (SITC). Subtracting agricultural trade from total trade generates non-agricultural trade data. Data representing public investment in telecommunication is from *the OECD Communication Outlook 2003* publication (OECD,

2003). Gravity models with cross sectional data for 1997-2001 periods are estimated using E-views software.

4. Empirical Results

4.1. Trade flows of aggregated goods

Table 1 presents ordinary least square (OLS) estimates of the modified gravity models with the cross-sectional data for the 1997-2001 periods. There are six columns which show independent variables and regression coefficients for each year from 1997 to 2001. White's heteroskedasticity-consistent standard errors are shown in parentheses.

The empirical model performs well in explaining bilateral trade flows of aggregated goods among the OECD countries. The adjusted R^2s are ranged between 0.835 in the 1997 model and 0.773 in the 2001 model, indicating that independent variables in the models explain variations of trade flows of goods in individual years. The estimated coefficients of the cross section gravity models are similar in magnitude for the 1997-2001 periods, indicating that there were no significant changes in trade flows among the countries over the period. The estimated coefficient of GDP per capita is statistically significant and has a positive sign, indicating that GDP per capita is positively correlated with trade. Since income in an exporting country represents production capacity, a country with higher income produces and exports more. On the

other hand, income in an importing country represents purchasing power. As income increases, consumers increase their consumption and imports. In this gravity model, however, an exporter's per capita GDP more significantly affects trade flows of goods than an importer's per capita GDP.

The country size variable has a positive sign and is statistically significant, confirming that a large country tends to engage in international trade more than a small-sized country. Large countries among the OECD members are specialized in production to take advantage of scale of economies based on resource endowment. However, the size of an importing country is more statistically significant and economically important than that of an exporting country. Most OECD countries with large geographical areas have a larger population than those with small geographical area and import more to meet the domestic consumption.

In contrast to the coefficients on per capital GDP and country size, the distance between two countries trade is statistically significant and negatively related to bilateral trade volume between the countries. Although the transportation system among the OECD member countries has been improved, the distances between countries have remained an impediment to trade. As expected, the coefficients of dummy variables representing regional free trade agreements (e.g., the EU and NAFTA) are statistically significant and positive, indicating that the trade agreements have enhanced trade

activities among the member countries. However, the dummy variable representing NAFTA is not significant in 2000 and 2001, but only in 1997 and 1999. The EU dummy variable is statistically significant at the 1 percent level and economically important in every year from 1997 to 2001. It implies that the EU has been more effective than NAFTA in enhancing trade among its member countries through trade creation and trade diversion. The results also indicate that sharing a common border and language increases bilateral trade volume among the countries. Since proximity is captured by the distance variable, the common border effect is statistically insignificant; it is statistically significant at 1 percent level only in 2001.

There is strong evidence which shows a vital impact of telecommunication infrastructure on international trade. Telecommunication proxy variables in both trading countries are statistically significant at the 1 percent level and have a positive sign. The coefficients are similar in each year for the 1997-2001 periods. In addition, the absolute value of telecommunication investment in exporting country drops slightly throughout the period, from 0.772 in 1997 to 0.671 in 2001. Meanwhile, the coefficient of telecommunication investment in an importing country does not have the same trend as that in an exporting country. The estimated coefficients in both exporting and importing countries indicate that investment in telecommunication within both countries tend to

stimulate international trade. However, the economical benefits of this telecommunication infrastructure may differ by country.

The improvement in the telecommunication infrastructure represents remarkable changes in the economic environments in both exporting and importing countries. The enormous number of internet users and subscribers to a variety of platforms brings about a new economic strategy for market entery. New marketing strategies are needed for a new economic environment. The recent development of the telecommunication industries that form the "info structure" has enhanced economic activity through improved information technology (IT). Information technology is also an important factor in the recent acceleration in productivity growth. IT could enlarge the volume of information flow, which accelerates productivity thorough efficient utilization of inputs for production. For instance, if a firm struggles to find labor, it will support higher wages to obtain the necessary workforce. However, with the development of information technology, the firm can indicate workers through advertisement online, implying that the owner may find a sufficient number of workers without paying high wages.

IT not only increases productivity but also reduces a firm's sunk cost in the market and provides it with greater freedom of entry. Telecommunication tools such as the internet have the potential to reduce this sunk cost because suppliers can advertise to numerous buyers at once through a multi-communication system. On the other hand,

importers can reduce the search costs for consumers to find desirable qualities and quantities of a good in the market. Furthermore, improved information flow makes a market more competitive and efficient by reducing transaction costs and eliminating the hysteresis effect. Consumers in an importing country can take advantage of lower prices through competition.

4.2. Trade flows of agricultural goods

Table 2 presents estimated coefficients of the agricultural trade model. The estimated coefficients are statistically significant and have the expected signs on the basis of economic theory. Adjusted R^2s are ranged between 0.552 in 1998 and 0.524 in 2000. The estimated coefficients of the cross section gravity models in agricultural trade are similar for each of the years over the 1997- 2001 period. The coefficients of per capita GDP in both countries are significantly different from zero at the 1 percent significance level and have a positive sign. The coefficient of per capita GDP in the importing country is higher than that in the exporting country in the agricultural trade model with

Table I. Estimated coefficients of the gravity model, for aggregated goods 1997-2001

	1997	1998	1999	2000	2001
Exporter's Per	0.657[a]	0.644 [a]	0.606[a]	0.595[a]	0.575[a]
Capita GDP	(12.24)	(11.86)	(10.14)	(10.01)	(8.65)
Importer's Per	0.371[a]	0.430 [a]	0.416[a]	0.351[a]	0.379[a]
Capita GDP	(6.52)	(7.11)	(6.34)	(5.56)	(5.68)
Exporter's Total	0.084[a]	0.092[a]	0.103[a]	0.096[a]	0.083[b]
Area	(2.51)	(2.83)	(3.24)	(2.90)	(2.37)
Importer's Total	0.156[a]	0.167[a]	0.202[a]	0.197[a]	0.175[a]
Area	(4.59)	(4.93)	(5.74)	(5.67)	(4.75)
Tel-com Invest	0.772[a]	0.761[a]	0.758[a]	0.733[a]	0.671[a]
(Exporters)	(22.67)	(19.77)	(17.08)	(18.11)	(16.55)
Tel-com Invest	0.714[a]	0.691[a]	0.693[a]	0.711[a]	0.679[a]
(Importers)	(24.65)	(22.24)	(22.94)	(21.95)	(19.97)
Distance	-1.080[a]	-1.069[a]	-1.125[a]	-1.125[a]	-1.126[a]
	(-18.86)	(-19.39)	(-19.85)	(-19.83)	(-19.16)
EU	0.335[a]	0.222[a]	0.313[a]	0.334[a]	0.202[a]
	(4.64)	(2.84)	(3.91)	(4.03)	(2.38)
NAFTA	0.910[a]	0.534[b]	0.515[a]	0.288	0.307
	(3.16)	(2.14)[a]	(2.05)	(1.31)	(1.56)
LANG	0.376[a]	0.523	0.465[a]	0.401[a]	0.592[a]
	(2.80)	(4.35)	(3.78)	(3.24)	(4.87)
BORDER	0.184	0.241[b]	0.246[c]	0.278[b]	0.257[a]
	(1.51)	(2.04) [a]	(1.83)	(2.29)	(2.08)
Constant	-2.874[a]	-3.453	-3.274[a]	-2.324[a]	-0.997
	(-3.41)	(-3.95)	(-3.61)	(-2.66)	(-1.01)
Number of					
Observations	702	702	702	702	702
Adj-R^2	0.835	0.815	0.801	0.791	0.773

Notes: Numbers in parenthesis are t-statistics using White's heteroskedasticity-consistent standard errors; **a**, **b**, and **c** denote significance at the 1, 5, and 10 percent levels.

the exception of 1997, indicating that per capita income in the importing country affects bilateral trade flows of agricultural goods more than that in the exporting country.

The country size variable is significant and positively related to bilateral trade volume of agricultural goods in both exporting and importing countries. Since agricultural production is land intensive, an agricultural exporting country needs abundant land with water. In addition, farming technology has been an important factor in improving agricultural competitiveness in developed countries. The coefficients of the size variable for agricultural trade are higher than for total trade, indicating that the country size reflecting available land is far more important in agricultural trade than non-agricultural trade. The size variable is much larger in the exporting country than the importing country. This strongly suggests that the country size is more important in agricultural trade in exporting country than an importing country. The coefficients in the exporting country are ranged between 0.419 in 1997 and 0.336 in 2001. A large country has a comparative advantage in producing and exporting agricultural goods. On the other hand, a large importing country usually has a high population density and imports to feed its population.

Telecommunication infrastructure is important in stimulating trade flows. The investment variables for telecommunication in both exporting and importing countries are statistically significant and are positively correlated with trade volume. However, the

estimated coefficients are smaller in agricultural trade (Table 2) than in total trade (Table 1), indicating that telecommunication in both trading countries has greater influence total trade than in agricultural trade. In general, telecommunication technology has not been inversely used in the agricultural sector, compared to the non-agricultural sector. In addition, the coefficients in the importing country are much larger than those in the exporting country, indicating that an importing country uses telecommunication more intensely than an exporting country.

The distance variable is statistically significant and is negatively correlated with bilateral trade volume of total agricultural trade, indicating that distance is an impediment to trade. The coefficients of the distance variable in agricultural trade are much larger than those in total trade, implying that the impact of distance in agricultural trade is much greater than that in total trade. This is mainly because transportation costs per unit of an agricultural good are higher than those for industrial goods.

Common language is statistically significant and is positively correlated to bilateral trade volume of agricultural trade, indicating that firms are more comfortable trading with countries that share a common language. Countries with a common language, in general, can communicate better with each other and create a better working environment.

Regional trade agreements, (the EU and NAFTA) are important in promoting international trade. The EU effect is statistically significant for agricultural trade at the 1 percent level, but the NAFTA effects are not significant. In addition, the coefficients of the EU in agricultural trade are larger than those of the NAFTA. This implies that the EU, more than NAFTA, has enhanced agricultural trade among its member countries. Agricultural trade among NAFTA countries (the United States, Canada, and Mexico) is small compared to trade of industrial goods, mainly because they are net agriculture exporting countries. On the other hand, the EU countries are generally specialized in agricultural production and trade with each other.

4.3. Trade flows of non-agricultural goods

The results of the gravity model for non-agricultural trade are presented in table 3. Non-agricultural trade data are obtained by subtracting agricultural trade from total trade. The adjusted R^2 is over 0.7 in each year; the highest R^2 is 0.839 in 1997, and the lowest one is 0.771 in 2001.

Per capita income variables in exporting and importing countries are statistically significant at the 1 percent level and are positively correlated with bilateral trade

Table 2. Estimated coefficients of the gravity model for agricultural goods, 1997-2001

	1997	1998	1999	2000	2001
Exporter's Per	0.588[a]	0.526[a]	0.602[a]	0.463[a]	0.467[a]
Capita GDP	(4.87)	(4.66)	(5.09)	(4.09)	(4.62)
Importer's Per	0.426[a]	0.601[a]	0.609[a]	0.569[a]	0.515[a]
capita GDP	(3.24)	(4.99)	(4.72)	(4.54)	(4.18)
Exporter's Total	0.419[a]	0.402[a]	0.392[a]	0.365[a]	0.336[a]
Area	(5.17)	(6.32)	(5.99)	(5.63)	(5.66)
Importer's Total	0.097	0.136[b]	0.201[a]	0.192[a]	0.144[b]
Area	(1.50)	(2.30)	(3.13)	(3.05)	(2.25)
Tel-com Invest	0.220[b]	0.281[a]	0.283[a]	0.354[a]	0.266[a]
(Exporters)	(2.39)	(3.01)	(3.28)	(3.54)	(2.91)
Tel-com Invest	0.899[a]	0.822[a]	0.820[a]	0.849[a]	0.867[a]
(Importers)	(10.22)	(15.05)	(12.47)	(12.68)	(11.32)
Distance	-1.248[a]	-1.253[a]	-1.264[a]	-1.316[a]	-1.260[a]
	(-9.96)	(-9.78)	(-10.62)	(-8.82)	(-9.52)
EU	0.794[a]	0.669[a]	0.781[a]	0.821[a]	0.774[a]
	(5.18)	(4.33)	(5.09)	(5.34)	(5.18)
NAFTA	0.722[c]	0.557	0.438	0.170	0.420
	(1.75)	(1.40)	(1.10)	(0.39)	(0.96)
LANG	0.652[a]	0.746[a]	0.722[a]	0.757[a]	0.857[a]
	(3.08)	(3.69)	(3.58)	(3.48)	(3.93)
BORDER	0.269	0.257	0.317	0.308	0.345
	(1.23)	(1.16)	(1.52)	(1.26)	(1.49)
Constant	-5.483[a]	-6.751[a]	-8.430[a]	-6.704[a]	-4.903[a]
	(-2.75)	(-3.73)	(-4.17)	(-3.90)	(-3.11)
Number of					
Observations	702	702	702	702	702
Adj-R^2	0.528	0.552	0.543	0.524	0.544

Notes: Numbers in parenthesis are t-statistics using White's heteroskedasticity-consistent standard errors; **a**, **b**, and **c** denote significance at the 1, 5, and 10 percent levels.

volume of the non-agricultural trade model. In addition, the estimated coefficients are generally stable for the 1997-2001 periods. Unlike the agricultural trade model (Table 2),

the coefficients in the exporting country are larger than those in importing countries, indicating that per capita income, which represents production capacity in an exporting country, is more important in producing and trading non-agricultural goods than agricultural goods. As discussed in the first section of this chapter, income enhanced trade flows of goods among countries.

The coefficients of the country size variable are not significant in the exporting country, indicating that the size of a country (area) is not important in producing and exporting non-agricultural goods. However, the coefficients of the country size variable in the importing country are significant and are positively related to bilateral trade of non-agricultural goods. These findings are contrary to trade for agricultural goods. The results clearly indicate that production of non-agricultural goods is not land intensive and a large country does not have a comparative advantage in producing the goods.

Public investment in the telecommunication industry in both exporting and importing countries is important in bilateral trade of non-agricultural trade goods. The coefficients are significant at the 1 percent level and are positively correlated with the trade volume of non-agricultural goods. As mentioned in the context of total trade, exporters should endure sunk costs to enter or exit the market. For instance, they pay for market search and advertising costs. Since non-agricultural goods are more heterogeneous, technology intensive than agricultural goods, the telecommunication

industry in an exporting country plays a more important role in providing characteristics of non-agricultural goods than in agricultural trade. The telecommunication industry is also very important for non-agricultural trade in an importing country. Consumers in an importing country can research necessary information about products through newly developed telecommunication tools. For example, they can easily contact producers through the internet. In addition, prices of goods are becoming cheaper because the internet increases competition in the market. The coefficients of are statistically significant at the 1 percent level and stable throughout the period. The range of this coefficient is 0.689 in 1997 to 0.651 in 2001.

As expected, the distances between countries are significant at the 1 percent level and are negatively correlated with bilateral trade volume of non-agricultural goods. However, the coefficients are somewhat smaller than for agricultural goods because transportation costs are generally a smaller portion of the value of non-agricultural goods than agricultural goods.

The coefficients of the EU dummy variable are statistically significant at the 1 percent level and are positively correlated with bilateral trade volume of non-agricultural goods. However, the coefficients of the NAFTA dummy variable are positively correlated with trade volume but are not significant. The positive relationship indicates that regional free trade agreements increase trade volume through trade creation and

diversion effects. The EU is more important than NAFTA for non-agricultural trade, mainly because the EU member countries are more specialized in production on the basis of their resource endowments compared to the NAFTA countries. These findings are similar to those for trade of aggregated goods.

Common language is positively correlated with bilateral trade volume of non-agricultural goods, and the relationship is statistically significant. These findings are similar to those for trade of agricultural commodities. As mentioned in the previous section, firms are much more comfortable in trading goods with countries who share a common language. Common language helps communication between producers and consumers. Common border is positively related to bilateral trade volume of non-agricultural goods but the relationship is not significant. The distance variable reflects the effect of a common border on trade.

Table 3. Estimated coefficients of the gravity model for non-agricultural goods, 1997-2001

	1997	1998	1999	2000	2001
Exporter's Per	0.585[a]	0.587[a]	0.540[a]	0.542[a]	0.522[a]
Capita GDP	(10.17)	(9.54)	(8.32)	(8.37)	(7.23)
Importer's Per	0.368[a]	0.422[a]	0.400[a]	0.345[a]	0.376[a]
capita GDP	(6.37)	(6.75)	(5.98)	(5.28)	(5.42)
Exporter's Total	0.054	0.066[c]	0.086[b]	0.084[b]	0.062
Area	(1.53)	(1.89)	(2.54)	(2.42)	(1.65)
Importer's Total	0.192[a]	0.207[a]	0.240[a]	0.236[a]	0.214[a]
Area	(5.54)	(5.83)	(6.61)	(6.59)	(5.61)
Tel-com Invest	0.920[a]	0.898[a]	0.885[a]	0.851[a]	0.796[a]
(Exporters)	(24.78)	(20.68)	(18.71)	(19.27)	(17.73)
Tel-com Invest	0.689[a]	0.662[a]	0.667[a]	0.686[a]	0.651[a]
(Importers)	(22.36)	(19.08)	(20.39)	(20.12)	(18.05)
Distance	-1.152[a]	-1.138[a]	-1.201[a]	-1.206[a]	-1.203[a]
	(-19.62)	(-20.24)	(-20.60)	(-20.85)	(-20.09)
EU	0.364[a]	0.251[a]	0.349[a]	0.360[a]	0.217[b]
	(4.72)	(2.88)	(3.97)	(3.99)	(2.37)
NAFTA	0.820[a]	0.410	0.381	0.139	0.160
	(2.58)	(1.47)	(1.33)	(0.54)	(0.70)
LANG	0.395[a]	0.565[a]	0.501[a]	0.413[a]	0.607[a]
	(2.91)	(4.57)	(3.97)	(3.25)	(4.78)
BORDER	0.117	0.185	0.182	0.209[c]	0.194
	(0.93)	(1.49)	(1.31)	(1.67)	(1.55)
Constant	-2.773[a]	-3.433[a]	-3.090[a]	-2.332[b]	-0.966
	(-3.13)	(-3.65)	(-3.22)	(-2.48)	(-0.91)
Number of					
Observations	702	702	702	702	702
Adj-R^2	0.839	0.809	0.799	0.789	0.771

Notes: Numbers in parenthesis are t-statistics using White's heteroskedasticity-consistent standard errors; **a**, **b**, and **c** denote significance at the 1, 5, and 10 percent level.

4.4. Structural Changes

This paper examines whether structural changes exist between trade flows in the 1997-2000 periods and that of 2001. The restricted and unrestricted F-tests are used. The four null hypotheses are:

1. the estimated coefficients in 1997 = the estimated coefficients in 2001
2. the estimated coefficients in 1998 = the estimated coefficients in 2001
3. the estimated coefficients in 1999 = the estimated coefficients in 2001
4. the estimated coefficients in 2000 = the estimated coefficients in 2001

Using the following F-statistics developed by Chow, the null hypotheses are tested as follows:

(1) Calculate the sum of squared errors (SSE) of the unrestricted model which is the sum of SSE_t and SSE_{2001}.

The degree of freedom associated with the unrestricted (UR) model is (n-k) + (m-K) = n + m – 2k.

(2) Calculate the SSE for the restricted model. Under the assumption that the null hypothesis is true, the regression model can be written by adding the data below the two models as

$$Y_h^* = \beta_1^* + \beta_2^* X_{h2}^* + ... + \beta_k^* X_{hk}^* + e_i^*, \qquad \text{h} = 1, 2, \ldots, \text{n} + \text{m} \qquad (16)$$

Run this restricted model and calculate SSE_R

(3) Calculate the value of F-statistic as follows:

$$F_{k,m+n-2k} = \frac{(SSE_R - SSE_{UR})/k}{SSE_{UR}/(m+n-2k)}. \quad (17)$$

(4) Find the critical F-value at the α percent significant level and compare it with the calculated F-value equation (17) to test the null hypothesis.

Table 4 shows the results of the F-tests. The tests indicate that there are no structural changes for trade flows in 1997 and 1998 compared to those in 2001. However, the tests reject the null hypotheses that there are no structural changes between trade flows in 1999 and 2000 and those in 2001. These imply that there are more significant changes in trade flows in 1999 and 2000 compared to those in 2001 than the earlier period.

For the agricultural trade model, the F-tests accept the null hypotheses that there are no structural changes in the 1997-2001 periods (Table 5). However, for the non-agricultural trade model, the hypotheses are rejected (Table 6). The tests indicates that agricultural trade has not been changed significantly as a result of changes in the independent variables, income, the size of country, investment on the telecommunication industry. These variables have influenced bilateral trade flows of non-agricultural goods for the period.

Table 4. The F-Test for structural change in total trade

	F-value	Critical value	Decision
1997 vs. 2001	1.84[c]	2.10	Fail to reject H_0
	(0.09)	(5%)	
1998 vs. 2001	1.01[b]	2.10	Fail to reject H_0
	(0.41)	(5%)	
1999 vs. 2001	3.01[a]	2.80	Reject H_0
	(0.00)	(1%)	
2000 vs. 2001	2.40[a]	2.10	Reject H_0
	(0.03)	(1%)	

Notes: Numbers in parenthesis are p-value; **a**, **b**, and **c** denote significance at the 1, 5, and 10 percent levels.

Table 5. The F-Test for structural change in agricultural trade

	F-value	Critical value	Decision
1997 vs. 2001	0.68	2.10	Fail to reject H_0
	(0.67)	(5%)	
1998 vs. 2001	0.36	2.10	Fail to reject H_0
	(0.90)	(5%)	
1999 vs. 2001	0.38	2.10	Fail to reject H_0
	(0.89)	(5%)	
2000 vs. 2001	0.92	2.10	Fail to reject H_0
	(0.48)	(5%)	

Notes: Numbers in parenthesis are p-value; **a**, **b**, and **c** denote significance at the 1, 5, and 10 percent levels.

Table 6. The F-Test for structural change in non-agricultural trade

	F-value	Critical value	Decision
1997 vs. 2001	2.12[b]	2.10	Reject H_0
	(0.05)	(5%)	
1998 vs. 2001	1.09	2.10	Fail to reject H_0
	(0.37)	(5%)	
1999 vs. 2001	2.91[a]	2.80	Reject H_0
	(0.00)	(1%)	
2000 vs. 2001	2.24[b]	2.10	Reject H_0
	(0.04)	(5%)	

Notes: Numbers in parenthesis are p-value; **a**, **b**, and **c** denote significance at the 1, 5, and 10 percent levels.

5. Conclusions

The recent development of the telecommunication industries that form the environment of information structure has enhanced economic activity through improved information technology (IT). Information technology is also an important factor in the recent acceleration in productivity growth. IT could enlarge the volume of information flow, which accelerates productivity, but its impact on international trade has hardly been tested.

In addition, IT reduces entry costs in market and provides firms with greater freedom of entry and exit. On the other hand, importers can reduce search costs in the market. Thus, improved information flow makes markets more competitive and efficient by reducing transaction costs and employing the hysteresis effect.

The investment in telecommunication by a country is one of the factors affecting the country's information structure. Most previous studies have analyzed the total volume

of trade as a function of changes in infrastructure. These studies did not differentiate agricultural trade from manufactured commodity trade. There is no literature analyzing the role of IT in the international trade of agricultural goods.

Transportation infrastructure is generally considered a more important variable affecting agricultural trade as transportation costs because it connects production and consumption areas Moreover, the transportation costs of agricultural commodities are much higher than those for non-agricultural commodities, relative to the prices of commodities. Since most agricultural goods are necessities, they may not be influenced by the commercial environment or level of education of the workers. In the other view, even though the prices of agricultural products are not influenced by a better transportation infrastructure, the volume of agricultural trade may be continuously increased as aggregated international products.

A modified gravity-type model is employed in this study. The gravity model has been extensively applied to identify factors affecting international trade flows from exporting countries to importing countries (Tinbergen, 1962; Anderson, 1979; Bergstrand 1985 and 1989). In a typical gravity model, the dependent variable is the bilateral trade value between two countries and the independent variables are incomes and sizes in both the exporting and importing countries and the distances between them. In addition, the model usually includes dummy variables representing a common border, language, or

free trade agreements. Our study revises the traditional gravity model by including variables representing the telecommunication infrastructure in exporting and importing countries to evaluate the effect of the recent development in the telecommunication infrastructure on bilateral trade of agricultural and non-agricultural goods among the OECD countries.

The results indicate that per capita GDPs, geographical sizes, and telecommunication investments in both exporting and importing countries are significant and positively related to the value of bilateral trade between them. In agricultural trade, the investment in telecommunication in importing countries is more important than that of exporting countries. The geographical size of the exporting country is more important in agricultural trade than that of the importing country; but it is not the case in non-agricultural trade. This indicates that land is one of essential factors in agricultural trade. In non-agricultural trade, telecommunication investment of the exporting country is more important than that of the importing country. Moreover, the size of the selling market (exporting country) is more important than that of the importing country, relative to non-agricultural trade. In addition, the distance between trading countries is significant and negatively related to the bilateral trade value. The other dummy variables, representing the EU, NAFTA, common language, and common border, are also significant and positively related to bilateral trade values.

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