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FTAs and the Pattern of Trade: The case of the Japan-Chile FTA[1]

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Abstract

Economists have long sought to explain the pattern of trade by developing international trade theories since the theory of comparative cost/advantage was developed by David Ricardo in the 19th century. Applying the Ricardian continuum goods model developed by Dornbusch, Fischer and Samuelson (1977) and by incorporating contributions from a new new trade theory (heterogeneous firm trade theory), we estimate the impacts of the Japan-Chile free trade agreement (FTA) (JCEPA) on extensive and intensive margins of Japan's exports to Chile. Our results show that the tariff liberalization under the JCEPA increases both extensive and intensive margins of Japan's exports to Chile. We also find that a rise in the ranking of comparative advantage caused by the JCEPA increased extensive margins. These findings indicate the importance of expanding FTA networks and promoting the use of FTAs, in order to increase trade. Governments can contribute to an increase in the use of FTAs by implementing the measures such as disseminating information about the benefits of using FTAs and simplifying the procedure for obtaining the certificate of origin, which is required for using FTAs.

Keywords: Trade liberalization, FTA, Comparative advantage, Resource allocation
JEL Classifications: F130, F140, F150

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1. Introduction

Economists have long sought to explain the pattern of trade by developing international trade theories since the theory of comparative cost/advantage was developed by David Ricardo in the 19th century. According to the theory of comparative cost developed by Ricardo using the framework of the classical theory, differences in labor productivity are the determining factors for the pattern of comparative advantage. The Heckscher-Ohlin model, which is based on the neo-classical economic framework and is developed by Eli Heckscher and Bertil Ohlin in the 1930s, posits that differences in the endowments of productive factors, i.e., capital and labor, determine the patterns of comparative advantage. New trade theory, which was developed in the 1970s and 1980s, asserts that economies of scale and imperfect competition are important factors determining the pattern of comparative advantage. New trade theory relaxes the assumptions of constant returns to scale and perfect competition, which were adopted in the classical and neo-classical trade models. New new trade theory, which explains the trading patterns at the level of firms rather than sectors/industries, the case for the earlier trade models, was developed in the 2000s.

In order to test the validity of these trade theories in explaining trade patterns, empirical investigation has been conducted extensively. Seminal studies include MacDougal (1951) on the Ricardian model and Leontief (1953) on the Heckscher-Ohlin model. MacDougal finds that the Ricardian model can explain the patterns of trade for the US and the UK, while Leontief finds that the US trade pattern is not consistent with the Heckscher-Ohlin model (the Leontief paradox). One of the problems of these empirical studies is the presence of government intervention in the form of import protection in the real economy. This is because trade models assume free trade, or absence of government intervention.

Considering these developments in empirical studies of the patterns of trade, this paper attempts to explain the impacts of trade liberalization on the patterns of trade. Specifically, based on the Ricardian model of Dornbusch, Fischer and Samuelson (1997), we first derive the theoretical relationship to explain the changes in the patterns of trade by the changes in tariff rates and in comparative advantage. Combining this Ricardian and new new trade theory, we first focus on the gains from trade that are composed of newly traded goods that we refer to as extensive margin. Our Ricardian model predicts that trade liberalization will increase extensive as well as intensive margins, which are measured by an increase in volume of existing export goods, and suggests the possible impact of trade liberalization through the changes in comparative advantage structure. For the study of the impacts of trade liberalization, free trade agreement (FTA) provides an ideal environment, as it eliminates tariffs to result in free trade situation rather than lowering tariff rates, which have been the practices under multilateral trade liberalization under the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) as well as unilateral trade liberalization.

Applying this model, we estimate the impacts of Japan-Chile FTA (JCEPA), which entered into force in 2007, on extensive and intensive margins, by using pre and post FTA product-level tariff, and trade data. Our results show that the tariff elimination/liberalization under the JCEPA increases both extensive and intensive margins of Japan's exports to Chile. We also find that the changes in the pattern of comparative advantage caused by the FTA affect extensive and intensive margins.

The remainder of the paper is organized as follows. Section 2 presents the related literature on trade liberalization and extensive margin. Section 3 provides the model used for our analysis. Section 4 discusses two alternative revealed comparative advantage indices used in our empirical analysis, while section 5 conducts an empirical analysis and discuss the results. Section 6 concludes the paper.

2. Related Literature on Trade Margins

Since trade theories of representative firms with product variety such as Krugman (1980) and Helpman and Krugman (1985) were developed, it has been recognized that an increase in the number of goods traded is an important component of the gains from trade. These representative firm models, however, cannot explain the fact that only a few firms export and what types of firms export. A heterogeneous firm model by Melitz (2003) connects link between exporters and variety of the traded goods by introducing productivity differences among firms which pay a fixed entry cost.[5] With the heterogeneous firm model, Chaney (2008) shows that the size of elasticity of substitution between differentiated goods affects extensive and intensive margins differently, while Arkolakis and Muendler (2010) show the positive relationship between extensive and intensive margins. Chaney also addresses that trade barriers have larger impact on trade flows in the heterogeneous firm model than in the representative firm model.[6] These theoretical developments coupled with an increasing availability of

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[5] Arkolakis et al. (2012), however, show that the difference of welfare gains from trade between Ricardian and Melitz models is small.

[6] Bernard et al. (2007) survey the relationship between trade theories and extensive margins. They also show the evidence that the extensive margin plays an important role for the aggregate trade expansion.

firm-level data accelerated empirical studies on extensive margin of trade[7] and trade liberalization.

One of the early important empirical studies on extensive margin is Feenstra (1994). In that study, Feenstra proposes an exact price index of a CES unit-cost function that incorporates new varieties in order to estimate the true income elasticity of demand. Applying Feenstra's price index, Broda and Weinstein (2006) find that import varieties from 1972 to 2001 in the US expanded by 2.6 percent of GDP.[8] Another important article on this issue is Hummels and Klenow (2005) that proposes the decomposition of total trade into extensive and intensive margins. Using cross-section data, they find that larger economies tend to export more than smaller economies, and the extensive margin plays a crucial role in export expansion.

As Goldberg and Pavcnik (2016) state, however, that among extensive margin literature, there are not many studies that focus on the impact of trade liberalization. Feenstra and Kee (2007), Kihoe and Ruhl (2013), and Hilberry and McDaniel (2002) examine the impact of the North American Free Trade Agreement (NAFTA) on extensive margin and show the positive relationship between tariff reductions and the increase in extensive margin. On the contrary, Debaere and Mostashari (2010), with the US tariff schedule (HTS) data over the period of 1988-2005, find that the tariff reduction has a limited impact on the extensive margin; in fact, only 5-12 percent of the increase in extensive margin can be explained by tariff reductions induced by the NAFTA.

There are some other empirical studies that show the positive relationship between trade liberalization and extensive margin. Foster (2012) studies the effect of preferential trade agreement involving 174 countries over the period of 1962-2000, and finds that a large part of the increase in import growth is explained by the extensive margin. Dutt et al. (2013) examine the pattern of trade for 150 countries over the period of 1962–1999, and find that the participation into the WTO enlarges the extensive margin while it shrinks the intensive margin. On the other hand, Buono and Lalanne (2012) estimate the impact of the Uruguay Round on French firms' export extensive margin over the period 1993-2002, and find that the tariff reduction increases mainly intensive margins, not extensive margins. Our brief survey of the literature revealed no

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7 Fellbermyr and Kohler (2006) define the extensive margin as the number of new markets (countries). Goldberg and Pavcnuk (2016) distinguish between the products and the markets by referring to the latter as "new variety," while Bernard et al. (2007) use the same word for both product and destination varieties.

8 Feenstra (1994) and Broda and Weinstein (2006) do not use the words of "extensive" and "intensive" margins.

conclusive relationship between trade liberalization on the one hand and extensive or intensive margins on the other hand.

3. The Model

We make use of Dornbusch, Fischer, and Samuelson (1977) model, DFS hereafter, to study the impact of FTA on trade of the FTA member countries. We consider a world comprising two countries, Home and Foreign, and a continuum of goods indexed by $z \in [0,1]$. Labor is the only one factor of production that is freely mobile across industries but immobile between countries. Production technology is defined as the constant unit labor requirements of good z in Home and Foreign countries, measured by $a(z)$ and $a^*(z)$ respectively as follows:

$$a(z) = \frac{l(z)}{x(z)}, \quad a^*(z) = \frac{l^*(z)}{x^*(z)}.$$

$l(z)$ and $l^*(z)$ are labor requirements, and $x(z)$ and $x^*(z)$ are outputs of good z in Home and Foreign countries.

Relative opportunity costs of two countries are defined by $A(z)$ that is arranged such that A(z) is a monotonically decreasing in z.

$$A(z) = \frac{a^*(z)}{a(z)}.$$

Competitive market assures $p(z) \cdot x(z) = w \cdot l(z)$ or $p(z) = w \cdot a(z)$ in Home, and $p^*(z) \cdot x^*(z) = w^* \cdot l^*(z)$, or $p^*(z) = w^* \cdot a^*(z)$ in Foreign, where p, p^* are prices, and w, w^* are wage rates and hence marginal costs of production in Home and Foreign countries.

Free trade ensures $p(z) = p^*(z)$ and then leads to $w \cdot a(\tilde{z}) = w^* \cdot a^*(\tilde{z})$. In the equilibrium, the function A must equal to the relative wages of both countries.

$$A(\tilde{z}) \equiv \frac{a^*(\tilde{z})}{a(\tilde{z})} = \frac{w}{w^*} \equiv \omega, \quad (1)$$

where ω is relative wage between home and foreign countries.

Demand is assumed identical Cobb-Douglas function and the expenditure share of good z is b(z). The trade balance hence becomes

$$\int_{\tilde{z}}^{1} b(z)wldz = \int_{0}^{\tilde{z}} b(z)w^* l^* dz.$$

or

$$\omega = \frac{l^*}{l}\frac{\int_0^{\tilde{z}} b(z)dz}{\int_{\tilde{z}}^1 b(z)dz} \tag{2}$$

Equations (1) and (2) solve the equilibrium combination of ω and $\tilde{z}$.

We next introduce symmetric ad valorem tariffs, $\tau, \tau^* > 0$ for analyzing the effects of FTA. Home country's uniform ad valorem tariff τ against foreign good *z* is

$$p(z) = (1+\tau)p^*(z) \leftrightarrow A(z) = \frac{a^*(z)}{a(z)} = \frac{\omega}{(1+\tau)}$$

Symmetrically foreign country's uniform ad valorem tariff τ^* against home good *z* is

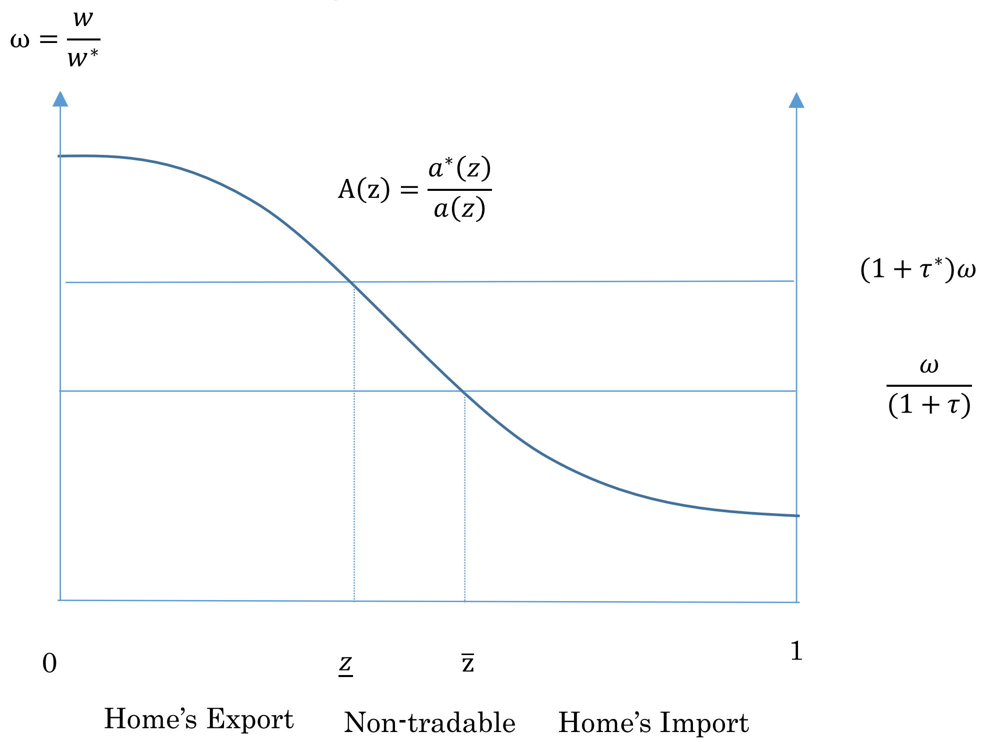
$$(1+\tau^*)p(z) = p^*(z) \leftrightarrow A(z) = \frac{a^*(z)}{a(z)} = (1+\tau^*)\omega$$

These two tariff conditions require the following

$$\begin{cases} (1+\tau^*)\omega < A(z) & \cdots \quad \text{Home exports goods } z \in [0, \underline{z}] \\ \dfrac{\omega}{(1+\tau)} < A(z) < (1+\tau^*)\omega & \cdots \quad \text{Goods } z \in [\underline{z}, \bar{z}] \text{are nontradable} \\ A(z) < \dfrac{\omega}{(1+\tau)} & \cdots \quad \text{Foreign exports goods } z \in [\bar{z}, 1] \end{cases}$$

Equilibrium concept with uniform tariffs is shown in the following figure.

Figure 1



According to the above model, the effect of trade liberalization ($\tau \to 0$, $\tau^* \to 0$) is to narrow (or eliminate) the range of non-tradable goods, by introducing new export goods. If we focus the impact of trade liberalization on home economy, the upper range of home country's exportable goods $\underline{z}$ is defined as equilibrium of $\underline{z}$ and ω:

$$A(\underline{z}) = (1+\tau^*)\omega, \tag{3}$$

or using an implicit function of comparative advantage, we have:

$$\underline{z} = A^{-1}(\tau^*, \omega).$$

This equation shows that the upper range of export goods is a decreasing function of foreign tariff rate, τ^*, and relative wage rate, ω. The relative wage rate ω is an endogenous variable that is determined in the general equilibrium framework. Now we assume demand side condition. Both home and foreign countries' consumers have identical Cobb-Douglas demand function with $b(z)$ as expenditure share for goods z. The trade balance with tariffs therefore can be expressed as:

$$\frac{1-\theta(\bar{z})}{1+\tau}y = \frac{1-\theta^*(\underline{z})}{1+\tau^*}y^*. \tag{4}$$

where

$$\theta(\bar{z}) = \int_0^{\bar{z}} b(z)dz, \quad \theta^*(\underline{z}) = \int_{\underline{z}}^1 b(z)dz.$$

The left side of the equation (4) stands for the imports of home from foreign country and the right side defines the foreign imports from home country. The home and foreign incomes denoted by y and y^* include tariff rebates as in the same way by DFS, such as:

$$y = wl + \frac{1-\theta(\bar{z})}{1+\tau}\tau y, \quad y^* = w^*l^* + \frac{1-\theta^*(\underline{z})}{1+\tau^*}\tau^* y^*$$

The second terms of the right sides of these two equations express lump sum transfers of tariff revenues. Solving these equations for y and y^* and inserting into the trade balance equation (4), we have the following new balance condition.

$$\frac{1-\theta(\bar{z})}{1+\tau\theta(\bar{z})}wl = \frac{1-\theta^*(\underline{z})}{1+\tau^*\theta^*(\underline{z})}w^*l^*,$$

or

$$\omega = \frac{1-\theta^*(\underline{z})}{1-\theta(\bar{z})}\frac{1+\tau\theta(\bar{z})}{1+\tau^*\theta^*(\underline{z})}\frac{l^*}{l}. \tag{5}$$

Equation (5) indicates that the relative wage rate is a function of ranges of exportable goods, tariff rates, and the relative labor abundance of two countries. Equation (5) can be simplified as $\omega = \omega(\theta^*(\underline{z}), \tau^*) = \omega(\underline{z},\ \tau^*)$, where $\theta^*(\underline{z})$ is monotonically decreasing function of $\underline{z}$. Note that a decrease in foreign tariff rate τ^* raises relative wage rate, ω and an increase in the range of home exportable $\underline{z}$ decrease the relative wage rate, or $\partial\omega/\partial\tau^* < 0$ and $\partial\omega/\partial\underline{z} > 0$ (note again that $\partial\theta^*(\underline{z})/\partial\underline{z} < 0$). Equations (3) and (5) solve the equilibrium upper range of home export, $\underline{z}$, and the relative wage rate, ω, endogenously. Now we focus on only the effect of foreign tariff reduction on the home economy. From the relation between $\underline{z}$ and τ^* in the diagram, a declining in foreign tariff rate expands the number of exportable goods from home to foreign country. Equation (3) and (5) give the following relation.

$$A(\underline{z}) = (1+\tau^*)\omega(\underline{z}, \tau^*) \tag{6}$$

This demand and supply equilibrium condition solves the upper range of home country's exportable goods $\underline{z}$. Note that the equation describes the relation between the foreign tariff rate and the upper range of home exportable, not the structure or ranking of comparative advantage.

Changes in comparative advantage

The impact of FTA depends on not only the reduction of tariff rate but also the change in comparative advantage. Even though the relative wage rate and foreign tariff rate do not change, the magnitude or ranking of the function A(z) can affect the trade structure. FTA affects the supply side conditions such as an introduction of new technology, changes in exchange rate and factor prices that in turn affect the structure of comparative advantage.

In order to explicitly analyze the effects by changes of comparative advantage, we form the function of $A(z)$ as the following monotonically decreasing function in z:

$$A(z) = \exp(-\varphi z + \mu),$$

where $\varphi > 0$ determines the curvature of the function and μ defines the horizontal level of the distribution. We assume $\exp(-\varphi + \mu) < (1+\tau^*)\omega < \exp(\mu)$ so that there is a unique equilibrium. Given the level of relative wage and tariff rates, an increase in φ makes the curvature steeper and reduces home's exports. An increase in μ, on the other hand, shifts up the function and hence increases home's exports.

Export growth can be decomposed into two parts: one is extensive margin, and the other is intensive margin that is the growth in export volume per good. While the extensive margin is defined as a change in the number of variety of goods exported, the intensive margin is measured by changes in average trade volume. The growth of total volume of exportable goods can therefore be expressed by $dE = d\underline{z} \times d(E/\underline{z})$. While $\underline{z}$ is the number of exportable goods, the term $\mathrm{d}(E/\underline{z})$ is the average volume of exports. The first term is the extensive margin and the latter equals to the intensive margin.

Intensive margin

Using trade balance condition, an average volume of home's export goods is given by:

$$\frac{E}{\underline{z}} = I(\underline{z}, \tau^*, w^*, l^*) = \frac{1-\theta^*(\underline{z})}{1+\tau^*\theta^*(\underline{z})} \frac{w^* l^*}{\underline{z}} \tag{7}$$

It is obvious from this equation that an increase in foreign income (wage times labor force) raises home's average export volume $E/\underline{z}$ and that the foreign tariff rate inversely correlated with the average volume of export. It is intuitively understood by the definition of intensive margin, $dI = d(E/\underline{z})$ where they are inversely correlated. Same as in the case of extensive margin, the relation between intensive margin and the changes in the comparative advantage remains unknown in our model.

Extensive margin

We now define extensive margin of trade flow. The extensive margin is defined as an incremental number of variety, $d\underline{z}$. Combining this function with equation (6), and taking logarithm and total differentiation, we obtain the following relation:

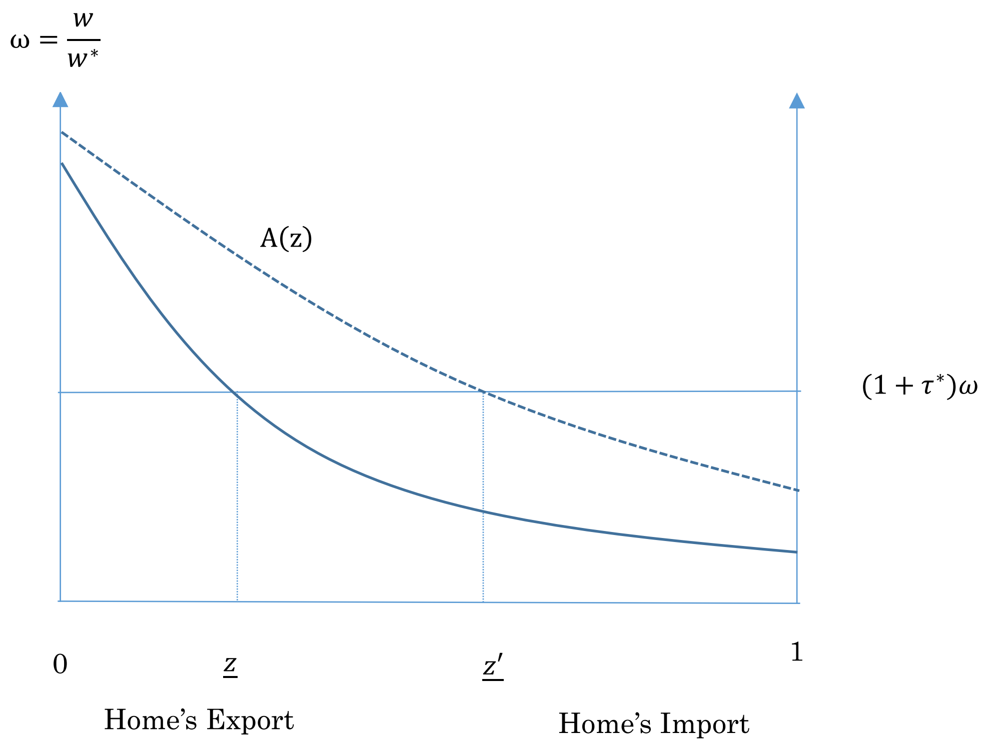
$$d\underline{z} = -\Theta\left(\frac{1}{1+\tau^*} + \frac{1}{\omega}\frac{\partial\omega}{\partial\tau^*}\right) d\tau^* - \Theta\underline{z} d\varphi + \Theta d\mu, \tag{8}$$

where $\Theta = \left(\varphi + \frac{1}{\omega}\frac{\partial\omega}{\partial\underline{z}}\right)^{-1}$.

Equation (7) defines the extensive margin and its components that are changes in foreign tariff and comparative advantage. Since $\partial\omega/\partial\underline{z}$ is positive from the previous arguments, Θ must be positive. The first term of the right side of the equation (7) indicates that the impact of tariff change on the extensive margin is negative if wage effect of tariff changes is small enough to keep the inside of the parenthesis is positive noting that $\partial\omega/\partial\tau^* < 0$. This situation is inferred from the Figure 1.

The effects of changes in comparative advantage are captured by the terms $d\varphi$ and $d\mu$. Coefficients of these two terms are $-\Theta\underline{z} < 0$ and $\Theta > 0$, respectively. In other word, φ negatively affects the extensive margin while μ increases the extensive margin. Figure 2 illustrates the possible situation of the changes in comparative advantage. φ changes the curvature of the function and as it becomes smaller, $\underline{z}$ increases. μ shifts up the function and therefore increases the extensive margin. New A(z) function is described by the dotted line in Figure 2.

Figure 2



To test our hypotheses and estimate the effects of FTA on extensive and intensive margins, we conduct an empirical study in the next section using Chile's tariff data which are almost uniform at the level of 6%.

4. Revealed Comparative Advantage Indices

A theoretical analysis in the previous section showed that the impacts of FTAs on the pattern of trade depend on the level of tariff reduction and the pattern of comparative advantage. This section discusses two alternative indices of revealed comparative advantage, which are used in our analysis to capture the pattern of comparative advantage. In empirical trade research, Balassa's "revealed comparative advantage" (RCA) index has been widely used (Balassa 961965). It is measured as:

$$BRCA_{ij} \equiv \frac{E_{ij}}{E_j} \Big/ \frac{E_i}{E_w}, \tag{9}$$

where E_{ij} denotes country i's exports of commodity j, E_j denotes exports of commodity j by all countries, E_i denotes country i's exports of all commodities, and

E_w denotes exports of all commodities by all countries. The numerator represents country i's market share in commodity j's export market, whereas the denominator represents country i's market share in the world export market. Where the BRCA is greater than unity, the country is said to show specialization in that commodity, revealing its comparative advantage. Yu *et al.* (2009) point out that this index has a bias to indicate strong comparative advantage for commodities which comprise a small market share of the world export market (E_j/E_w). Yu *et al.* (2009) also argue that the BRCA has a fixed lower bound of 0, whereas its upper bound is not delimited, resulting in inconsistent mean value of BRCA scores across countries or commodities. This suggests that "the same value of BRCA might indicate different levels of comparative advantage for different countries or commodities (Yu *et al.* (2009), p. 269)." Lastly, the BRCA is also criticized for its poor empirical distribution characteristics, as the moments of BRCA distribution change over time (Hinloopen and Van Marrewijk , 2001).

With the aim to overcome the shortcomings of BRCA, Yu *et al.* (2009) propose a new RCA index called "normalized revealed comparative advantage" (NRCA) index, which enables us to compare across countries, sectors and over time. It is defined as:

$$NRCA_{ij} \equiv \frac{\Delta E_{ij}}{E_w},$$

where ΔE_{ij} denotes the difference between country i's *actual* exports of commodity j (E_{ij}) and country i's hypothetical exports of commodity j ($\hat{E}_{ij}$). Hypothetical export $\hat{E}_{ij}$ is calculated by setting Equation (9) equals unity: $(\hat{E}_{ij}/E_{ji})/(E_{iwj}/E_w) = 1 \iff \hat{E}_{ij} = E_i E_{wj}/E_w$. We therefore obtain

$$\Delta E_{ij} = E_{ij} - \hat{E}_{ij} = E_{ij} - \frac{E_i E_{wj}}{E_w}.$$

Normalizing ΔE_{ij} by the world export market, E_w, we obtain the $NRCA$ index as follows

$$NRCA_{ij} \equiv \frac{\Delta E_{ij}}{E_w} = \frac{E_{ij} - \frac{E_i E_{wj}}{E_w}}{E_w} = \left(\frac{E_{ij}}{E_w} - \frac{E_{wj} E_i}{E_w E_w}\right). \quad (10)$$

$NRCA_{ij} > 0$ ($NRCA_{ij} < 0$) indicates that country i's exports of commodity j

is higher (lower) than its comparative-advantage-neutral level, suggesting that country i has comparative advantage (disadvantage) in commodity j. The $NRCA$ becomes zero when the actual export is same as expected under the comparative advantage neutral situation ($\Delta E_{ij} = E_{ij} - \hat{E}_{ij} = 0$). Hence, the NRCA corrects the asymmetry problem of the BRCA discussed above. Moreover, Yu *et al.* (2009) shows that the sum of a country or a commodity's $NRCA$ is constant and equals zero. That is, if a country gains comparative advantage in some commodities, then the country loses it in the other commodities. In addition, if a country gains comparative advantage in a commodity, then the other country loses it in that commodity. Finally, zero export ($E_j = 0, \text{hence } E_{ij} = 0$) yields zero value of $NRCA$, whereas $BRCA$ cannot be calculated in the case of zero export (equation 9).

Table 1 presents Japan's NRCA and BRCA values and rankings vis-à-vis Chile. Following Yu *et al.* (2009), we scale the NRCA values with a constant of 10,000, as the values of $NRCA$ becomes very small when it is normalized by the size of world total export (E_w). Table 1 indicates that the relative ranking of commodities measured by the NRCA and the BRCA differ considerably. It also shows that the sum of Japan's $NRCA$ is constant and equals to zero. For instance, according to its NRCA rankings, Japan has stronger comparative advantage in "chemical industries" (6th) than in "stone, cement, ceramic, and glass" (8th), while its BRCA rankings show the opposite order (14th and 4th).

Figure 1 presents changes in patterns of Japan's pre- and post-FTA RCA indices at the HS section level and the HS 2-digit level. Although the absolute values of both NRCA and BRCA for each industry change over time, NRCA values shows more symmetric and stable patterns of comparative advantage. Moreover, there are several missing values for pre-FTA period in the case of BRCA (see the graph for HS 2-digit level), due to the zero export problem discussed above. In sum, NRCA has more desirable properties as a proxy for comparative advantages in empirical analyses.

Figure 1 Japan's Pre- and Post-FTA RCA indices (HS Section level and 2-digit level)

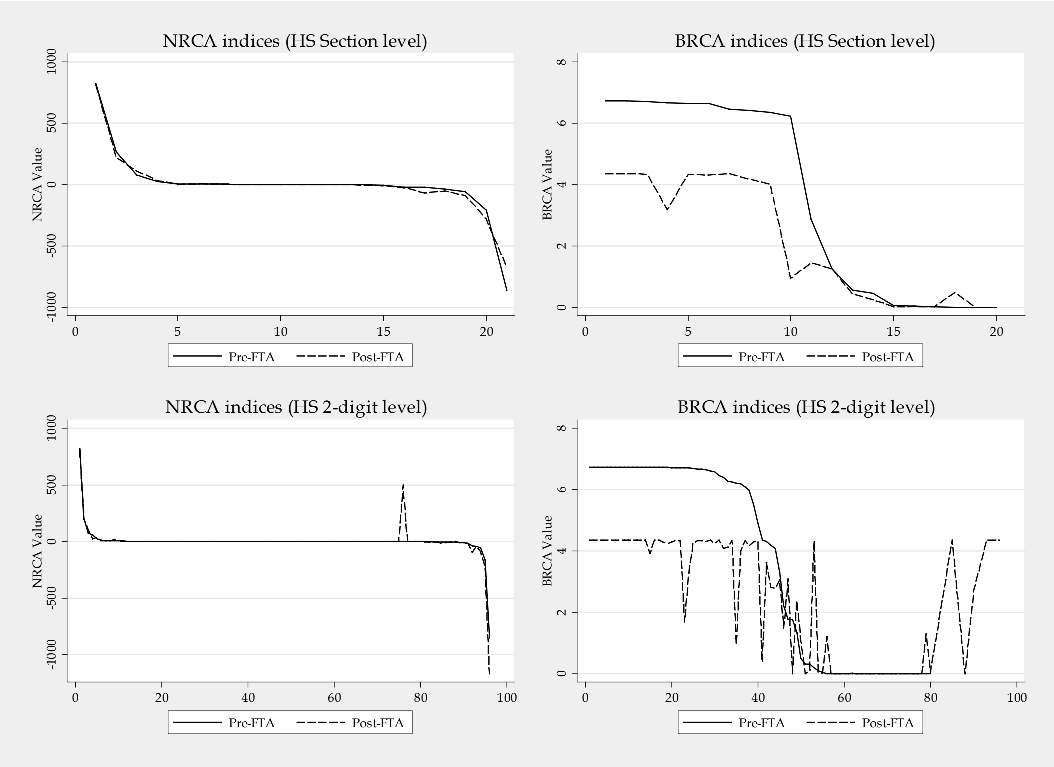

NRCA indices (HS Section level)
BRCA indices (HS Section level)
NRCA indices (HS 2-digit level)
BRCA indices (HS 2-digit level)
NRCA Value
BRCA Value
Pre-FTA
Post-FTA

Table 1 Japan's NRCA and B RCA vis-à-vis Chile during pre- (2005-2006) and post-FTA periods (2010-2011)

HS Section	Pre-FTA (1)				Post-FTA (2)				(2)-(1)	
	NRCA		BRCA		NRCA		BRCA		NRCA	
	Value	Ranking	Value	Ranking	NRCA	Ranking	Value	Ranking	Value	Ranking
17 transport equipment	821.72	1	6.7342	2	810.17	1	4.35136	3	-11.55	0
16 machinery and electrical equip.	265.80	2	6.7108	3	221.45	2	4.34236	4	-44.34	0
7 plastics and rubber	77.35	3	6.4194	8	109.72	3	4.18219	7	32.37	0
18 optical, precision, & medical inst.	24.59	4	6.6431	6	33.77	4	4.31389	6	9.18	0
11 textiles	5.49	5	6.3550	9	1.93	7	4.01204	8	-3.56	-2
6 products of the chemical industries	5.33	6	1.2601	12	8.34	5	1.25657	11	3.01	1
20 miscellaneous	5.26	7	6.6534	5	4.33	6	4.33084	5	-0.93	1
13 stone, cement, ceramic, and glass	2.32	8	6.6654	4	1.72	8	3.18597	9	-0.60	0
14 pearls, precious stones/metals	0.07	9	6.2189	10	0.00	13	0.95738	12	-0.07	-4
12 footwear, umbrellas, etc.	0.01	10	6.4632	7	0.16	9	4.35240	2	0.15	1
8 raw hides and skins, leather	0.01	11	2.8712	11	0.00	10	1.46443	10	-0.01	1
21 art/antiques	0.01	12	6.7343	1	0.00	11	4.35282	1	-0.01	1
19 arms and ammunition	0.00	13	na		0.00	12	na		0.00	1
3 animal/vege. fats, oils, and waxes	-1.27	14	0.0000	20	-2.88	14	0.00065	19	-1.61	0
10 pulp wood and paper	-5.86	15	0.4541	14	-9.31	15	0.25249	15	-3.45	0
2 vegetable products	-20.89	16	0.0505	16	-23.90	16	0.03717	16	-3.01	0
15 base metals	-21.33	17	0.5686	13	-66.70	18	0.44612	14	-45.37	-1
4 prep. food., beverages, and tobacco	-37.42	18	0.0584	15	-52.27	17	0.02941	17	-14.85	1
9 wood, cork, and straw	-55.43	19	0.0007	19	-88.71	19	0.00005	20	-33.29	0
1 live animals/animal products	-210.01	20	0.0348	17	-279.39	20	0.02570	18	-69.38	0
5 mineral products	-855.75	21	0.0019	18	-668.44	21	0.49342	13	187.31	0
Total	0.00				0.00				0.00	

Source: Authors' Calculation.

5. Empirical Analysis

5.1 Empirical Framework.

Our empirical analysis aims to test how trade liberalization and change in patterns of comparative advantage affect trade patterns, especially extensive and intensive margins, by applying the model shown in section 33. In particular, we estimate two probit models to investigate the relationship between probabilities of observing positive extensive and intensive margins for a commodity, the dependent variables, and changes in tariff rate and ranking of revealed comparative advantage (RCA) of the commodity, the independent variables of interest.

We introduce latent variables as follows: the observed binary variable EM_j, extensive margin ($d\underline{z}$) for commodity j, takes unity if the unobserved latent variable $EM_j^* > 0$, and zero otherwise. Likewise, the observed binary variable IM_j, intensive margin (dI) for commodity j, takes unity if the unobserved latent variable $IM_j^* > 0$, and zero otherwise. EM_j^* and IM_j^* are hypothesized to be a function of tariff and RCA. Chilean tariff rate and RCA of commodity j are represented by T_j and RCA_j respectively. Independent variables, tariff rates and RCAs, are included in the difference term in accordance with the theories in section 3.

$$EM_j^* = \beta_1^{EM}\Delta T_j + \beta_2^{EM}\Delta RCA_j + \mu_j, \tag{11}$$
$$IM_j^* = \beta_1^{IM}\Delta T_j + \beta_1^{IM}\Delta RCA_j + \mu_j. \tag{12}$$

The error terms μ_j are assumed to be normally distributed with zero mean. The estimated equations are given as:

$$\Pr(EM_j = 1) = \Phi(\beta_1^{EM}\Delta T_j + \beta_2^{EM}\Delta RCA_j), \tag{11$'$}$$
$$\Pr(IM_j = 1) = \Phi(\beta_1^{IM}\Delta T_j + \beta_2^{IM}\Delta RCA_j). \tag{12$'$}$$

From equations (7) and (8), the expected signs of these variables are $\beta_1^{EM} < 0$ and $\beta_1^{IM} < 0$, while the expected signs of β_2^{EM} and β_2^{IM} are not clear.

5.2 Data and Variables

The data for dependent variables, the positive extensive (EM) and intensive margins (IM) of Japan's exports to Chile, are constructed using HS 6-digit level United Nations' *UN Comtrade* trade data, and aggregating them to HS 4-digit commodity level. We define $EM = 1$ if Japan did not export commodity j in both 2005 and 2006, the years prior to the enactment of JCEPA (2007), and if it started exporting the commodity in either 2010 or 2011, three years after the enactment. The data for year 2008 and 2009 are not used in our empirical analysis, so that we can avoid possible effects of global financial crisis on trade patterns during this period. On the other hand, we define $IM = 1$ if the sum of Japan's export value for commodity j in 2010 and 2011 exceeds the sum of export value in 2005 and 2006, and if export value in both 2005 and 2006 are not zero. We also construct an alternative variable EM and IM using data for 2004, 2005, and 2006 as a pre-FTA export data and 2010, 2011, and 2012 as a post-FTA data. The distribution of the number of EM and IM is shown in Table 2. Japan started exporting 81 new commodities and increased export value for 232 commodities after the enactment of JCEPA. Whether these changes in trade patterns were achieved by Chile's tariff reduction and change in comparative advantage pattern in Japan is an empirical matter. We also observe some commodities of which Japan exited from the export market (categorized as "negative extensive margin") and Japan decreased its export value ("negative intensive margin") after the enactment of JCEPA. Possible explanations for these phenomena might include, among others, trade diversion effects caused by FTAs between Chile and third countries, relocation of production site from Japan to a foreign country (including Chile), or decrease in demand for the commodities in the Chilean market,

Table 2 Decomposition of Export Growth between Japan and Chile

Data Aggregation	HS 4-digit		HS 2-digit	
Data period	2 Years	3 Years	2 Years	3 Years
Positve Extensive Margin (EM)	81	83	11	10
Negative Extensive Margin	77	81	3	6
Positive Intensive Margin (IM)	232	259	39	42
Negative Intensive Margin	124	130	20	21
No Trade	730	691	23	17
Total	1244	1244	96	96

Source: Authors' Calculation

Note: "2 years" ("3 years") indicates that the extensive and intensive margins are calculated using data for 2005 and 2006 (2004, 2005, and 2006) as the pre-FTA data and 2010 and 2011 (2010, 2011 and 2012) as the post-FTA data.

The data for Chilean tariffs (T) are extracted from the UNCTAD TRAINS database provided on the *World Integrated Trade Solution* (WITS) website. ΔT is calculated by taking the difference between Chilean Most-Favored Nation (MFN) applied tariffs in 2007 and its preferential tariffs vis-à-vis Japan in 2010 under the JCEPA. We construct two alternative revealed comparative advantage variables $NRCA$ and $BRCA$ derived in the previous section. We use ranking data rather than absolute value for $NRCA$ and $BRCA$ of each commodity in our analysis. The data for $NRCA$ and $BRCA$ are computed based on equations (10) and (9) using HS 4-digit level export data taken from *UN Comtrade*. Table 1 shows absolute value and ranking of NRCA and BRCA vis-à-vis Chile at HS section level. Although the rankings of Japan's pre- and post-FTA NRCA (BRCA) are strongly and positively correlated (Table A-1 in Annex), there are some variations in terms of both absolute value and ranking for several industries. For instance, Japanese textile industry (HS section 11) dropped from the 5th competitive industry to 7th in terms of NRCA vis-à-vis Chile after the enactment of JCEPA, whereas ranking of chemical industry (HS section 6) rose from 6th to 5th (Table 1).

5.3 Estimation Results

Table 3 reports our probit regression results. Separate regression results are presented for two alternative RCA variables ($\Delta NRCA$ and $\Delta BRCA$) for two different dependent variables: extensive margin (EM) and intensive margin (IM).

First of all, the result in column (1) indicates that the estimated coefficient for tariff reduction (ΔT) is negative as expected but it is not statistically significant in extensive margin regression. However, if we incorporate the RCA variables into the models, it shows the expected sign and is statistically significant at the 5 percent level (columns (4) and (5)). This suggests that tariff reduction realized in an industry by Japan-Chile FTA is likely to have increased the probability of expanding the range of product varieties exported by Japan. This is consistent with the prediction of the model discussed in Section 2. Secondly, columns (6), (9), and (10) indicate that the coefficients for intensive margins have the negative signs and are all statistically significant at the 1 percent level, suggesting that tariff reduction by Chile increased Japan's exports to Chile. It should also be emphasized that the marginal effects of tariff reduction on the probability of generating margins are larger in intensive margin compared to extensive margin.

Thirdly, the coefficients for RCA variables in extensive margin regressions are positive and statistically significant at 1 percent in the case of NRCA and at 5 percent in the case of BRCA. Although the relationship cannot be established in our model, our results indicate that a rise in ranking of RCA among Japanese exports increased the probability of expanding the range of varieties exported by Japan. Finally, columns (7) to (10) show that the estimated coefficients for ΔRCA are not statistically significant in intensive margin regressions with the exception of (7), and that signs are not identical across models.

Table 3 Estimation Results: Marginal Effects on Probability of Generating Extensive and Intensive Margins (Probit Analysis)

	(1) EM	(2) EM	(3) EM	(4) EM	(5) EM
⊿T	-0.0108			-0.00580**	-0.00147**
	(0.00886)			(0.00274)	(0.000725)
⊿NRCA		0.000149***		0.000148***	
		(2.22e-05)		(2.26e-05)	
⊿BRCA			4.05e-05**		3.90e-05**
			(1.90e-05)		(1.92e-05)
Observations	1,244	1,244	1,244	1,244	1,244
Pseudo R-squared	0.00285	0.309	0.574	0.312	0.579

	(6) IM	(7) IM	(8) IM	(9) IM	(10) IM
⊿T	-0.151***			-0.150***	-0.152***
	(0.0231)			(0.0231)	(0.0230)
⊿NRCA		7.21e-05**		4.76e-05	
		(2.87e-05)		(3.40e-05)	
⊿BRCA			-1.69e-05		-3.98e-05
			(2.29e-05)		(2.47e-05)
Observations	1,244	1,244	1,244	1,244	1,244
Pseudo R-squared	0.119	0.00292	0.000200	0.120	0.120

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Conclusion

Based on the Ricardian trade model, this paper attempts to investigate the impacts of Japan-Chile FTA (JCEPA) on extensive and intensive margins of Japan's exports to Chile, by using information on pre- and post-FTA product-level tariff and the patterns of comparative advantage. Our results show that the tariff liberalization under the JCEPA increases both extensive and intensive margins of Japan's exports to Chile. We also find that a rise in the ranking of comparative advantage caused by the FTA increased extensive margin, that is, expanding the range of export product variety.

Our analysis contributes to a deeper understanding of the impacts of FTAs on international trade by decomposing their impacts on overall trade into extensive and intensive margins. Our results are consistent with earlier studies such as Ando and Urata (2015) and Urata and Okabe (2014) that showed positive impacts of FTAs on international trade. These findings indicate the importance of expanding FTA networks and promoting the use of FTAs, in order to increase trade. Governments can contribute to the increase in the use of FTAs by implementing the measures such as disseminating the information about the benefits of using FTAs and simplifying the procedure for obtaining the certificate of origin, which is required for using FTAs.

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Appendix

Table A-1 Correlation between Japan’s Pre and Post FTA NRCA Ranks

	NRCA		BRCA	
Aggregation	Obs.	Spearman's rank correlation coefficient	Obs.	Spearman's rank correlation coefficient
HS6	964	0.8453 ***	771	0.3746 ***
HS4	472	0.8976 ***	356	0.4645 ***
HS2	78	0.8837 ***	59	0.8528 ***
Section	20	0.9850 ***	19	0.9193 ***

Source: Authors’ Calculation