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# Analysis of Trade Patterns and Duration: Evidence from Food Industry in the OECD countries

Yung-Hsuan Lin[a], Pei-Yu Chi[a], and Kuo-I Chang[a*]

*Department of Applied Economics, National Chung Hsing University, No. 145, Xinda Rd., Taichung 402, Taiwan*
*sharonlin2010@gmail.com; cingring46@gmail.com; kic@nchu.edu.tw*

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## ABSTRACT

This study conducts Kaplan-Meier survival estimates on food trade patterns among the OECD countries and explores whether different survival conditions exist in different trade patterns of food sub-industries. By applying the extended Cox proportional hazard model, this study examines the effects of consumption on the survival rate for horizontal intra-industry trade pattern at the SITC four-digits level. Our findings show an important policy implication that the stability of horizontal intra-industry trade on the survival duration is driven by consumption in food industry among the OECD countries. Therefore, we suggest that policies should encourage the support of the horizontal intra-industry trade within the food industry to avoid unstable durations of trade in the global supply chain caused by the severe employment adjustments associated with traditional comparative advantage.

***Keywords**: Duration; Intra-industry Trade; Survival analysis*

***JELClassification**: F15; F23*

## 1 Introduction

The food industry is highly dynamic. Countries in Organization for Economic Co-operation and Development (OECD) are major importers and consumers of food products. According to the data from UN Comtrade database, the trade volume of food industry increases steadily among the OECD countries during 2001 to 2007. Approximate $90 billion worth of food trade flowing in the OECD in 2007, is nearly twice that of 2001. This interesting trend implies the existence of dynamic and stable trade patterns in the food industry, which is worth exploring. Also, the latest release by APEC (2014) towards 2020 Food Security Roadmap mention that the stability of food trade play an important role on stable food supply chain. However, studies about stability of intra-industry trade (IIT) patterns in the food industry among the OECD countries are scarce. Based on this gap in previous literature, we attempt to employ survival analysis to observe the duration of IIT patterns and its stability in the food industry among the OECD countries, focusing on the period after World Trade Organization (WTO) was established and before global financial crisis (GFC) occurred. In particular, by considering the OECD countries that belong to the North-North trade, we examine the duration within horizontal intra-industry trade (HIIT) in more disaggregated level. The remainder of this paper is organized as follows. The literature review discuss existing studies related to trade pattern and survival analysis. The data sources and methodology section describes the data mining and research methods, respectively. The empirical results is presented in the subsequent section, and final section concludes by summarizing the main findings.

## 2 Literature Review

After briefing above motivation, we present literature review in two. We first review literature on IIT patterns of food industry and then describe how survival analysis is addressed in the field of trade. A country will produce and export homogenous goods with relatively high labor productivity, while importing goods with relatively low labor productivity according to classical comparative advantage. Heckscher and Ohlin (1991) found that a country with an abundant factor of production tends to produce and export factor-intensive commodity. The theoretical foundation of comparative advantage holds that inter-industry trade or one-way trade arises from differences in production technology or factor endowment between two trading countries. According to the rules of comparative advantage, two trading countries conduct specialized production for trade to achieve economic efficiency. Over time, industrialized countries have generated increasingly which caused homogeneous levels of production technologies, human resources, and capital. Consequently, differences in technological breakthroughs or factor endowments among industrialized countries have been eliminated; in other words, no obvious comparative advantage can be found among these countries. Empirical studies, however, have discovered that countries with similar resources and technologies, especially those in Western Europe, participate heavily in the trade of similar products in the same industry. The trade pattern is known as two-way trade (or IIT), which can be classified into HIIT and vertical intra-industry trade (VIIT).

Previous studies show that HIIT and VIIT are based on different theoretical foundations. Krugman (1979), Lancaster (1980), and Helpman and Krugman (1985) devoted their theoretical research to HIIT. They argue that consumers' preference for product diversity is the main determinants of HIIT. Therefore, the goods in HIIT pattern mainly have homogeneous quality but heterogeneous attributes. On the contrary, several studies point out that VIIT is primarily driven by differences in factor endowments based on quality ladder (Falvey, 1981; Flam and Helpman, 1987); thus, in VIIT pattern, trading partners import/export heterogeneous quality products. Therefore, we attempt to empirically investigate the duration of HIIT and VIIT derived from different theoretical foundations. On the other hand, several studies have been devoted to empirical investigation of IIT issues. For instance, application of threshold decomposition methods to decompose disaggregated trade into IIT, VIIT and HIIT (Abd-el-Rahman, 1991; Greenaway et al., 1994, 1995; Fontagné et al. 1997; Ferto, 2005, 2015; Ando, 2006; Chang and Wei, 2010; Ito and Okubo, 2012). Especially, Ferto (2005; 2015) classify the trade patterns of the food industry between Hungary and EU into South-North trade in line with theoretical foundation addressed by Flam and Helpman (1987). In view of this, our research scope of the current study is limited to the OECD countries in order to conform to the North-North trade model.

Recently, a growing number of studies have examined the duration of trade. Many previous studies of the determinants of trade have typically focused on trading partners, timings, and trade cost. However, few works have discussed the duration and stability of trade between trading partners. Besedeš and Prusa (2006a, 2006b) first apply survival analysis to the study of trade duration. They also discussed determinants of duration and survival rate, which pioneered the use of survival approach. Their studies show an industry that can survive the first years of an export market has lower hazard rates and is endowed with a relatively survival advantage. However, most previous survival studies of trade focus on manufacturing products (Besedeš and Prusa, 2006b; Martincus and Carballo, 2008; Nitsch, 2009 Besedeš and Blyde, 2010; Obashi, 2010; Fugazza and Molina, 2011). Moreover, most of them address one homme country and multiple partner countries such as Peru addressed by Martincus and Carballo (2008), Germany addressed by Nitsch (2009), and USA addressed by Besedeš and Blyde (2010), respectively. Few of them focus on food industry (Abraham, 2012); and few of them choose the N×N country-pairs as the trading partners (Obashi, 2010; Fugazza and Molina, 2011). Besedeš and Prusa (2006b) points out that the degree of product differentiation dramatically influences the average duration of US importing relationships. Martincus and Carballo (2008) finds that geographical diversification in an export market results in higher survival rates than product differentiation. Nitsch (2009) reveals that final products have a very short duration of survival. Fugazza and Molina (2011) shows that prosperous economy has lower hazard ratio (or longer durations). By conducting a questionnaire survey in Spain, Esteve-Pérez et al. (2013) explores the duration of small and medium-sized enterprises as well as the influence of relevant determinants on the duration of export firms. Abraham et al. (2012) explores the duration of firms that produced chocolate in Belgium as well as the relationship between the chocolate trade and different firms. Most of the studies discussed above support the idea that differentiated products have longer duration. Further, the intermediate and final goods are selected exogenously (Obashi, 2010). Moreover, sample selection has mainly been exogenous and based on the level of aggregated trade volume. However, studies on the duration of different trade patterns selected by classifying endogenously (e.g., regarding trade patterns as endogenous variables by classifying them using threshold decomposition methods) is still scarce.

Based on the foregoing, the current study contributes to previous studies in three aspects. Firstly, by utilizing the threshold decomposition method, this study identifies IIT in the food industry among the OECD countries and examines two trade patterns, namely VIIT and HIIT to observe their duration and stability. Secondly, this study compares the difference in duration regarding food industry under VIIT and HIIT by statistical test. Thirdly, the difference in the duration of HIIT for food sub-industries and its determinants under North-North trade among the OECD countries are discussed.

## 3 Data

To explore the duration of HIIT under North-North trade patterns, we use SITC (Rev.3) five-digit data on bilateral export volume and quantity (unit: kilogram) from UN Comtrade Database. For the data merging, we select ISIC (Rev. 3) four-digit production data corresponding to food sub-industries from UNIDO Industrial Statistics Database (INDSTAT4 2011), which are then converted with SITC five-digit industries (see Appendix A.). The converting results show ISIC sub-industries with SITC 300 detailed food products. The reporter countries of trade are the 34 members of the OECD and the partner countries are the remaining 33 countries of the OECD. There are 1,122 pair wise observations in total between the bilateral trading partners and 300 products. By considering the pricing problem in the trade data, we apply the F.O.B (Free on Board) of both reporter and partner in bilateral trade to solve the different pricing problem between exporters and importers. We convert related data into million USD and kilograms as well, to standardize the pricing unit. With regard to processing the data on duration, we integrate and aggregate reporter countries, partner countries, and the five-digit SITC product code, which are combined to form a paired country-country-product code. This code is used as the observation of this study. The interrupts of trade patterns are defined as the “Event” as well. Consequently, the survival duration is calculated from the starting point to the occurrence of the “Event” in each observation by above-mentioned.

## 4 Methodology

Based on the different theoretical foundation of IIT, the current study decompose IIT among the OECD countries into VIIT and HIIT by utilizing the threshold decomposition method (Abd-el-Rahman, 1991; Greenaway et al., 1994, 1995; Fontagné et al. 1997; Ferto, 2005; Ando, 2006; Ito and Okubo, 2012). Following the approaches of Besedeš and Prusa (2006a, 2006b), Nitsch (2009), and Obashi (2010), we apply the Kaplan–Meier (K-M) estimator (Kaplan and Meier, 1958), a nonparametric method, as one of our research methods. Our main purpose is to estimate the K-M curves of the HIIT and VIIT patterns among the OECD countries as well as the food sub-industries within HIIT. Durations of HIIT and VIIT are compared by using the estimated K-M curves and log rank test. To simplify the problem, we explore the first spell only, of IIT patterns and the duration of different types of industries. Lastly, we apply the Cox proportional hazards model (Cox, 1972) to analyze the determinants of HIIT.

### 4.1 Vertical and Horizontal Intra-Industry Trade

With reference to the threshold decomposition method addressed above, IIT could be decomposed into VIIT and HIIT. Firstly, we need to identify whether a product belonged to one-way trade or two-way trade. The formula for identifying the trade patterns is as follows:

$$Min(X_{ijqt}, X_{jiqt}) \Big/ Max(X_{ijqt}, X_{jiqt}) \tag{1}$$

Where $X_{ijq}$ represents the trade value of product *q* that country *i* exports to country *j* in terms of industry *X* in year *t*, while $X_{ijqt}$ represents the trade value of product *q* that country *j* exports to country *i* in year *t*. *X* consists of 18 industries, *q* consists of 300 products, *i* consists of 34 countries, *j* consists of 34 countries (*i≠j*), and *t* refers to the 13 years from 1995 to 2007, focusing the period after WTO established and before GFC occurred.

The IIT pattern can be identified through formula (1). An index greater than 0.1 indicates that a product q belongs to IIT. After identification as being IIT, products are decomposed and identified as VIIT or HIIT. The formula for this are shown as (2) and (3) by unit price (*UV*). If the result falls into the range from 0.8 to 1.25, the product is identified as HIIT; otherwise, the product is identified as VIIT.

$$\textbf{HIIT:}\ \mathbf{1} \Big/ (\mathbf{1+0.25}) < \boldsymbol{UV^X_{ijqt}} \Big/ \boldsymbol{UV^X_{jiqt}} < \mathbf{1+0.25} \tag{2}$$

$$\text{VIIT: } UV^X_{ijqt} \Big/ UV^X_{jiqt} \geq 1 + 0.25\ or\ UV^X_{ijqt} \Big/ UV^X_{jiqt} \leq 1 \Big/ (1 + 0.25) \tag{3}$$

### 4.2 Analysis of Survival Curves

#### 4.2.1 K-M Estimator

In general, when dealing with a censored data, the semi-parameter K-M estimator is applied[1]. As shown in (4), the K-M estimator allows different zero time points for each datum:

$$\widehat{S_{KM}}(t) = \prod_{t_{ijq} \leq T} ijq(n_{ijq} - d_{ijq}/n_{ijq} \quad (4)$$

$\widehat{S_{KM}}(t)$ is a cumulative K-M odds of survival at time point *t* before a certain time point *T.* $n_{ijq}$ refers to the two trade patterns (VIIT or HIIT) that are still surviving at time *t*; $d_{ijq}$ refers to the trade patterns that are discontinued at time *t*; and ijqrefers to all the product combinations according to the codes of the 1,122 two-way trading country pairs and 300 food products.

#### 4.2.2 Log Rank Test

To demonstrate the significance of the total survival curve of the two types of IIT, a log rank test is applied as follows:

$$Z = \frac{U}{\sqrt{Var(U)}}, \quad U = \sum_{ijq=1}^{k} [d_{ijq} - \varepsilon(D_{ijq})] \quad (5)$$

where **Z** is the statistics of the log test; **U** is the sum of the expected value and the observed value; and ijq is the combination of data on the two-way trading partners and products. The null hypothesis in this log rank test is that there is no difference in duration between the two IIT patterns. Under this hypothesis, the statistics of the log rank tests would employ a Chi-squared distribution value with variance equal to 1. If P-value=0 or near 0, then the null hypothesis is rejected, which shows that a significant difference exists between VIIT and HIIT.

### 4.3 Cox Proportional Hazards Model

To solve the problem of the relationship between the explanatory variables (covariates) and duration, the proportional hazards model (Cox, 1972) has frequently been used in previous studies for the survival analysis of trade issues. In our empirical model, the Cox model is applied to explore the explanatory variables on the HIIT survival rate. The Cox model can be seen in equation (6):

$$h_{ijq}(t,\beta,z) = h_0(t)*\exp(\beta z_{ijq}) \quad (6)$$

where $h_{ijq}(t,\beta,z)$ is a hazard function or risk ratio; $h_0(t)$ is the baseline risk function; $\beta$ is a parameter vector of the hazard function; ijq is a combination of data on the two-way trading partners and products; t is a survival duration; z is a vector of the explanatory variables; and $\exp(\beta z_{ijq})$ is a function of the covariance matrix to measure the variation of the baseline risk rate caused by the explanatory variables.

To validate the demand side hypothesis addressed by Helpman and Krugman (1985), namely that the main determinant for HIIT is the difference in consumption level, consumption is added to the current study as an explanatory variable. However, consumption can change over time

[1]A censored data refers to an event time that cannot be observed completely and can thus be classified as central, left, and right data limitations.

(known as time-dependent covariates). Therefore, an extended model with time-dependent covariates should be considered (Cox, 1972; Therneau and Grambsch, 2001).

The extended model is employed to analyze the relationship between the explanatory variables and survival rate as follows[2]:

$$h_{ijq}(t,\beta,z)=h_0(t)*\exp(\beta z_{ijq}+\log(Tvc)) \quad (7)$$

Where $h_{ijq}(t,\beta,z)$ is a hazard function; $h_0(t)$ is a baseline hazard function; ijq is a combination of data on the two-way trading partners and products; t is a survival duration; z is a vector of non-time-dependent explanatory variables; Tvc is a vector of the time-dependent explanatory variables; and $\exp(\beta zijq+\log(Tvc))$ is a covariance function with time-dependent covariates included to measure the variation of the baseline hazard rate $h_0(t)$ caused by the explanatory variables.

### 4.4 Explanatory Variables

With reference to Besedeš and Prusa (2006a, 2006b), Nitsch (2009), Obashi (2010) and Chang and Wei (2010), this study utilize explanatory variables in a gravity model to explore the survival rates of HIIT as well as the determinants of HIIT in food sub-industries. The cross-section variables are the distance between the two countries (Dist), while the dummy variables are common language (Comlang), colonial history (Colony), and presence of contiguous borders (Contiguity). Furthermore, previous theoretical foundation of HIIT suggests that the main factor that affects HIIT is consumption level caused by love of variety or diversity of preferences (Krugman, 1979; Lancaster, 1980; Krugman and Helpman, 1985). Therefore, the consumption value of the reporter country is selected as an explanatory variable to validate the hypothesis. The consumption value, during our study, calculated from the amounts of domestic production + amounts of imports – amounts of exports – changes in stock according to the equation addressed in food balance sheets. The domestic production and changes in stock are obtained from UNIDO database. The amounts of imports and exports are obtained from UNcomtrade. As aforementioned, the food industry is sorted into sub-industries by the four-digit ISIC (Rev.3) level. Therefore, we obtain disaggregated consumption values for food sub-industries among OECD countries. On the other hand, GDP, usually proposed in the previous studies (Besedeš and Prusa, 2006a, 2006b; Obashi, 2000), is replaced by consumption value in current study due to the possible collinearity between GDP and consumption level. Detailed description of explanatory variables can be found in Table 1.

[2] This model is rarely used in the medical field because follow-up investigation is not conducted in each individual (patient); thus, covariates are difficult to obtain in medical statistics, which leads to the failure to conform to the hypothesis of this model. However, the hypothesis can be reached in the economics field, suggesting the model is applied in this study.

**Table 1.**
List of Explanatory Variables

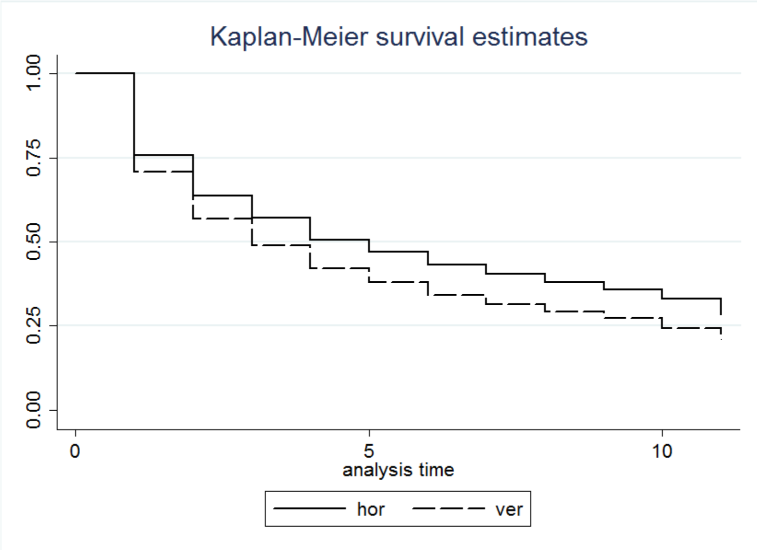
| Variable name | Definition | Avg. | Var. | Source |
|---|---|---|---|---|
| Distance ($Dist_{ij}$) | Distance between two capitals of reporter country *i* and partner country *j* in a straight line (unit: 100kilometer). | 53.15 | 52.77. | CEPII |
| Common Language ($Comlang_{ij}$) | Whether common official language is used by reporter country i and partner country j. The dummy variable equals to 1 represents two countries in trade use the common official language. Dummy variable equals to 0 represents no use in common official language. | 0.302 | 0.4592 | CEPII |
| Contiguity ($Contiguity_{ij}$) | Reporter country i and partner country j have a geographic contiguity. The contiguity dummy variable=1 demonstrate two countries are neighboring country; otherwise, the contiguity dummy variable equals to 0. | 0.038 | 0.192 | CEPII |
| Colony ($Colony_{ij}$) | Reporter country i and partner country j have a colony history relationship. The dummy variable equals to 1 represents have a colony history. Otherwise, Dummy variable equals to 0 represents have no colony history. | 0.140 | 0.347 | CEPII |
| Consumption ($Consumption_i$) | Consumption value of reporter country i (unit: million US dollars). | 22.24 | 30.84 | UNIDO UNComtrade |

## 5 Empirical Results

This study examines the survival rates of HIIT patterns as well as their determinants. In the Cox model, a hazard ratio higher (lower) than 1 indicates that the explanatory variable is negatively (positively) related with survival rate of HIIT patterns. In other words, a positive and higher hazard ratio indicates a higher possibility of interruption in trade, while a positive and lower hazard ratio indicates a higher possibility of maintaining the same trade patterns and a tendency toward stability.

### 5.1 Empirical Result of the Survival Curves

Based on the estimated K-M curve, the IIT survival curves of a country paired sample for the products of the two-way trading patterns under HIIT and VIIT are obtained (see Fig. 1).




Comment: note: hor represents HIIT, and ver represents VIIT.
Vertical axis is a survival rate. Horizontal axis is a survival duration

**Figure 1.** Survival Curve of HIIT and VIIT in OECD Food Industry

The K-M survival curve within 13-year (The beginning year of WTO established in 1995 and the ending year of GFC occurred in 2007) indicates that between the two IIT survival curves, HIIT represents a higher degree of survival rate than VIIT, suggesting that HIIT with a higher survival rate in IIT. Further, a log rank test shows that $X^2(1)=1152.83$ and that the P-value approached 0, which rejects the null hypothesis. Therefore, we can propose that HIIT and VIIT are significantly different; specifically, the survival rate of HIIT is significantly higher than that of VIIT. The findings contribute to previous studies without endogenously decomposing products in to different trading patterns instead suggesting the exogenously differentiated products have relatively longer durations (e.g., Nitsch, 2009; Obashi, 2010; Fugazza and Molina, 2011).

In addition, we explore the survival curves of HIIT regarding more detail sectors of industries based on the four-digit ISIC classification. The estimated results can be seen in Appendix B. The survival rates of several sub-industries are higher than 0.5 in the first year, such as the manufacture of dairy products (1520), manufacture of prepared animal feeds (1533), bakery products (1541), cocoa, chocolate, and sugar confectionery (1543), and macaroni, noodles, couscous, and similar farinaceous products (1544). On the other hand, sub-industries such as the processing and preserving of fish and fish products (1512) and the manufacture of tobacco products (1600) have a lower overall and first-year of survival rate.

### 5.2 Empirical Results of the Cox Model

The comparison of the duration allow us to conclude that HIIT is more stable than VIIT among the OECD countries in the food industry. Thus, this study applies the Cox model to explore the determinants of the survival rate of HIIT. The estimated results can be summarized as follows.

1. Table 2 shows that the hazard ratio between *Dist* and HIIT is greater than 1 and significant. This result indicates that the distance between bilateral trade among the OECD countries is negatively related to the survival rate of HIIT, which implies that a greater distance led to a higher possibility of discontinuation in duration of HIIT. This phenomenon is consistent with the conclusion stressed in Chang and Wei (2010) that IIT is negatively related to distance.
2. The hazard ratio between *Comlang* and HIIT is lower than 1 and significant. This result indicates that whether the reporter and partner countries of trade among the OECD countries with a common language is positively related to the survival rate of HIIT, which means that the existence of a common language between two trading partners led to a higher survival rate in HIIT patterns.

3. The hazard ratio between *Colony* and HIIT is greater than 1 and significant. This result indicates that whether the reporter and partner countries of trade among the OECD countries with a colonial relationship is negatively related to HIIT patterns, which means that the existence of a colonial relationship between two trading partners led to a higher possibility of discontinuation in duration of HIIT. This finding probably occurred because bilateral trade between the colonizer and colonized countries generally shows a technological gap, which implies *Colony* is close to the determinant for VIIT. Thus, a colonial relationship between two trading partners may lead to a discontinuation in duration of HIIT.
4. The hazard ratio between *Contiguity* and HIIT is greater than 1 but not significant.
5. The hazard ratio between *Consumption* and HIIT is lower than 1, which validates the hypothesis that the main factor that influences HIIT is caused by demand side. In other words, more consumption brings more stable survival rates of HIIT.
6.

**Table 2.**

Empirical Results of the Cox Model on HIIT

| Variables | Hazard ratio |
|---|---|
| $Dist$ | 1.000023*** |
| | (-12.37) |
| $Comlang$ | 0 .9153949 *** |
| | (-5.26) |
| $Colony$ | 1.051491* |
| | (-2.23) |
| $Contiguity$ | 0.969794 |
| | (-0.85) |
| $Consumption$ | 0.9994046** |
| | (-2.66) |
| Log likelihood | -16247.27 |
| LR Chi-Square statistics | 213.19 |
| $\chi^2$test p-value | 0.0000 |
| Observations | 17,341 |

note: The Coefficients denote the hazard ratio. Inside the parentheses are Z-value. *, **, and *** represents p-value less than 0.05, 0.01, and 0.001, respectively.

## 5.3 Empirical Results of the Cox Model for Food Sub-Industries

The empirical results of the influence of consumption on the duration of HIIT for food sub-industries are presented in Table 3, respectively (The more detailed results, please refer Appendix C).

The hazard ratios reveal that seven sub-industries are significantly influenced by the consumption value on the survival rate of HIIT in the 34 paired trading partners among the OECD countries. Among these seven sub-industries, five sub-industries demonstrate expected positive relationship (smaller than 1) between consumption level and survival rate of HIIT, namely the manufacture of dairy products (1520), grain mill products (1531), bakery products (1541), cocoa, chocolate, and sugar confectionary (1543), and distilling, rectifying, and blending of spirits (1551). These sub-industries included the manufacture of dairy products (1520), bakery products (1541), and cocoa, chocolate, and sugar confectionary (1543). The empirical results indicate that these sub-industries belong to heavily differentiated products under North-North trade pairs and conform to the determinants driven by consumption addressed by theoretical foundation of HIIT. In terms of policy implication, we suggest an important implication addressed in smooth adjustment hypothesis (SAH) that employment within countries and industries does not adjust dramatically under a relatively stable survival rate of HIIT.

**Table 3.**
Empirical Results of Food Sub-Industries

| Industry code[†] | 1511 | 1512 | 1513 | 1514 | 1520 | 1531 |
|---|---|---|---|---|---|---|
| *Consumption* | 1.000001 | .9999837 | .9999981 | .9999963 | .9999972* | .9999928* |
| | (1.27) | (-0.136) | (0.237) | (-1.24) | (-1.25) | (-2.15) |
| Log likelihood | -6555.766 | -8092.6246 | -14541.554 | -611.5798 | -5573.0615 | -5271.2551 |
| Observations | 1,422 | 1,279 | 2,090 | 1,361 | 1,237 | 758 |

| Industry code | 1532 | 1533 | 1541 | 1542 | 1543 | 1549 |
|---|---|---|---|---|---|---|
| *Consumption* | .9999921 | 1 | .999993*** | .999984 | .9999834 *** | 1.000002* |
| | (-0.63) | (-0.00) | (-4.02) | (-0.76) | (-4.13) | (2.14) |
| Log likelihood | -3999.229 | -3801.194 | -5764.6255 | -1848.7313 | -5966.1708 | -12910.035 |
| Observations | 781 | 622 | 1,379 | 294 | 932 | 1,848 |

| Industry code | 1551 | 1554 | 1600 | 1552 | 1544 | 1553 |
|---|---|---|---|---|---|---|
| *Consumption* | .9999662 ** | .9999969 | 1.000016*** | 1 | 1 | N/A |
| | (-3.09) | (-1.22) | (7.91) | (-0.00) | (-0.00) | N/A |
| Log likelihood | -4162.5256 | -5957.6305 | 566.8495 | -2543.9484 | -2298.9532 | N/A |
| Observations | 688 | 658 | 1,064 | 370 | 558 | N/A |

## 6 Conclusion

The contribution of this study can be summarized as follows. By employing a survival analysis, this study explores the duration of IIT patterns in the food industry among the OECD countries. Our findings show that the OECD countries conform to the North-North trade addressed by previous theoretical and empirical literature. In addition, the estimated results imply significant in consumption level among the determinants of HIIT. With regard to the survival rate of IIT among the OECD countries (North-North trade), HIIT shows a higher survival rate than VIIT, suggesting the importance of HIIT among developed countries. The consumption is rarely use in previous empirical studies of the determinants of HIIT due to the difficulties converting data toward different industries. Therefore, this study fills the gap in the discussion in terms of correlating variables on consumption level with the survival rate of HIIT. By decomposing the sub-industries based on their four-digit ISIC codes and analyzing the survival rate of HIIT through the detailed five-digit SITC (Rev. 3) codes, we discover that several sub-industries presenting relatively high survival rates, such as the manufacture of dairy products (1520), bakery products (1541), and cocoa, chocolate, and sugar confectionary (1543). Furthermore, the significant positive relationship between consumption level and the survival rate of HIIT is also observed. To sum up, our findings could serve as a valuable guideline to pioneer work in the field of IIT (e.g., Ferto, 2005; 2015) and policy-makers for stability of food supply chain addressed in APEC (2014).

The HIIT of food industry among developed countries has been growing significantly in spite of the stagnation of negotiation on the World Trade Organization (WTO) multilateral trade liberalization. This study quantitatively evaluates the vital economic significance of the stability of trade duration driven by HIIT at the consumption level. The growing level of regional economic integration will definitely stimulate the integration of the regional food value chain. In 2012, the

† Industry code refers to Appendix A. The Coefficients denote the hazard ratio. Inside the parentheses are Z-value. *, **, and *** represents p-value less than 0.05, 0.01, and 0.001, respectively.

secretary general of the WTO pointed out that agriculture and food industry should improve their value added with regards to the global food supply chain (Lamy, 2012). Therefore, this study suggests that policies that support HIIT in the food industry should be addressed to avoid instability in the duration of trade in the global food supply chain, as caused by the severe adjustments in employment associated with conventional comparative advantage.

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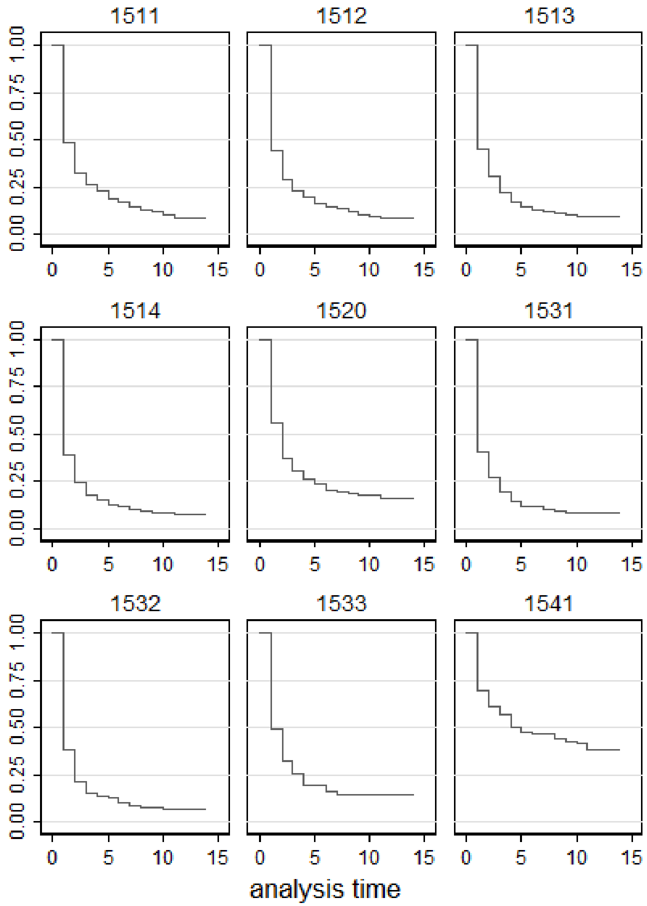
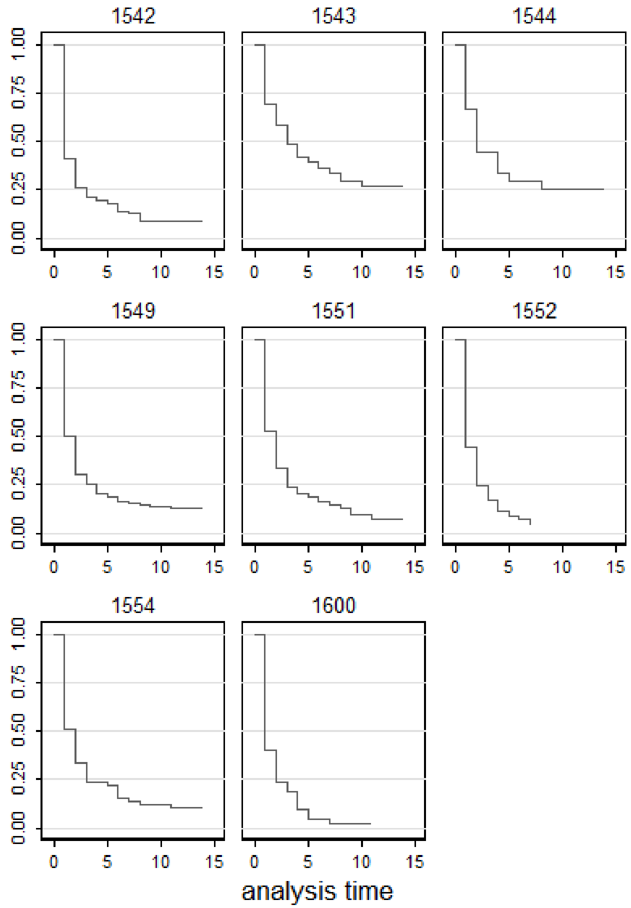
**Appendix A.** Conversion of 4-digit ISIC (Rev. 3) and 5-digit SITC (Rev. 3): 18 food sub-industries with 300 food products

| No. | English Name | ISIC | SITC |
|---|---|---|---|
| 1 | Production processing and preserving of meat and meat products | 1511 | 01111,01112,01121,01122,01211,01212,01213,01221,01222,01231,01232,01233,01234,01235,01236,01240,01251,01252,01253,01254,01255,01256,01291,01299,01611,01612,01619,01681,01689,01710,01720,01730,01740,01750,01760,01790,08141,21111,21112B,21113,21120,21140,21160,21170,26819,41120,41131,41132 |
| 2 | Processing and preserving of fish and fish products | 1512 | 03637,03639,03711,03712,03713,03714,03715,03716,03717,03721,03722,08142,29196,03419,03421,03422,03423,03424,03425,03426,03427,03428,03429,03440,03451,03455,03511,03512,03513,03521,03522,03529,03530,03540,03550,03611,03619 |
| 3 | Processing and preserving of fruit and vegetables | 1513 | 05461,05469,05470,05485,05611,05612,05613,05619,05641,05642,05661,05669,05671,05672,05673,05674,05675,05676,05677,05679,05810,05821,05822,05831,05832,05839,05892,05893,05894,05895,05896,05897,05910,05920,05930,05991,05992,05993,05994,05995,05996 |
| 4 | Manufacture of vegetable and animal oil and fats | 1514 | 08131,08132,08133,08134,08135,08136,08137,08138,08139,09101,09109,22390,26320,41111,41112,41113,41133,41139,42111,42119,42121,42129,42131,42139,42141,42142,42149,42151,42159,42171,42179,42180,42211,42219,42221,42229,42231,42239,42241,42249,42250,42291,42299,43121,43122,43133,43141 |
| 5 | Manufacture of dairy products | 1520 | 02430,02491,02499,06191,59221,02211,02212,02213,02221,02222,02223,02224,02231,02232,02233,02241,02249,02300,02410,02420 |
| 6 | Manufacture of grain mill products | 1531 | 04220,04231,04232,04610,04620,04711,04719,04721,04722,04729,04811,04812,04813,04814,04815,04850,05646,05647,05648 |
| 7 | Manufacture of starches and starch products | 1532 | 05645,06193,06194,06195,06196,06199,42161,42169,59211,59212,59213,59214,59215,59216,59217,59226 |
| 8 | Manufacture of prepared animal feeds | 1533 | 08195,08199 |
| 9 | Manufacture of bakery products | 1541 | 04841,04842, 04849 |
| 10 | Manufacture of sugar | 1542 | 06111,06112,06121,06129,06151,06159,06192 |
| 11 | Manufacture of cocoa, chocolate, and sugar confectionery | 1543 | 06210,06221,06229,07220,07231,07232,07240,07310,07320,07330,07390 |
| 12 | Manufacture of macaroni, noodles, couscous, and similar farinaceous products | 1544 | 04830,09891 |
| 13 | Manufacture of other food products n.e.c. | 1549 | 02521,02522,02530,07112,07120,07131,07132,07133,07411,07413,07432,09811,09812,09813,09814,09841,09842,09843,09844,09849,09850,09860,09893,09894,09899 |

| | | | |
|---|---|---|---|
| 14 | Distilling, rectifying, and blending of spirits; ethyl alcohol production from fermented materials | 1551 | 11241,11242,11243,11244,11245,11249,51215,51216, |
| 15 | Manufacture of wines | 1552 | 11211,11213,11215,11217,11220 |
| 16 | Manufacture of malt liquors and malt | 1553 | 04820,11230, |
| 17 | Manufacture of soft drinks; production of mineral water | 1554 | 11101,11102 |
| 18 | Manufacture of tobacco products | 1600 | 12210,12220,12231,12232,12239 |
| | | | |

**Appendix B.** The K-M Curves of Food Sub-Industries




note: Vertical axis is a survival rate. Horizontal axis is a duration in HIIT per industry. Analysis time unit: year. Detailed industry code refers to Appendix A.

**Appendix C.** Empirical Results of the Cox Regression for Food Sub-Industries

| **Industry code**[‡] | **1511** | **1512** | **1513** | **1514** | **1520** | **1531** | **1532** | **1533** | **1541** |
|---|---|---|---|---|---|---|---|---|---|
| *Consumption* | 1.000001 | .9999837 | .9999981 | .9999963 | .9999972* | .9999928* | .9999921 | 1 | .999993*** |
| | (1.27) | (-0.136) | (0.237) | (-1.24) | (-1.25) | (-2.15) | (-0.63) | (-0.00) | (-4.02) |
| LR $\chi^2$ statistics | 15.61 | 3.57 | 23.76 | 2.92 | 19.52 | 6.88 | 8.02 | 0.00 | 28.02 |
| $\chi^2$test p-value | 0.0004 | 0.1675 | 0.000 | 0.237 | 0.0001 | 0.032 | 0.0181 | 1.00 | 0.000 |
| Log likelihood | -6555.766 | -8092.6246 | -14541.554 | -611.5798 | -5573.0615 | -5271.2551 | -3999.229 | -3801.194 | -5764.6255 |
| Observations | 1422 | 1279 | 2090 | 1361 | 1237 | 758 | 781 | 622 | 1379 |

| **Industry code** | **1542** | **1543** | **1549** | **1551** | **1554** | **1600** | **1552** | **1544** | **1553** |
|---|---|---|---|---|---|---|---|---|---|
| *Consumption* | .999984 | .9999834 *** | 1.000002* | .9999662 ** | .9999969 | 1.000016*** | 1 | 1 | N/A |
| | (-0.76) | (-4.13) | (2.14) | (-3.09) | (-1.22) | (7.91) | (-0.00) | (-0.00) | N/A |
| LR $\chi^2$ statistics | 1.04 | 17.59 | 4.97 | 9.92 | 2.38 | 328.59 | 0.00 | 0.00 | N/A |
| $\chi^2$test p-value | 0.5956 | 0.0002 | 0.0834 | 0.0070 | 0.3044 | 0.000 | 1.00 | 1.00 | N/A |
| Log likelihood | -1848.7313 | -5966.1708 | -12910.035 | -4162.5256 | -5957.6305 | 566.8495 | -2543.9484 | -2298.9532 | N/A |
| Observations | 294 | 932 | 1848 | 688 | 658 | 1064 | 370 | 558 | N/A |

[‡] Detailed industry code refers to Appendix A. The Coefficients denote the hazard ratio. Inside the parentheses are Z-value. *, **, and *** represents p-value less than 0.05, 0.01, and 0.001, respectively.