

EXPORT VARIETY AND INTRA-INDUSTRY TRADE: THEORETICAL AND EMPIRICAL EVIDENCE

Yoko Oguro, Meikai University

ABSTRACT

This paper theoretically and empirically investigates the relationship between the number of product varieties and the extent of intra-industry trade (IIT). IIT provides more trade opportunities for countries in which differentiated products are produced. The model presented shows that the extent of bilateral IIT is higher the smaller the gap in the number of export varieties between two countries. The empirical analysis of Japan and twenty-five countries provides support for the theoretical model presented in this paper. The theory also shows that similar number of export varieties between two countries, that is, more IIT can be a tool to redress trade imbalance between two countries. The policy implication of the results is that promoting higher product variety will increase the opportunity for IIT regardless of country specific effects.

JEL: F00, F10, F14, F19

KEYWORDS: Export Variety, Trade, Intra-Industry Trade

INTRODUCTION

This paper theoretically and empirically investigates the relationship between the number of product varieties and the extent of intra-industry trade (IIT). IIT provides more trade opportunities for countries in which differentiated products are produced, and has become to play a key role in the world in concert with the global economic integration. The model presented shows that the extent of bilateral IIT is higher the closer the number of export varieties between two countries. The theory also shows that more IIT can play a role in redressing trade imbalance between two countries. The empirical analysis of Japan and twenty-five countries for the electrical and optical equipment industry provides support for the theoretical model presented in this paper, and shows that more export variety is associated with more IIT regardless of country specific effects. The remainder of the paper is organized as follows. The next section discusses earlier literature in the field. Data and Methodology section describes the data used in this paper and the theoretical model developed in the paper. The empirical results are presented and discussed in the following section. The paper closes with some concluding comments.

LITERATURE REVIEW

Product variety plays a key role in the theories of monopolistic competition and trade. The theoretical model of monopolistic competition established by a series of early works such as Dixit and Stiglitz (1977) and Krugman (1979). After the establishment of monopolistic competition model, a lot of research that shows the importance of product variety has been done. Hummels and Klenow (2005) and Schott (2004) found that product variety plays an important role in trade. Broda and Weinstein (2006) showed the "gains from variety" by analyzing the U.S. imports. Productivity growth is of great interest to the world in order to maintain the sustainability of growth. Several studies found the link between export variety and productivity. Feenstra et al (1999) investigated South Korea and Taiwan, and by Funke and Ruhwedel (2001a, 2001b, 2002) analyzed the OECD and the East Asian countries. Feenstra and Kee (2008) investigated 48 countries from 1980 to 2000, and the confirmed the positive correlation between export variety and productivity growth. Oguro (2014) reevaluated the relationship between export variety and productivity for exports from 25 countries, which are the subject countries in this paper, to Japan.

Export variety often cannot simply be counted since the product categories of data are modified from time to time. This modification occurs in the Harmonized Commodity Description Coding System (HS) of the United Nations Commodity Trade Statistics Database (Comtrade database), which is used in this paper, as well. In addition, the most detailed data available for the HS Comtrade database are 6-digit-based. Feenstra and Kee (2004) provide the measurement of product variety in trade. However, there exist studies that calculate product variety by counting such as Gagnon (2007), Funke and Ruhwedel (2005), Frensch and Wittich (2009). This paper is the first investigation that shows the link between product variety and intra-industry trade. However, there exist studies that investigate intra-industry trade under the framework of monopolistic competition such as Melitz (2003), Oguro, Fukao, and Khatri (2008), and Oguro (2011).

DATA AND METHODOLOGY

Table 1 shows subject countries analyzed in this research. Twenty-five countries are selected based on the Industry-specific Real Effective Exchange Rate database produced by International Macroeconomics Research Program at The Research Institute of Economy, Trade and Industry (RIETI). This paper empirically analyzes Japan and the twenty-five countries shown in Table 1.

Table 1: Subject Countries

No.	Country	Code	No.	Country	Code
1	Australia	AUS	14	Malaysia	MYS
2	Belgium	BLX	15	Netherlands	NLD
3	Canada	CAN	16	Norway	NOR
4	China	CHN	17	Philippines	PHL
5	Germany	DEU	18	Russian Federation	RUS
6	Spain	ESP	19	Singapore	SGP
7	France	FRA	20	Sweden	SWE
8	Greece	GRC	21	Thailand	THA
9	Indonesia	IDN	22	Turkey	TUR
10	India	IND	23	United Kingdom	UK
11	Ireland	IRL	24	USA	USA
12	Italy	ITA	25	South Africa	ZAF
13	Rep. of Korea	KOR			

Source: <http://www.rieti.go.jp/users/eeri/> Table 1 shows subject countries analyzed in this research. This paper empirically analyzes Japan and the twenty-five countries.

The value of exports data are taken from the Harmonized Commodity Description Coding System (HS) 1996 of the United Nations Commodity Trade Statistics Database (Comtrade database). The degree of IIT for each trading pair for the industry is calculated using the HS 1996 6-digit-based Comtrade database, which is the most detailed data available. The HS1996 6-digit-based extent-of-IIT data for each pair of countries are aggregated into the industry weighted by trade values. The discussion in this paper is limited to the electrical and optical equipment industry. This paper, at first, adapts and summarizes the measure method of product variety developed by Feenstra and Kee (2004). In the next step, the paper provides an extension of Feenstra and Kee (2004) model, and provides the theoretical relationship between intra-industry trade and product variety, which is the contribution of the paper. Assume that country c ($c = 1, \dots, C$) produces various varieties. The set of goods that is produced in country c in year t is $I_t^c \subset \{1,2,3, \dots\}$. The quantity of product varieties i ($i \in I_t^c$) is q_{it}^c ($q_{it}^c > 0$), and the vector of goods produced in country c in period t is denoted by $\mathbf{q}_t^c > \mathbf{0}$. The total output of country c , Q_t^c , is characterized by the following CES function. (The studies of import variety such as Feenstra (1994) and Broda and Weinstein (2006) assume $\sigma > 1$.)

$$Q_t^c = f(\mathbf{q}_t^c, I_t^c) = \left(\sum_{i \in I_t^c} a_i (q_{it}^c)^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \tag{1}$$

$$a_n > 0 \quad c = 1, \dots, C$$

$-\infty < \sigma < 0$: elasticity of substitution among product varieties

The total production of the economy is constrained by the following transformation curve.

$$F[f(q_t^c, I_t^c), V_t^c] = 0 \tag{2}$$

$V_t^c = (v_{1t}^c, v_{2t}^c, \dots, v_{Mt}^c) > 0$: the endowment vector of country c in year t

Each country c obtains the value of output $P_t^c Q_t^c$ under the assumption of perfect competition and equation

(1). P_t^c is denoted by the CES function of the prices of all product varieties as follows.

$$P_t^c \equiv c(p_t^c, I_t^c) = \left(\sum_{i \in I_t^c} b_i (p_{it}^c)^{1-\sigma} \right)^{1/(1-\sigma)} \tag{3}$$

$b_i = a_i^\sigma > 0 \quad c = 1, \dots, C \quad p_t^c > 0$: domestic price vector of each country c

$$\frac{P_t^{c_1}}{P_t^{c_2}} = \prod_{i \in I_t} \left(\frac{p_{it}^{c_1}}{p_{it}^{c_2}} \right)^{w_{it}(I_t)} \left(\frac{\lambda_t^{c_1}(I_t)}{\lambda_t^{c_2}(I_t)} \right)^{1/(\sigma-1)} \quad c_1, c_2 = 1, \dots, C \quad I_t \equiv (I_t^{c_1} \cap I_t^{c_2}) \neq \emptyset \tag{4}$$

Equation (4) is equal to the ratio of the CES cost functions between countries c_1 and c_2 . (See Feenstra (1994), Diewert (1976), Sato (1976), and Vartia (1976) for details.) The weights $w_{it}(I_t)$ in equation (4) is the revenue shares as follows.

$$w_{it}(I_t) \equiv \left(\frac{s_{it}^{c_1}(I_t) - s_{it}^{c_2}(I_t)}{\ln s_{it}^{c_1}(I_t) - \ln s_{it}^{c_2}(I_t)} \right) / \sum_{i \in I_t} \left(\frac{s_{it}^{c_1}(I_t) - s_{it}^{c_2}(I_t)}{\ln s_{it}^{c_1}(I_t) - \ln s_{it}^{c_2}(I_t)} \right) \tag{5}$$

$c_1, c_2 = 1, \dots, C$

$$s_{it}^c(I_t) \equiv p_{it}^c q_{it}^c / \sum_{i \in I_t} p_{it}^c q_{it}^c \tag{6}$$

$c = c_1, c_2$

$$\lambda_t^c(I_t) = \frac{\sum_{i \in I_t} p_{it}^c q_{it}^c}{\sum_{i \in I_t^c} p_{it}^c q_{it}^c} = 1 - \frac{\sum_{i \in I_t^c, i \notin I_t} p_{it}^c q_{it}^c}{\sum_{i \in I_t^c} p_{it}^c q_{it}^c} \tag{7}$$

$c = c_1, c_2$

The term, $(\lambda_t^{c_1}(I_t) / \lambda_t^{c_2}(I_t))^{1/(\sigma-1)}$, in equation (4) shows changes in product variety developed by

Feenstra and Kee (2004).

The complete set of the export varieties exported from the world (*) to the world (*) is $I_t^* = \cup_{c=1}^C I_t^c$, and the total export value of product variety i is $p_{it}^* q_{it}^*$. Comparing exports from country c to the world (*) and exports from the world (*) to the world (*), the common set of goods exported I_t is $(I_t^c \cap I_t^*) = I_t^c$. Thus, the equations (8) and (9) are derived from equation (7).

$$\lambda_t^{c1}(I_t) \equiv \lambda_t^c(I_t) = \lambda_t^c(I_t^c) = \frac{\sum_{i \in I_t} p_{it}^c q_{it}^c}{\sum_{i \in I_t^c} p_{it}^c q_{it}^c} = \frac{\sum_{i \in I_t^c} p_{it}^c q_{it}^c}{\sum_{i \in I_t^c} p_{it}^c q_{it}^c} = 1 \tag{8}$$

$$\lambda_t^{c2}(I_t) \equiv \lambda_t^*(I_t) = \lambda_t^*(I_t^c) = \frac{\sum_{i \in I_t} p_{it}^* q_{it}^*}{\sum_{i \in I_t^*} p_{it}^* q_{it}^*} = \frac{\sum_{i \in I_t^c} p_{it}^* q_{it}^*}{\sum_{i \in I_t^*} p_{it}^* q_{it}^*} = 1 - \frac{\sum_{i \in I_t^*, i \notin I_t^c} p_{it}^* q_{it}^*}{\sum_{i \in I_t^*} p_{it}^* q_{it}^*} \tag{9}$$

$c = 1, \dots, C$

$(\lambda_t^{c1}(I_t)/\lambda_t^{c2}(I_t))^{1/(\sigma-1)} \equiv (\lambda_t^c(I_t)/\lambda_t^*(I_t))^{1/(\sigma-1)}$ in equation (4) can be rewritten as follows.

$$\left(\frac{\lambda_t^c(I_t^c)}{\lambda_t^*(I_t^c)}\right)^{1/(\sigma-1)} = \left(\frac{1}{\lambda_t^*(I_t^c)}\right)^{1/(\sigma-1)} = (\lambda_t^*(I_t^c))^{1/(1-\sigma)} \tag{10}$$

$c = 1, \dots, C$

Therefore, export variety of country c can be measured as the export value from country c to the world (*) relative to the export value from the world (*) to the world (*), which is called Feenstra and Kee (2004) method. This paper measures the number of export varieties of each country c extending Feenstra and Kee (2004) empirical method as in equation (11).

$$\frac{\text{Value of exports from country } c \text{ to the world } (*)}{\text{Value of exports from 26 subject countries to the world } (*)} \tag{11}$$

In this paper, it is implicitly assumed that a certain portion η of the aggregate production is exported. The assumption is not explicitly explained in Feenstra and Kee (2004). This paper defines the degree of intra-industry trade (IIT) between countries a and b for product variety i as the value of trade overlap as in equation (12). (Several previous studies such as Fukao, Ishido and Ito (2003); Greenaway, Hine and Milner (1995); Fontagné, Freudenberg and Péridy (1997); Oguro, Fukao and Khatri (2008); and Oguro (2011) use the same definition of IIT. Another famous IIT measure is Grubel and Lloyd (1975) index.)

$$IIT_{it}^{ab} = \frac{Min(EX_{it}^{ab}, EX_{it}^{ba})}{Max(EX_{it}^{ab}, EX_{it}^{ba})} \equiv \frac{Min(\sum_{i \in I_t^a} p_{it}^{ab} q_{it}^{ab}, \sum_{i \in I_t^b} p_{it}^{ba} q_{it}^{ba})}{Max(\sum_{i \in I_t^a} p_{it}^{ab} q_{it}^{ab}, \sum_{i \in I_t^b} p_{it}^{ba} q_{it}^{ba})} \tag{12}$$

$a, b = 1, \dots, C$

EX_{it}^{ab} ($= \sum_{i \in I_t^a} p_{it}^{ab} q_{it}^{ab}$) shows the value of exports from country a to country b, and EX_{it}^{ba} ($= \sum_{i \in I_t^b} p_{it}^{ba} q_{it}^{ba}$) shows the value of exports from country b to country a. IIT_{it}^{ab} takes a value between 0 and 1. IIT_{it}^{ab} is equal to zero when there is no IIT between country a and country b, whereas IIT_{it}^{ab} becomes one when the value of trade overlap is exactly the same between two countries. This paper now shows the relationship between IIT and product variety. Equation (12) can be developed as follows assuming $EX_{it}^{ab} < EX_{it}^{ba}$ and using equations (8) and (10). The paper defines exports from one country to another country as exports from an exporting country to the world times an importer's share in the world market as shown in equation (13). Equation (13) can be rewritten as equation (14) using two countries' export variety.

$$\begin{aligned} IIT_{it}^{ab} &= \left(\frac{\text{Value of exports from country a to country b}}{\text{Value of exports from country b to country a}} \right) \\ &= \left(\frac{EX_{it}^{ab}}{EX_{it}^{ba}} \right) \\ &\equiv \left[\frac{(\text{Value of exports from country a to the world } (*)) \cdot (\text{country b's share in the world market})}{(\text{Value of exports from country b to the world } (*)) \cdot (\text{country a's share in the world market})} \right] \tag{13} \\ &\equiv \left[\frac{(\text{Value of exports from country a to the world } (*)) \cdot (\text{country b's share in the world market})}{(\text{Value of exports from country b to the world } (*)) \cdot (\text{country a's share in the world market})} \right] \\ &\equiv \left[\frac{EX_{it}^{a*} \cdot \left(\frac{\text{Value of exports from the world } (*) \text{ to country b}}{\text{Value of exports from the world } (*) \text{ to the world } (*)} \right)}{EX_{it}^{b*} \cdot \left(\frac{\text{Value of exports from the world } (*) \text{ to country a}}{\text{Value of exports from the world } (*) \text{ to the world } (*)} \right)} \right] = \left[\frac{EX_{it}^{a*} \cdot \left(\frac{EX_{it}^{*b}}{EX_{it}^{**}} \right)}{EX_{it}^{b*} \cdot \left(\frac{EX_{it}^{*a}}{EX_{it}^{**}} \right)} \right] \\ &= \left[\frac{\left(\frac{EX_{it}^{a*}}{EX_{it}^{**}} \right) \cdot (EX_{it}^{*b})}{\left(\frac{EX_{it}^{b*}}{EX_{it}^{**}} \right) \cdot (EX_{it}^{*a})} \right] \\ &= \left[\frac{(\text{country a's export variety}) \cdot (EX_{it}^{*b})}{(\text{country b's export variety}) \cdot (EX_{it}^{*a})} \right] \tag{14} \\ &= \left[\frac{(EX_{it}^{a*}) \cdot (EX_{it}^{*b})}{(EX_{it}^{b*}) \cdot (EX_{it}^{*a})} \right] \end{aligned}$$

$$= \left[\frac{\left(\frac{\sum_{i \in I_t^a} p_{it}^* q_{it}^*}{\sum_{i \in I_t^*} p_{it}^* q_{it}^*} \right) \cdot (\sum_{i \in I_t^*} p_{it}^{*b} q_{it}^{*b})}{\left(\frac{\sum_{i \in I_t^b} p_{it}^* q_{it}^*}{\sum_{i \in I_t^*} p_{it}^* q_{it}^*} \right) \cdot (\sum_{i \in I_t^*} p_{it}^{*a} q_{it}^{*a})} \right] = \left[\frac{(\sum_{i \in I_t^a} p_{it}^* q_{it}^*) \cdot (\sum_{i \in I_t^*} p_{it}^{*b} q_{it}^{*b})}{(\sum_{i \in I_t^b} p_{it}^* q_{it}^*) \cdot (\sum_{i \in I_t^*} p_{it}^{*a} q_{it}^{*a})} \right] \tag{15}$$

$a, b = 1, \dots, C$

Partial derivatives of equation (14) with respect to country a’s export variety are positive (Equation (16)). Thus, the extent of IIT between countries a and b is higher the higher the export variety of country a. That is, the theoretical model presented shows that IIT_{it}^{ab} approaches one as the number of export varieties between two countries gets closer.

$$\frac{\partial IIT_{it}^{ab}}{\partial(\text{country a's export variety})} > 0 \tag{16}$$

Consider the case $IIT_{it}^{ab} = 1$ using equation (15). Equation (17) is the expanded form of equation (15).

$$\frac{\left(\frac{\sum_{i \in I_t^a} p_{it}^* q_{it}^*}{\sum_{i \in I_t^*} p_{it}^* q_{it}^*} \right)}{\left(\frac{\sum_{i \in I_t^b} p_{it}^* q_{it}^*}{\sum_{i \in I_t^*} p_{it}^* q_{it}^*} \right)} = \frac{\sum_{i \in I_t^*} p_{it}^{*a} q_{it}^{*a}}{\sum_{i \in I_t^*} p_{it}^{*b} q_{it}^{*b}} = \frac{\sum_{i \in I_t^a} p_{it}^* q_{it}^*}{\sum_{i \in I_t^b} p_{it}^* q_{it}^*} \tag{17}$$

$a, b = 1, \dots, C$

$\frac{\text{country a's export variety}}{\text{country b's export variety}}$

$$= \frac{\text{Value of exports from the world (*) to country a}}{\text{Value of exports from the world (*) to country b}} = \frac{(EX_{it}^{*a})}{(EX_{it}^{*b})}$$

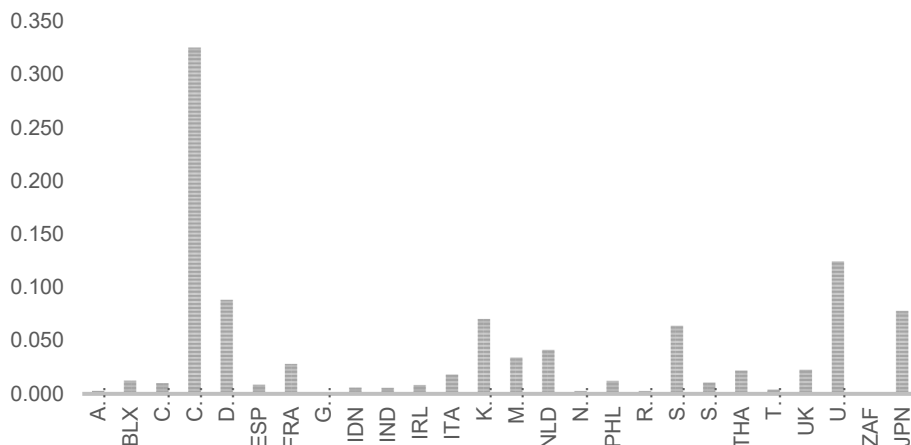
$$= \frac{\text{Value of exports from country a to the world (*)}}{\text{Value of exports from country b to the world (*)}} = \frac{(EX_{it}^{a*})}{(EX_{it}^{b*})} \tag{18}$$

Equations (17) and (18) show that the theory developed in this paper also suggests that similar number of export varieties between two countries, that is, more IIT can be a tool to redress trade imbalance between two countries.

RESULTS

Figure 1 shows the number of product varieties of Japan’s and the twenty-five countries’ exports in the electrical and optical equipment industry in 2012. The number of export varieties is measured using equation (11), that is, the value of exports from country c to the world (*) relative to the value of exports from the twenty-six countries to the world (*). Equation (11) is the empirical measure, which is the application of equation (10). The value of exports data are taken from the HS 1996 of Comtrade database. China has the largest number of export varieties. Japan is the fourth largest among the twenty-six countries.

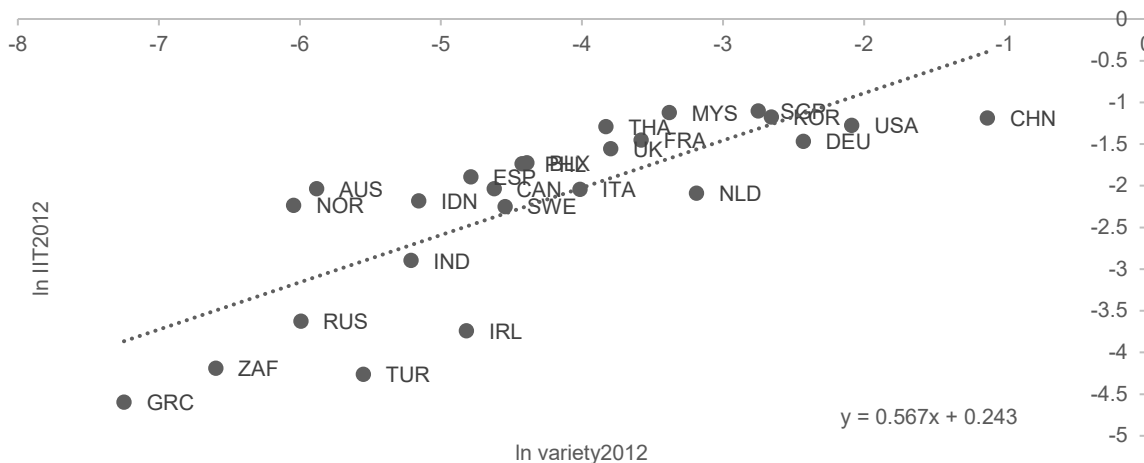
Figure 1: Export Variety (Electrical and Optical Equipment, 2012)



Data source: Comtrade HS 1996 This figure shows the number of product varieties of Japan's and the twenty-five countries' exports in the electrical and optical equipment industry in 2012. The number of export varieties is measured using equation (11).

Figure 2 shows the plot of the logarithm of export variety and the logarithm of IIT in 2012 for the electrical and optical equipment industry. IIT is measured as the bilateral trade between Japan and one of the twenty-five countries using equation (12). The degree of IIT for each trading pair for the industry is calculated using the HS 1996 6-digit-based Comtrade database, which is the most detailed data available. The HS1996 6-digit-based extent-of-IIT data for each pair of countries are aggregated into the industry weighted by trade values.

Figure 2: Plot of Export Variety and Intra-Industry Trade (IIT) (Electrical and Optical Equipment, 2012)



Data source: HS 1996 6-digit-based Comtrade database This figure shows the plot of the logarithm of export variety and the logarithm of IIT in 2012 for the electrical and optical equipment industry. IIT is measured as the bilateral trade between Japan and one of the twenty-five countries using equation (12). The results confirm the theoretical model, especially equation (16), since it demonstrates the positive correlation between the number of export varieties and IIT.

Table 2 shows the results of the OLS estimation of the data in Figure 2. This paper simply regresses the logarithm of IIT on the logarithm of export variety. The estimated coefficient of $\ln IIT_{2012}$ is positive as expected, and is significantly different from zero at 1 percent level. Therefore, a one percent increase in the number of export varieties results in a 0.567 percent increase in the degree of IIT in 2012 for the electrical and optical equipment industry. The results of Figure 2 and Table 2 confirm the theoretical model, especially equation (16), since it demonstrates the positive correlation between the number of export

varieties and IIT regardless of country specific effects.

Table 2: Result of OLS (Electrical and Optical Equipment, 2012)

Dependent Variable: ln IIT2012	
ln variety2012	0.567 *** (6.23)
Constant	0.243 (0.59)
Number of obs	25
R ²	0.628
Adj. R ²	0.612
***: significant at 1% level (): t value	

This table shows the results of the OLS estimation of the data in Figure 2. The estimated coefficient of ln IIT2012 is positive as expected, and is significantly different from zero at 1 percent level. A one percent increase in the number of export varieties results in a 0.567 percent increase in the degree of IIT in 2012 for the electrical and optical equipment industry.

CONCLUDING COMMENTS

The objective of this paper is to discuss the relationship between the number of product varieties and the extent of intra-industry trade (IIT). The paper adapts the measure method of product variety developed by Feenstra and Kee (2004), and provides an extension of Feenstra and Kee (2004) model to derive the theoretical relationship between intra-industry trade and product variety, which is the contribution of the paper. In the empirical analysis, the value of exports data are taken from the Harmonized Commodity Description Coding System (HS) 1996 of the United Nations Commodity Trade Statistics Database (Comtrade database). The degree of IIT for each trading pair for the industry is calculated using the HS 1996 6-digit-based Comtrade database, which is the most detailed data available. The model presented in this paper shows that the extent of bilateral IIT is higher the smaller the gap in the number of export varieties between two countries. The theory also shows that similar number of export varieties between two countries, that is, more IIT can be a tool to redress trade imbalance between two countries. The empirical analysis of Japan and twenty-five countries provides support for the theoretical model presented in this paper. That is, more export variety is associated with more IIT. The policy implication of the results is that promoting higher product variety will increase the opportunity for IIT regardless of country specific effects. The discussion in this paper is limited to Japan and twenty-five countries for the electrical and optical equipment industry in 2012. The additional investigation for different industries and years remains a fertile area for future research.

REFERENCES

- Broda, Christian and David E. Weinstein (2006) "Globalization and the Gains from Variety," *The Quarterly Journal of Economics* vol. 121(2): 541-585.
- Diewert, W. E. (1976) "Exact and superlative index numbers," *Journal of Econometrics* vol. 4(2): 115-145.
- Dixit, Avinash K. and Joseph E. Stiglitz (1977) "Monopolistic Competition and Optimum Product Diversity," *American Economic Review* 67(3): 297-308.
- Feenstra, Robert C (1994) "New Product Varieties and the Measurement of International Prices," *American Economic Review* vol. 84(1): 157-177.
- Feenstra, Robert C., Dorsati Madani, Tzu-Ha Yang, and Chi-Yuan Liang (1999) "Testing endogenous growth in South Korea and Taiwan," *Journal of Development Economics* vol. 60(2): 317-341.
- Feenstra, Robert and Hiau Looi Kee (2004) "On the Measurement of Product Variety in Trade," *American Economic Review* vol. 94(2): 145-149.

Feenstra, Robert and Hiau Looi Kee (2008) "Export variety and country productivity: Estimating the monopolistic competition model with endogenous productivity," *Journal of International Economics* vol. 74(2): 500-518.

Fontagné, Lionel, Michael Freudenberg, and Nicholas Péridy (1997) "Trade Patterns Inside the Single Market," *Working Paper 1997-07*, Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

Frensch, Richard and Vitalija Gaucaite Wittich (2009) "Product variety and technical change," *Journal of Development Economics* vol. 88(2): 242-257.

Fukao, Kyoji, Hikari Ishido, and Keiko Ito (2003) "Vertical Intra-Industry Trade and Foreign Direct Investment in East Asia," *Journal of the Japanese and International Economies* 17(4): 468-506.

Funke, Michael and Ralf Ruhwedel (2001a) "Product Variety and Economic Growth: Empirical Evidence from the OECD Countries," *IMF Staff Papers* 48(2): 225-242.

Funke, Michael and Ralf Ruhwedel (2001b) "Export Variety and Export Performance: Evidence from East Asia," *Journal of Asian Economics* 12: 493-505.

Funke, Michael and Ralf Ruhwedel (2002) "Export Variety and Export Performance: Empirical Evidence for the OECD Countries," *Weltwirtschaftliche Archiv* 138(1): 97-114.

Funke, Michael and Ralf Ruhwedel (2005) "Export variety and economic growth in East European transition economies," *The Economics of Transition* vol. 13(1): 25-50.

Gagnon, Joseph E. Gagnon (2007) "Productive Capacity, Product Varieties, and the Elasticities Approach to the Trade Balance," *Review of International Economics* vol. 15(4): 639-659.

Greenaway, David, Robert C. Hine, and Chris Milner (1995) "Vertical and Horizontal Intra-Industry Trade: A Cross Industry Analysis for the United Kingdom," *The Economic Journal* 105(433): 1505-18.

Grubel, Herbert G. and P.J.Lloyd (1975) *Intra-Industry Trade: The Theory and Measurement of International Trade in Differenced Products*, New York: Wiley.

Hummels, David and Peter J. Klenow (2005) "The Variety and Quality of a Nation's Exports," *American Economic Review* vol. 95(3): 704-723.

Krugman, Paul (1979) "Increasing Returns, Monopolistic Competition, and International Trade," *Journal of International Economics* vol. 9(4): 469-479.

Melitz, Marc J. (2003) "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica* vol. 71(6): 1695-1725.

Oguro, Yoko (2011) "The Sensitivity of Export Quantities to Exchange Rates in the Context of Intra-Industry Trade," *Global COE Hi-Stat Discussion Paper Series* gd10-167, Institute of Economic Research, Hitotsubashi University.

Oguro, Yoko (2014) "Yusyutsuzai Variety to Zenyososeisansei no Saikensyo [Reevaluation of Export Variety and Total Factor Productivity]," *Meikai Economic Review* Vol.27, No.1.

Oguro, Yoko, Kyoji Fukao, and Yougesh Khatri (2008) "Trade Sensitivity to Exchange Rates in the Context of Intra-Industry Trade," *IMF Working Paper* 08/134.

Sato, Kazuo (1976) "The Ideal Log-Change Index Number," *The Review of Economics and Statistics* vol. 58(2), pages 223-28, May.

Schott, Peter K. (2004) "Across-Product Versus Within-Product Specialization in International Trade," *The Quarterly Journal of Economics* vol. 119(2): 647-678.

Vartia, Yrjö (1976) "Ideal log-Change Index Numbers," *Scandinavian Journal of Statistics* 1976; 3: 121-126.

ACKNOWLEDGEMENT

The author acknowledges funding from the 2014-2015 Miyata Research Grant.

BIOGRAPHY

Yoko Oguro is an Associate Professor in the Faculty of Economics, Meikai University. She can be reached at Faculty of Economics, Meikai University, 1 Akemi, Urayasu, Chiba 279-8550, Japan, yoguro@meikai.ac.jp.