「Globalization, firms and products」

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Introduction

Recently the world economy is increasingly globalized by trade liberalization and the development of information technology. The globalization of firms and the diversity of products are by no means observed. Research in international trade has also changed as its focus has shifted from industries and countries to firms and products. This transformation was instigated by the emergence of a wide range of micro-data sets exhibiting sharp variation in firms' characteristics and products. Behind this background, this paper analyzes the relationship among globalization, firms and products using firm- and product-level trade data.

This paper consists of 3 chapters. The title of the 1st chapter is "Globalization and internal corporate organization: evidence from Japanese firms". This chapter is to empirically examine the relationship between firms' organizational characteristics and their global activities by exploiting a unique firm-level data. The title of the 2nd chapter is "Effects of agglomeration and R&D activities on plant internationalization: evidence from Japan". This chapter examines the effects among agglomeration, R&D, and firms' other characteristics on their global activities. The title of the 3rd chapter is "Extensive and intensive margins of adjustments in Japan's exports after the Great East Japan Earthquake 2011". This chapter analyzes the impact of the Great East Japan Earthquake 2011 on Japanese export decomposing the fall of exports into the extensive and intensive margins.

Chapter 1

「Globalization and internal corporate organization: evidence from Japanese firms」

Globalization and internal corporate organization: evidence from Japanese firms

Abstract

Recent years have witnessed that firm hierarchies are becoming flatter amid globalization. Span of control (*Span*) has broadened and the number of levels (*Layer*) within firms has declined. Motivated by these changes in the world, international trade theory has recently incorporated a rich organizational model into trade and heterogeneous firm contexts. However, empirical evidence for this theory has been so far limited because of the constrained data availability. This paper fills a part of this gap by exploiting a unique firm-level organization data in Japan, by which we can ascertain the relationship between a firm's organization and its characteristics. The globalization of firms which is measured by the foreign sales ratio has a positive link with *Span*, but it has a negative link with *Layer*. IT investment is also negatively related with *Layer*.

Key words: Globalization; Internal Corporate Organizations; Firm-level data

1 Introduction

Cross-border business activities, such as exporting and foreign direct investment (FDI), have been facilitated by trade liberalization and the development of information technology in recent year. The expansion of these global activities has been accompanied by organizational changes inside firms. The corporate structure of the firm has become increasingly complicated accelerated by reorganization of production on a global scale. For example, a multinational corporation General Electric (GE) announced that it reorganized its energy business into three separate businesses units[1]. As the three new businesses units started to report directly to the CEO, GE's organization has become "flatter". This trend of flattering firms is documented in a number of academic literature and often discussed in business papers[2]. Motivated by these changes in the world, international trade theory has incorporated a rich organizational model into trade and heterogeneous firm contexts. The theory is so unique that it sheds light on corporate organization which previous heterogeneous firm literature have never taken into account. In order to understand the firm's globalization, the role of corporate organization in expanding overseas business can no longer be ignored. The goal of this paper is to empirically examine the relationship between firms' organizational characteristics and their foreign sales ratios by exploiting a unique firm-level organization data set.

The trend of the flattening firm is broken down into two components. First, CEO's span of control has increased. The CEO has been urged to quickly cope with wider, more multidivisional and complex problems than before. Rajan and Wulf (2006) find that CEO's span of control increased steadily from 1986 to 1998 in a sample of 300 U.S large firms. Although the number of positions reporting directly to the CEO was 4.4 on average in 1986, it keeps on increasing to 8.2 in 1998. Second, the number of layers within firms has decreased. They reported that the number of positions between the CEO and the lowest managers with profit center responsibility is decreased by more than 25% over the same period[3].

A recent theoretical model enables us to study the internal organization of firms in the globalizing world. Caliendo and Rossi-Hansberg (2012) formalize how a firm decides its internal organization, which is defined by span of control of each agent and the number of layers of management. In this model, firms face heterogeneous demands, which lead to heterogeneity

[1] General Electric distributed press release titled "GE simplifies Energy business," on July, 20, 2012.

[2] Japanese major electrical company Panasonic changed its corporation to a flatter organization, as illustrated in The Nikkei Business Daily (Nikkei-Sangyo-Shinbun in Japanese) dated November 15, 2005.

[3] Other academic literature documenting similar tends in the internal organization of firms includes Whittington et al. (1999) and Robert (2006).

in productivity, output and employement. Because the output that minimizes average cost increases with the number of layers, the optimal number of layers varies depending on the output. As a result of trade liberalization, many of the firms that sell all their output in domestic market reduce their number of layers. In contrast, many exporters increase thier number of layers of management. Other work that links international trade to internal organization of firms includes Marin and Verdier (2008, 2010). They show that increasing international trade leads to decentralized corporate hierarchies even though they do not refer to span of control of each agent and the number of layers of management[4].

Empirical studies on international trade and the internal organization remain limited. Much literature on international trade and heterogeneous firm has documented the evidence that points to the heterogeneity not in organization but in size, productivity and wages[5]. But several papers have studied the internal organization of firms. Guadalupe and Wulf (2010) using the same data as Rajan and Wulf (2006) find that increasing competition due to trade liberalization leads organizations to become flatter. Since they use tariffs as the index of the exposure to market competition for a firm, they do not distinguish between exporters and non-exporters. Similarly, Bloom, et al. (2010) analyze the effect of market competition on the organizations using 4,000 medium sized manufacturing firms across a dozen countries. They find that the degree of import penetration is associated with greater firm-level decentralization[6]. Caliendo, et al. (2012) examine the relationship between the number of layers and firms' characteristics. They divide French manufacturing firms into a collection of hierarchical layers and find that if expanding firms, including exporters, add their number of layers, these firms decrease their wages.

Despite growing literature on internal organization within heterogeneous firm, there are no

[4]Other papers, such as Antràs (2003) , Antràs and Helpman (2004) and Conco et al. (2012) analyze the firm ownership structure (integration or non-integration) in international economy.

[5]For more detailed discussion in this field, see the survey by Helpman (2013).

[6]In addition, Bloom, et al. (2012) examine the effect of trusts on the organizations across nations. They find that trust and rule of law are associated with more decentralization.

studies linking internal organization with firms' global activities because of the constrained data availability. This paper exploits detailed firm-level organization data and empirically examines how internal organizations are related to firms' global activities. Since there are various reasons that firms may change their organizational structures, this study also considers simultaneously other drivers of organizational changes, among which information technology is a prominent candidate[7].

The rest of this paper is organized as follows. Section 2 describes the data. Section 3 summarizes descriptive statistics. Section 4 explains empirical specifications. Section 5 reports estimation results. Section 6 closes with final remarks.

2 Description of Data

2.1 Data source

The organization data used for this paper is derived from The Handbook of Organizational and Systematical Figures (Soshikizu-Keitouzu-Binran in Japanese). This survey includes detailed information on divisions, business offices, plants, sections and titles, and their reporting relationships. The data is unique because it allows us to identify changes in hierarchies within firms. These are collected annually from a survey conducted by DIAMOND, Inc[8]. The survey participants are listed companies and typically major players in their sectors[9].

This paper focuses on two sectors, electric machinery and chemical industries. There are two reasons for choosing these industries. First, the electric machinery and chemical industries are two of the most globalized industries in Japan[10]. Second, these industries inherently have

[7]Bresnahan, et al. (2002) find complementarities between IT and workplace organization, for example.

[8]DIAMOND, Inc. is a lage publishing company specializing in businesses and economic issues. It was established in 1933 and currently has a total staff of 223 employees.

[9]As the survey is voluntary, it is possible that firms may not report the exact organization structure because of confidentiality or space limitations in the Handbook. In spite of this limitation, this survey is unique and very valuable information for studies of internal organization.

[10]Tomiura (2007) reports that electric machinery industry has the highest share of exporters, FDI firms and

different production processes. It is useful for this study to compare different type of industries. This paper developed over a 3-year period data from 2008 to 2010. Since some firms are represented as affiliated groups, this paper loses 37% of observations and loses another 22% while cleaning the data. The resulting sample is 253 firms for each year. The previous data set to come close to this sample size is that by Rajan and Wulf (2006) and Guadalupe and Wulf (2010) on about 300 large U.S firms.

This paper limits the sample to the listed 253 firms in the two industries in each year. This sample is not close to the population of firms in each industry. However, it is appropriate for examining the relationship between organization and firms' global activities on the data. First, small and medium-sized firms tend to have simple organization with narrow spans and few layers. Caliendo, et al. (2012) show that firms with more layers are larger in terms of value added. Further, 46% of firms in their sample have only one or zero layer. Second, it is well known that exporters and FDI firms are larger than domestic firms. Therefore small and medium-sized firms which are not included in the sample tend not to both have the complex organizations such as divisional organization and engage in overseas business. Excluding those businesses are of no matter for our analysis[11].

2.2 Measures of internal organizations

Before reporting empirical results, this section discusses two measures of internal organization. The first measure, CEO's span of control, is a measure that captures a horizontal dimension of the hierarchy. It is defined as the number of divisions, business offices, plants and sections reporting directly to the CEO. Since the CEO is at the top of the lines of authority and

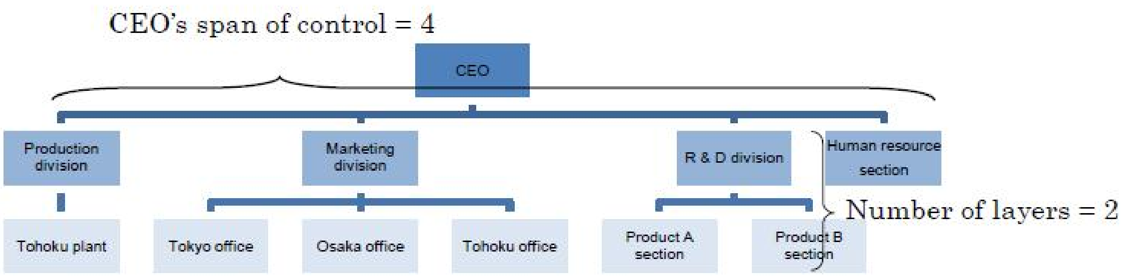
firms outsourcing to foreign suppliers among 22 industries in Japan. In addition, it also reports that the chemical industry has the highest percentage of exporters.

[11]Table A1 in Appendix reports statistics comparing the average of the number of employees, sales and Capital-labor ratio with Basic Survey of Japanese Business Structure and Activities (Kigyo Katsudo Kihon Chosa in Japanese). Not surprisingly, the sizes and the capital intensity in our sample are larger than those in the survey.

communication, CEO's span of control reflects the concept of decision-making at the highest level. The second measure, the number of layers, represents a vertical dimension of hierarchy and is defined as the number of divisions, business offices, plants and sections between the CEO and the lowest section. These two measures have been used repeatedly by previous research such as Rajan and Wulf (2006), Guadalupe and Wulf (2010) and Caliendo and Rossi-Hansberg (2012), although this paper substitutes the lowest section in the organization chart for the division manager[12].

Figure 1 displays an example of a hierarchy that demonstrates both measures of CEO's span of control and the number of layers. In this example, the measure of CEO's span of control is 4, since there are three divisions and one section directly connected to the CEO. On the other hand, the measure of the number of layers is 2, since there are one division and one section between the CEO and the lowest sections (in this case, the plant and the offices are the lowest).

Figure 1: An example of internal organization: CEO's span of control and number of layers



3 Descriptive statistics

3.1 Inter-industry comparisons

This section summarizes descriptive statistics derived from firm-level data. Firms are grouped by their industry. In a subsequent section, this paper will focus on characteristics

[12] Rajan and Wulf(2006) and Guadalupe and Wulf (2010) call CEO's span of control just "Span" and the number of layers "Depth".

of firms grouped by their involvement in export and FDI. Tables 1 and 2 present the basic statistics for CEO's span of control and the number of layers for each year respectively. Two important points emerge from these tables.

First, in the electrical machinery industry, firm hierarchies have been becoming flatter, which puts them in line with the existing evidence. CEO's span of control increases, which is 12.93 on average in 2008 and it keeps on increasing until it reaches 13.39 in 2010. On the other hand, the number of layers decreases, which is 2.30 in 2008 and it keeps on decreasing until it goes down to 2.26 in 2010. However, the same can not be seen in the chemical industry, where both CEO's span of control and the number of layers go up and down. One possible reason is that the observation period is too short to capture any long-term trend. Second, there is the possibility that the internal organizations vary across industries. For example, the chemical industry exceeds the electrical machinery industry in the number of layers. We will control for various factors in regression format to consider differences in technology or in other dimensions[13].

Table 1: Descriptive statistics for CEO's span of control

Span of control										
	Electric machinery					Chemical				
Year	Mean	S.D	Min	Max	N	Mean	S.D	Min	Max	N
2008	12.93	8.87	1	67	153	13.12	8.88	3	54	100
2009	13.33	9.24	1	69	153	13.03	8.48	2	50	100
2010	13.39	9.67	1	71	153	13.39	9.27	2	51	100

Table 2: Descriptive statistics for the number of layers

Number of layers										
	Electric machinery					Chemical				
Year	Mean	S.D	Min	Max	N	Mean	S.D	Min	Max	N
2008	2.30	0.85	1	4	153	2.90	1.00	1	6	100
2009	2.28	0.88	1	5	153	2.93	0.98	1	6	100
2010	2.26	0.90	1	5	153	2.91	0.96	1	6	100

[13]The distributions of CEO's span of control and the number of layers are provided in Appendix.

3.2 Inter- and Intra- industry comparisons

This section classifies firms by the volume of their export and FDI. Firms with non-zero export or FDI are defined as "globalized firms", the rest of firms which never export and invest abroad are defined as "domestic firms". Tables 3 and 4 compare globalized firms to domestic firms. Two notable differences between these two types of firms emerge from these tables.

First, internal organizations are considerably different depending on their globalized modes. Globalized firms exceed domestic firms in CEO's span of control, while domestic firms exceed globalized firms in the number of layers in both industries. Second, internal organizations have different trends depending on their globalized modes in the electric machinery industry, whose hierarchies become flatter on average as shown in Tables 1 and 2. CEO's span of control in the electric machinery industry steadily increases over the three years among globalized firms, while that of domestic firms fluctuates. On the other hand, the number of layers of globalized firms slightly increases, while that of domestic firms significantly decreases. On the whole, as we see in the previous section, the internal organization in the electric machinery industry becomes flatter. However, this trend can not be seen in the chemical industry. The evidence above is informative about the differences among firms in the same industry or with similar overseas operations, but it has been confounded by other dimensions of heterogeneity across firms. In the next section, we move to firm-level regressions controlling for various factors.

Table 3: Descriptive statistics for span of control: globalized firms vs. domestic firms

Span of control												
	Electric machinery						Chemical					
	Globalized firms			Domestic firms			Globalized firms			Domestic firms		
Year	Mean	S.D	N	Mean	S.D	N	Mean	S.D	N	Mean	S.D	N
2008	13.91	9.43	118	9.63	5.59	35	14.75	10.06	67	9.82	4.28	33
2009	14.33	9.80	119	9.82	5.78	34	14.64	9.60	66	9.91	4.35	34
2010	14.55	10.33	120	9.61	5.76	36	15.11	10.20	65	10.20	4.64	35

Table 4: Descriptive statistics for the number of layers: globalized firms vs. domestic firms

Number of layers												
	Electric machinery						Chemical					
	Globalized firms			Domestic firms			Globalized firms			Domestic firms		
Year	Mean	S.D	N	Mean	S.D	N	Mean	S.D	N	Mean	S.D	N
2008	2.18	0.80	118	2.71	0.89	35	2.79	1.05	67	3.12	0.86	33
2009	2.18	0.82	119	2.65	1.01	34	2.76	0.99	66	3.26	0.86	34
2010	2.21	0.88	120	2.44	0.97	36	2.75	0.87	65	3.20	1.08	35

4 Regression specification

To evaluate the effect of firm's global activities on their organizations, this paper starts by estimating the following regressions

$$Span_{ijt} = \beta_1 Foreignsales_{ijt-1} + X'_{ijt-1}\gamma + \alpha + \epsilon_{ijt} \tag{1}$$

$$Depth_{ijt} = \rho_1 Foreignsales_{ijt-1} + X'_{ijt-1}\mu + \delta + \eta_{ijt} \tag{2}$$

where i refers to a particular firm, j denotes the industry and the time period (year) is indexed by t. The dependent variables are the CEO's span of control in (1) and the number of layers in (2), respectively. The explanatory variable *Foreignsales* measures the extent to which a firm is involved in global activities. This measure is defined as the sum of export sales and sales by offshore affiliates over the total sales[14]. If a firm neither exports nor invests abroad, this ratio must be zero. X is a vector of other controls including the IT investment, the number of employees, R&D intensity, capital-labor ratio and other firm characteristics. ϵ and η are the error terms. The results from these regressions are comparable with Guadalupe and Wulf

[14]Hence, *Foreignsales* (Kaigai-Uriagedaka-Hiristu in Japanese) is defined as (export sales + sales by offshore affiliates) / total sales, and it is taken from Japan Company Handbook (Kaisya-Shikiho in Japane). Disaggregating *Foreignsales* into export sales and offshore sales or the volume of import is impossible due to data limitation in the Handbook.

(2010) based on basically the same specifications though they focus on the effect of import penetration on the organizations.

Equations (1) and (2) could suffer from an endogeneity problem. First, some organizational characteristics may lead firms to global activities, which results in a reverse causality problem. For example, Bloom, et al. (2012) show that more decentralized firms tend to be more globally active. Second, it is possible that some omitted variables, such as management quality, have an effect on both variables. In this case, the assumption that $Foreignsales$ and the error terms are independent is not held. To respond to these problems, all right-hand side variables are lagged by one year. Moreover, this paper also uses an instrumental variable, which is defined as the share of sales for North America (the United States, Canada and Mexico) in total foreign sales. The choice of this instrument is supported by the following argument: the share of foreign sales for a particular region is arguably correlated with the total foreign sales ratios while the destination composition of foreign sales is not supposed to be correlated with corporate internal organization structures[15].

As this paper exploits the panel nature of the data set, regressions including firm fixed effects to control for unobserved heterogeneity are as follow.

$$Span_{ijt} = \beta_1 Foreignsales_{ijt-1} + X'_{ijt-1}\gamma + \alpha_i + \epsilon_{ijt} \tag{3}$$

$$Depth_{ijt} = \rho_1 Foreignsales_{ijt-1} + X'_{ijt-1}\mu + \delta_i + \eta_{ijt} \tag{4}$$

where α_i and δ_i are the time-invariant characteristics for firm i. Firm-level data for all independent variables are taken from the securities report (Yukashoken-Hokokusho in Japanese). All listed companies are annually required to submit this publicly disclosed report to the government.

[15]In order to check the robustness of results, the author replaces North America with Asia region including China, India, Korea, Thailand, Indonesia and gets almost the same results. The results are provided in Appendix.

The right-hand side variables are expected to have following signs. First, *Foreignsales* is positively related with *Layer*. Caliendo and Rossi-Hansberg (2012) theoretically show that exporters increase the number of layers of management as a result of a trade liberalization. Second, IT investment is positively associated with *Span*. A number of papers such as Garicano (2000), Bresnahan, et al. (2002), Bartel, et al. (2007), demonstrate that IT is an important determinant of organizational design. Garicano (2000) predicts that a decrease in the cost of communication or the cost of acquiring knowledge increases the span of control, while they may have an ambiguous effect on the number of the layer. Third, the number of employees should be positively related with the internal organization since larger firms tend to have more complex organization. Fourth, R&D intensity might affect the internal organization. Acemoglu, et al. (2007) analyze the relationship between new technologies and organizational change. They show that firms closer to the technological frontier are more likely to choose decentralization. Therefore, this paper includes R&D-sales ratios as a measure of innovative activity. Finally, it is possible that the stock option dummy, which takes the value of one if a firm adopts the stock option, affects the internal organization. Prendergast (2002) and Wulf (2007) point out that decentralized decision-making can be coupled with higher performance pay.

This paper also includes other control variables. Capital / labor (K/L) is the typical determinant of overseas operations in the standard Heckscher-Ohlin factor proportions trade theory. Moreover, the author adds the holding company dummy, which takes the value of one if a firm is the holding company. The holding company whose aim is to own other companies' stock should have simple internal organizations. The subsidiary dummy, which takes the value of one if a firm is the subsidiary of another company, is also included, as the subsidiary organization might be different because of parent-subsidiary transactions.

5 Estimation results

This section reports our estimation results and discusses their interpretations. Table 5 displays the results of the CEO's span of control by pooled OLS, IV estimation and a fixed-effect model in all firms combined (columns 1, 2 and 3) and in each industry (columns 4-6 for the electric machinery industry and columns 7-9 for the chemical industry). The following findings are worth noting.

First, the main coefficient of interest β is positive and statistically significant in columns 1, 4 and 7 in the OLS results. Since the coefficient β captures the effect of firms' global activities on their span of control, this finding implies that increases in the foreign sales ratio are associated with wider span of control. The signs of the results are the same in both industries and the magnitudes of estimated coefficients are also similar (0.058 and 0.050). Columns 2, 5 and 8 present the IV results confirming that the main results remain unchanged even when using the instrument[16].

Second, the IT investment has different effects depending on the industry. The IT investment has a positive links with the span of control in the chemical industry, which is consistent with Garicano (2000). However, it has a negative link in the electric machinery industry. The same results remain in the IV estimates. One possible reason for this difference between industries is that industry combines IT with its production process differently. Products in the electric machinery industry themselves are related to IT, so measured IT investment might include investment in specific products. On the other hand, the IT investment is likely to be related with corporate activities of the whole company in the chemical industry, as predicted by the theoy.

Third, the larger a firm is, the greater span of control it has, confirming the existing evidence

[16] The estimated coefficient β with IV for the electric machinery industry (column 5) is smaller than that of the chemical industry (column 8), although the sings are both positive. The difference between industries will be discussed after reporting the result on *Layer*.

such as Guadalupe and Wulf (2010) and Caliendo, et al. (2012).

Fourth, controlling for the firm fixed-effect reduces the statistical significance of many of the independent variables. As the detailed description of the data in tables A4 and A5 indicate, there is little variation of the internal organization within a firm across three years. Therefore, the firm-specific characteristics (the firm dummy) explain a large part of the variations in the internal organization[17].

Fifth, not surprisingly, the holding company dummy has a negative effect on the span of control. The holding company clearly tends to have narrower span of control.

Finally, other control variables are not necessarily statistically significant. Although the signs of R&D coefficient are negative and statistically significant in the whole sample, they are not significant in each industry. The similar results can be seen in K/L.

Table 6 displays the results in the number of layer. The noteworthy findings are as follows. First, the coefficient of $Foreignsales\ \rho$ is negative and statistically significant in columns 1, 4 and 7. IV estimates in columns 2, 5 and 7 produce almost the same results. This finding implies that increases in the foreign sales dependence are associated with fewer layer. Although this outcome differs from the implication predicted by Caliendo and Rossi-Hansberg (2012), this finding is in line with the result of Bloom, et al. (2012) which show that multinationals are more likely to decentralize. Thus, the decline of the number of layers could reflect delegation[18].

Second, IT investment is significant and negatively related with *Layer*. This finding might suggest that IT investment is the driver of decreasing the number of layers. Guadalupe and Wulf (2010) find that the communication technology (CT) investment has the positive link with Layer. This difference might come from our data on IT investment where CT investment

[17]The F-test indicates that the null hypothesis that all the firm-specific effects are zero is rejected at the 1% significance level.

[18]The magnitude of estimated coefficient ρ in the electric machinery industry is larger than that in the chemical industry in the result of *Layer*. We find larger coefficient in the chemical industry in the result of *Span*. Although this difference is partly due to the difference in the original absolute level of *Span*/*Layer*, it also implies that the organization of firms in the chemical industry tend to be more complex since the chemical industry usually spends more on R&D. The complex organization might be pressured to change for speedy decision making to cope with global activities.

is not distinguished among IT in general.

Third, the fixed-effect model reduces the statistical significance of the independent variable, which is the same as *Span*. Fourth, R&D intensity is negatively associated with *Layer* in the whole sample and in the electric machinery, as consistent with the result by Acemoglu, et al (2007) but not in the chemical industry. One possible reason for this difference is that technology progress in the electric machinery industry is more dynamic than the chemical industry during our sample period. Finally, the holding company dummy and subsidiary dummy have a negative effect on *Layer*, as expected.

Table 5: Estimation results (Span of control)

	Dependent variable: Span of control								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Industry		All industries			Electric machinery			Chemical	
Estimation method	OLS	IV	FE	OLS	IV	FE	OLS	IV	FE
Foreign sales/Total sales	0.075	0.127	-0.047	0.058	0.082	-0.017	0.050	0.175	-0.144
	[4.79]***	[3.37]***	[-1.31]	[3.27]***	[1.88]*	[-0.31]	[1.67]*	[2.00]*	[-1.81]*
Employee	1.042	0.991	-0.337	0.994	0.976	-0.494	3.985	3.005	14.398
	[6.50]***	[6.04]***	[-0.71]	[6.14]***	[5.90]***	[-1.02]	[5.62]***	[2.88]***	[1.79]*
IT/Total assets	-1.063	-0.915	-0.269	-1.642	-1.571	-0.325	8.084	7.707	0.299
	[-1.49]	[-1.20]	[-0.82]	[-2.36]**	[-2.10]**	[-0.31]	[6.79]***	[6.07]***	[1.28]
R&D/Total sales	-10.304	-11.596	1.245	-6.968	-8.062	2.645	-22.439	-36.903	-9.397
	[-2.20]**	[-2.11]**	[0.57]	[-1.52]	[-1.55]	[0.81]	[-1.45]	[-1.75]*	[-0.54]
Capital/labor (K/L)	10.332	11.665	-1.280	0.266	-0.261	0.174	22.862	37.758	9.665
	[2.14]**	[2.06]**	[-0.57]	[0.29]	[-0.03]	[0.38]	[1.43]	[1.74]*	[0.54]
Stock option Dummy	0.033	-0.008	-0.012	-0.020	-0.033	-0.023	2.379	1.303	-0.213
	[0.71]	[-0.15]	[-0.62]	[-0.48]	[-0.69]	[-0.44]	[1.09]	[0.68]	[-0.74]
Holding Dummy	-5.667	-6.008		-4.091	-3.853		-8.515	-9.034	
	[-3.39]***	[-3.15]***		[-2.25]**	[-2.20]**		[-3.76]***	[-3.66]***	
Subsidiary Dummy	0.370	0.977		1.402	1.700		-1.963	-0.561	
	[0.47]	[1.11]		[1.41]	[1.54]		[-1.55]	[-0.39]	
Electric Dummy	-1.713	-2.262							
	[-2.37]**	[-2.57]**							
Constant	10.971	9.957	15.128	9.726	9.080	14.816	8.734	7.231	4.379
	[18.87]***	[13.19]***	[12.42]***	[16.73]***	[7.34]***	[7.23]***	[14.16]***	[7.05]***	[0.66]
Adjusted R-squared	0.335	0.318	-0.004	0.417	0.413	-0.006	0.332	0.288	0.067
N	506	506	506	306	306	306	200	200	200

Note: The asterisks ***, ** and * denote the statistical significance at 1%, 5% and 10%, respectively. T statistics (in parentheses) are computed from Heteroskedasticity-robust standard errors. All explanatory variables are one-year lagged.

Table 6: Estimation results (Number of Layers)

Dependent variable: Number of layers									
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Industry	All industries			Electric machinery			Chemical		
Estimation method	OLS	IV	FE	OLS	IV	FE	OLS	IV	FE
Foreign sales/Total sales	-0.008	-0.018	0.005	-0.007	-0.017	0.003	-0.014	-0.025	0.013
	[-4.83]***	[-3.97]***	[0.61]	[-3.78]***	[-3.01]***	[0.31]	[-2.39]**	[-2.34]**	[0.60]
Employee	0.008	0.017	0.102	0.006	0.014	0.111	0.101	0.186	-1.076
	[1.21]	[1.96]*	[1.12]	[0.93]	[1.60]	[1.19]	[1.62]	[2.01]**	[-1.06]
IT/Total assets	-0.673	-0.700	-0.035	-0.517	-0.547	-0.043	-2.435	-2.402	0.082
	[-3.75]***	[-3.98]***	[-0.75]	[-5.60]***	[-5.08]***	[-0.80]	[-13.02]***	[-13.01]***	[0.50]
R&D/Total sales	-1.676	-1.439	-0.378	-2.009	-1.534	-0.775	-0.991	-0.264	3.184
	[-3.08]***	[-2.46]**	[-0.86]	[-3.78]***	[-2.23]**	[-1.38]	[-0.46]	[0.10]	[1.56]
Capital/labor (K/L)	1.728	1.439	0.390	0.357	1.624	0.135	1.034	-0.258	-3.280
	[3.08]***	[2.46]**	[0.86]	[0.33]	[1.07]	[0.80]	[0.46]	[-0.10]	[-1.56]
Stock option Dummy	0.034	0.041	0.003	0.037	0.042	0.007	-0.021	0.072	-0.168
	[6.32]***	[6.70]***	[0.86]	[6.76]***	[6.14]***	[1.42]	[-0.13]	[0.40]	[-0.84]
Holding Dummy	-1.022	-0.959		-0.897	-1.001		-0.804	-0.759	
	[-3.98]***	[-3.78]***		[-2.48]**	[-2.64]***		[-5.38]***	[-4.99]***	
Subsidiary Dummy	-0.404	-0.515		-0.479	-0.608		-0.293	-0.414	
	[-2.84]***	[-3.40]***		[-2.54]**	[-3.05]***		[-1.38]	[-1.66]*	
Electric Dummy	-0.455	-0.355							
	[-5.09]***	[-3.60]***							
Constant	3.116	3.302	2.240	2.665	2.946	1.991	3.162	3.292	3.561
	[40.37]***	[29.40]***	[8.64]***	[29.33]***	[21.26]***	[5.88]***	[28.22]***	[29.40]***	[3.65]***
Adjusted R-square	0.177	0.124	-0.003	0.101	0.009	0.006	0.052	0.024	-0.006
N	506	506	506	306	306	306	200	200	200

Note: The asterisks ***, ** and * denote the statistical significance at 1%, 5% and 10%, respectively. T statistics (in parentheses) are computed from Heteroskedasticity-robust standard errors. All explanatory variables are one-year lagged.

6 Concluding remarks

This paper empirically examines how internal organizations are related to firms' global activities using firm-level data. In order to study this relationship, this paper uses firm-level data in Japan over the year 2008 to 2010. This paper first divides firms' organizations by the extent of firm's global activities and compare their features. The disaggregation shows that exporters or FDI firms exceed domestic firms in CEO's span of control (*Span*) on average, while domestic firms exceed exporters or FDI firms in the number of layers (*Layer*). Then this paper estimates firm-level regressions controlling for various factors. The major findings of regressions are threefold. First, the organizations of more globally engaged firms tend to have broader *Span*. Second, they also tend to have fewer *Layer*. Third, IT investment has a negative link with *Layer*.

The findings of this paper have important policy implications. It is widely supported by many previous literature that only productive firms are able to tap into foreign markets. Helpman, et al. (2004) predict the sorting pattern among FDI firms, exporters and domestic firms according to productivity and empirical papers such as Tomiura (2007) confirm this ordering. On the other hand, it is also evident that the organization affects the firm performance (Bresnahan, et al. (2002), Acemoglu, et al. (2007)). These two line of studies combined imply that organization could be one of the channels to link firms' global activities to their productivities. Further organizational change may make this link stronger. This paper is an attempt to focus on this unexplored link. As there are many organizational restrictions in many countries, facilitating corporate reorganizations might be useful to overcome entry barriers to exporting and FDI. For instance, improving regulations on mergers and acquisition is fruitful for potential exporters and FDI firms.

Although this paper reports informative firm-level observations, cementing the generality of this finding will be desirable in the future studies. One will also find it interesting to seek firms' organization data which are linked with trade liberalization in longitudinal format and identify the causal effect among firms' organization, international trade and their productivities.

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Appendix. Data Description and Robustness checks

Figure A1: Span of control in 2008

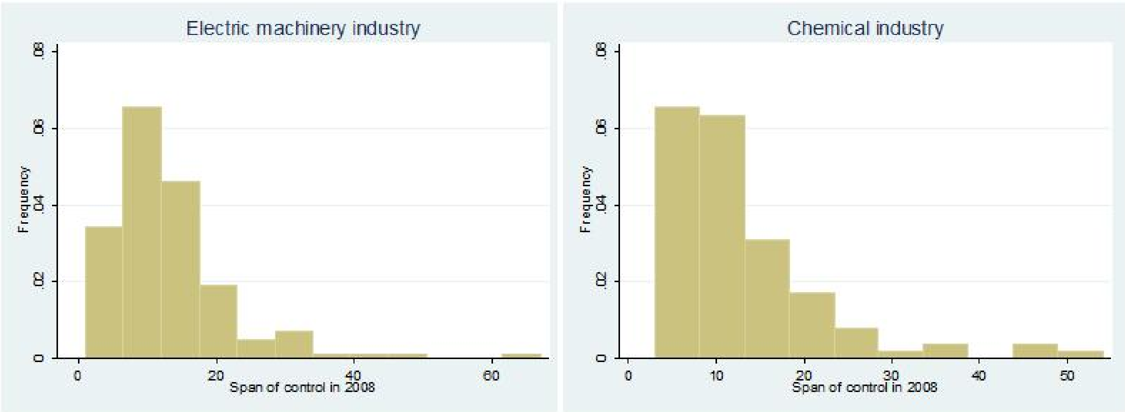

Figure A2: Number of layers in 2008

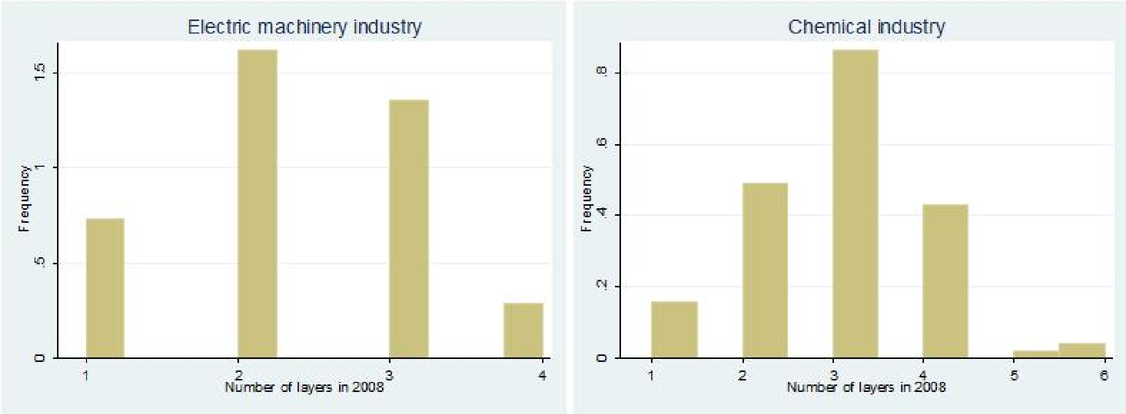

Table A1: Comparisons with the average in Basic Survey of Japanese Business Structure and Activities (BSJ)

	Electric machinery		Chemical	
	Our sample	BSJ	Our sample	BSJ
Number of employees	2,135	622	810	501
Sales	182,406	46,870	79,827	40,114
Capital/labor (K/L)	12.7	10.7	27.6	24.8

Notes: The original data of sales are in millions of yen.

Source: The securities report, Basic Survey of Japanese Business Structure and Activities

Table A2: Correlation matrix of electric machinery industry

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Foreign sales/Total sales	[1]	1.00							
Employee	[2]	0.18	1.00						
IT/Total assets	[3]	-0.01	-0.003	1.00					
R&D/Total sales	[4]	0.19	0.003	-0.01	1.00				
Capital/Labor (K/L)	[5]	0.16	0.01	-0.01	0.08	1.00			
Stock option Dummy	[6]	0.09	0.00	0.02	0.34	-0.01	1.00		
Holding Dummy	[7]	0.03	-0.05	-0.02	0.10	0.56	-0.01	1.00	
Subsidiary Dummy	[8]	-0.13	-0.04	-0.01	-0.01	-0.05	0.14	-0.05	1.00

Source: The securities report

Table A3: Correlation matrix of chemical industry

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Foreign sales/Total sales	[1]	1.00							
Employee	[2]	0.49	1.00						
IT/Total assets	[3]	0.01	-0.02	1.00					
R&D/Total sales	[4]	-0.01	-0.03	0.15	1.00				
Capital/Labor (K/L)	[5]	-0.02	-0.03	0.15	0.99	1.00			
Stock option Dummy	[6]	0.32	0.24	-0.01	-0.04	-0.04	1.00		
Holding Dummy	[7]	0.03	-0.07	-0.01	-0.01	-0.01	0.20	1.00	
Subsidiary Dummy	[8]	-0.10	-0.01	-0.01	-0.02	-0.02	0.05	-0.03	1.00

Source: The securities report

Table A4: Robustness check (Span of control)

	Dependent variable: Span of control		
	[1]	[2]	[3]
Industry	All industries	Electric machinery	Chemical
Estimation method	IV	IV	IV
Foreign sales/Total sales	0.111	0.089	-0.018
	[3.80]***	[2.22]***	[-1.87]*
Employee	1.005	0.969	0.131
	[6.22]***	[5.90]***	[1.45]
IT/Total assets	-0.995	-1.492	-2.423
	[-1.29]	[-2.20]**	[-12.99]**
R&D/Total sales	-11.242	-8.482	-0.544
	[-2.16]**	[-1.68]*	[-0.23]
Capital/labor (K/L)	11.230	1.810	0.574
	[2.11]**	[-0.18]	[0.24]
Stock option Dummy	0.034	-0.034	0.012
	[0.07]	[-0.72]	[0.08]
Holding Dummy	-5.914	-3.824	0.788
	[-3.24]**	[-2.18]**	[-5.04]***
Subsidiary Dummy	0.811	1.787	-0.336
	[0.94]	[1.57]	[-1.48]
Electric Dummy	-2.112		
	[-2.49]**		
Constant	10.235	8.900	3.208
	[15.11]***	[7.22]***	[22.40]***
Adjusted R-squared	0.326	0.407	0.482
N	506	506	506

Note: IV for the foreign sales ratio is the foreign sale ratio for Asia region including China, India, Korea, Thailand, Indonesia. The asterisks ***, ** and * denote the statistical significance at 1%, 5% and 10%, respectively. T statistics (in parentheses) are computed from Heteroskedasticity-robust standard errors. All explanatory variables are one-year lagged

Table A5: Robustness check (Number of Layers)

	Dependent variable: Span of control		
	[1]	[2]	[3]
Industry	All industries	Electric machinery	Chemical
Estimation method	IV	IV	IV
Foreign sales/Total sales	-0.014	-0.012	0.024
	[-3.36]***	[-2.37]**	[0.45]
Employee	0.013	0.010	4.185
	[1.67]*	[1.30]	[5.27]***
IT/Total assets	-0.690	-0.541	8.161
	[-3.78]***	[-5.41]***	[6.82]***
R&D/Total sales	-1.581	-1.747	-19.815
	[-2.74]***	[-2.82]**	[-1.20]
Capital/labor (K/L)	0.038	0.039	2.599
	[6.49]***	[6.38]***	[1.16]
Stock option Dummy	0.038	0.039	2.599
	[6.49]***	[6.38]***	[1.16]
Holding Dummy	-0.984	-0.946	-8.410
	[-3.94]***	[-2.49]**	[-3.70]***
Subsidiary Dummy	-0.471	-0.546	-2.249
	[-3.16]***	[-2.77]***	[-1.67]*
Electric Dummy	-0.395		
	[-3.99]***		
Constant	3.228	2.811	9.0414
	[30.31]***	[17.02]***	[11.69]***
Adjusted R-squared	0.173	0.09	0.357
N	506	506	506

Note: IV for the foreign sales ratio is the foreign sale ratio for Asia region including China, India, Korea, Thailand, Indonesia. The asterisks ***, ** and * denote the statistical significance at 1%, 5% and 10%, respectively.
T statistics (in parentheses) are computed from Heteroskedasticity-robust standard errors. All explanatory variables are one-year lagged

Table A6: Basic statistics of electric machinery industry

Variable		Mean	S.D.	Min	Max	Observations
Span of control	overall	13.21	9.25	1	71	N = 459
	between		9.08	1	69	n = 153
	within		1.84	-0.79	22.21	T = 3
Number of Layers	overall	2.28	0.88	1	5	N = 459
	between		0.82	1	4.33	n = 153
	within		0.32	0.95	3.61	T = 3
Foreign sales/Total sales	overall	32.66	27.33	0	100	N = 459
	between		27.22	0	100	n = 153
	within		3.01	17	44	T = 3
Employee	overall	2.15	5.64	0.01	37.28	N = 459
	between		5.64	0.01	35.16	n = 153
	within		0.34	-1.95	4.26	T = 3
IT/Total sales	overall	0.02	0.13	0	2.58	N = 459
	between		0.07	0	0.86	n = 153
	within		0.10	-0.84	1.74	T = 3
R&D/Total sales	overall	0.06	0.08	0	0.64	N = 459
	between		0.06	0	0.38	n = 153
	within		0.04	-0.17	0.43	T = 3
Capital/Labor (K/L)	overall	0.16	0.40	0	4.92	N = 459
	between		0.33	0	3.28	n = 153
	within		0.23	-2.96	1.80	T = 3
Stock option Dummy	overall	0.48	3.15	0	67.00	N = 459
	between		1.86	0	22.67	n = 153
	within		2.54	-22.19	44.81	T = 3
Holding Dummy	overall	0.02	0.15	0	1	N = 459
	between		0.15	0	1	n = 153
	within		0.04	-0.64	0.36	T = 3
Subsidiary Dummy	overall	0.10	0.30	0	1	N = 459
	between		0.30	0	1	n = 153
	within		0	0.10	0.10	T = 3

Notes: In “Observations” column, N refers to the total observations; n refer to the number of firms; T refers to the year when data are available.

Source: The securities report and The Handbook of Organizational and Systematical Figures (Soshikizu-Keitouzu-Binran in Japanese).

Table A7: Basic statistics of chemical industry

Variable		Mean	S.D.	Min	Max	Observations
Span of control	overall	13.18	8.85	2	54	N = 300
	between		8.72	3	51.67	n = 100
	within		1.71	4.18	19.85	T = 3
Number of Layers	overall	2.91	0.98	1	6	N = 300
	between		0.90	1	5.33	n = 100
	within		0.39	1.25	4.25	T = 3
Foreign sales/Total sales	overall	19.73	17.96	0	68	N = 300
	between		17.93	0	67.33	n = 100
	within		1.77	9.73	26.73	T = 3
Employee	overall	0.82	1.06	0.04	6.23	N = 300
	between		1.06	0.04	6.07	n = 100
	within		0.06	0.22	1.15	T = 3
IT/Total sales	overall	0.01	0.05	0	0.80	N = 300
	between		0.03	0	0.27	n = 100
	within		0.04	-0.26	0.54	T = 3
R&D/Total sales	overall	0.16	1.48	0	18.34	N = 300
	between		1.21	0	12.17	n = 100
	within		0.86	-11.20	6.33	T = 3
Capital/Labor (K/L)	overall	0.14	1.38	0	17.80	N = 300
	between		1.12	0	11.27	n = 100
	within		0.80	-11.12	6.67	T = 3
Stock option Dummy	overall	0.21	0.41	0	1	N = 300
	between		0.39	0	1	n = 100
	within		0.12	-0.46	0.87	T = 3
Holding Dummy	overall	0.01	0.10	0	1	N = 300
	between		0.10	0	1	n = 100
	within		0.00	0.01	0.01	T = 3
Subsidiary Dummy	overall	0.07	0.26	0	1	N = 300
	between		0.26	0	1	n = 100
	within		0.00	0.07	0.07	T = 3

Notes: See note to Table A4.

Source: The securities report and The Handbook of Organizational and Systematical Figures (Soshikizu-Keitouzu-Binran in Japanese).

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Chapter 2

「Effects of agglomeration and R&D activities on plant internationalization: evidence from Japan」

Chapter2
Effects of agglomeration and R&D activities on plant internationalization: evidence from Japan

Abstract

Promoting the global activities of domestic firms has been a main concern of policy makers in many countries. Although recent trade theories predict that productive firms will engage in global activities, empirical studies have pointed out that the impact of the productivity of firms on the exports is diluted by other factors. This paper investigates the agglomeration effect on plant global activity by using a unique plant-level data in Yokohama City. As agglomeration is likely to be related with others' characteristics, this study examines the effects between agglomeration and R&D on their global activities. The major findings are threefold. First, agglomeration is positively related to the plants' global activities. Second, spillovers from other plants located nearby to a plants decision to engage in global activities are the strongest when they are in the same industry and trade with the same countries. Third, the effect of agglomeration is stronger in smaller plants.

Key words: Globalization; Agglomeration; R&D; Plant-level data

1 Introduction

Promoting internationalization of domestic firms has been a main concern of policy-makers in many countries. As competition with low-wage developing countries has become more intense, manufacturers in industrialized countries need to strengthen their competitive positions more to expand overseas business. Although trade theories predict that firm's internal characteristics such as productivity, firm size and skill-intensity will induce firms self-select into global markets, empirical literature has pointed out that the impact of a firm's characteristics on export decision is diluted by other factors. This fact implies that other determinants of a firm's global activities cannot be ignored. On the other hand, there is increasing consensus that a firm's external network relations matters for its economic and innovative performance. It is possible that firms can gain information from other innovative firms which are located nearby. Firms might be more willing to export after learning from the experience of other local firms. This paper examines how external networking and internal firm's characteristics as captured by R&D spending are related with firms' global activities.

Recent international trade theories have formalized how firms engage in global activities. According to these models, a firm's global activities depend on the firm's own productivity. Melitz (2003) introduces firm heterogeneity into the intra-industry trade model to produce a standard platform for analyzing a host of issues in international trade. Firms which are productive enough to cover fixed costs can be exporters. Less productive firms engage only in the domestic market. Whereas, Helpman et al. (2004) generalizes the analysis to incorporate FDI, allowing firms to choose between incurring the fixed costs of exporting or a fixed cost of establishing an overseas affiliate. They predict that the most productive firms operate in the foreign market through FDI, medium productive firms export and less-productive firms only operate in the domestic market. Antrs and Helpman (2004) demonstrate how a firm outsources intermediate inputs to a standalone supplier or foreign subsidiary in the firm heterogeneity context. In this model, more productive firms outsource components to engage in FDI, while less-productive firms outsource to a domestic supplier. These models shift empirical research from the national-level to firm-level to examine new predictions of these theories and explore other dimensions of the data not originally captured by previous theories.

Firm heterogeneity in international trade has been extensively investigated. The researches have uncovered significant relationships between a firm's global activities and a firm's characteristics. Bernard and Jensen (1995) show that within an industry, some firms export while many others do not and that exporters are larger, more skill-intensive, more capital-intensive and more productive[1]. However, there are still far from sufficient to explore firms' global activities. Bernard, et al. (2003) and Mayer and Ottaviano (2007) find that part of productive firms do not serve foreign markets, while part of non-productive firms are active in export and FDI in U.S. and Belgian firms, respectively. Tomiura (2007) shows the similar regularity between domestic firms and firms which source abroad through foreign outsourcing. These findings imply that productivity alone does not sufficiently explain the self-selection of firms into exporting and often global business activities and find a wide overlap in productivity distributions.

On the other hand, accumulated studies point out that a firm's external network plays an important role of innovation. Gilsing et al. (2008) indicate that a firm's embeddedness in a network of interfirm relations matters for its economic and innovative performance. Jong and Freel (2010) show that a firm's absorptive capacity is positively related to the geographical distance to innovation partners. The studies on international trade are also motivated by this issue. Greenaway and Kneller (2008) investigate the relationship between agglomeration and firms' exporting. They find that spillovers associated with agglomeration raise the probability of export market entry by studying manufacturing firms in the UK. Similarly, Koenig, et al. (2011) examined 8,000 French single-plant firms and showed that the presence of export spillover on the export decision but not on the exported volume. Silvente and Gimenez (2007) and Yang, et al. (2004) show similar results using Spanish and Taiwanese small- and medium-sized enterprises (SMEs), respectively.

By combining these two strands of research, this paper compares the importance of the

[1]For example, Bernard and Jensen (1995) present that exporters are 97% larger in employment, 12% more capital-intensive and 11% more productive than domestic firms.

external networks and internal activities such as R&D on global activities. In recent years, firms have increasingly relied not only on the internal R&D activity, but also on external sources of knowledge such as information garnered from other firms. For example, Tomiura (2007b) examine the impact own R&D and external networking on the firm's exporting decision, although agglomeration is not considered. The role of this external networks when firms engage in foreign markets cannot be ignored to well understand firms' global activities. Further, innovation-related agglomeration has attracted the attention of policy makers in order to propose appropriate policies to support firms' global activities.

The rest of this paper is organized as follows. Section 2 describes the data. Section 3 explains empirical specifications. Section 4 reports estimation results. Section 5 closes with final remarks.

2 Description of Data

2.1 Data source

The plant-level data used for this paper is derived from Yokohama City SMEs Survey (Yokohama-Shi Chusho Kigyo Jittai Chosa in Japanese), which are conducted by the department of commerce and tourism of Yokohama city. This survey covers 2,900 manufacturing SMEs plants in Yokohama city, one of the largest city in Japan. Since it is designed for the SMEs policy, this survey does not include 133 large-sized plants with more than 300 employees. But the survey covers 98% of the population of all plants in Yokohama city. Thus this sample is regarded as the almost covered representation of the whole of manufacturing plants in the city. This survey includes such detailed information as employment, R&D, sales, industries, status of global activities (countries) and addresses . Since 37% of observations are lost due to no response or missing data, the resulting sample is 1,844 and the survey was conducted only once in 2010.

2.2 Variables of agglomeration and productivity

The next step consists of setting spillover variables for the global activities using data. The author defines spillover variables by the number of plants which engage in global activities. In this counting concept, spillovers can be of three different natures. This paper defines country specific spillovers (the number of other plants trading with the same country), industry specific spillovers (the number of other plants trading with foreign firms in the same industry) and country-industry specific spillovers (the number of other plants trading with the same country in the same industry). All 1,844 plants are grouped into 23 two-digit industries. Foreign countries include 15 countries, which are the major trading partners for Japanese plants, and 3 regions (EU, Middle East and Africa). Thus, industry and country spillover variables for plant i, country j, in industry k is defined as follows

$$Spillover_{ijk} = the\, number\, of\, other\, plants_{ijk} \tag{1}$$

As the variable for productivity, this paper uses labor productivity as it is one of the most frequently used measures. It is defined by log of a firm's gross output (sales) per worker. The numeration is firm's output, as we cannot calculate value-added due to data constraint in our micro-data. Since a plant's productivity cannot be calculated due to the data limitation, this paper uses a firm's productivity[2]. As the globalization decision is likely to made at the corporate level, our use of firm-level productivity can be justified for our research purpose. The author cannot calculate Total Factor Productivity (TFP) by estimating of a production function because of the cross-section in data format.

[2]The number of employees is reported both plant- and firm- level, but the sales is reported only at the firm level in the survey.

3 Descriptive statistics

This section summarizes descriptive statistics derived from the plant-level data. Plants are classified by whether they transact with foreign firms. Plants which never deal with foreign firms are defined as " domestic plants ", while plants which have some kind of business transactions with overseas firm, including exports, FDI, foreign outsource and import, are defined as " globalized plants " [3]. Table 1 compares globalized plants to domestic plants. This paper notes the following points from this table. First, about 85% of the plants are " domestic plants " (never involved in global activities). Despite this paper's broad definition of global activities, the share of domestic plants among all the sample is overwhelming. This result is consistent with a number of previous studies such as Bernard, et al. (2007) and Mayer and Ottaviano (2007). Second, plants which engage in global activities are larger, more productive and more R&D-intensive. For example, globalized firms' log of the number of employees is 117% larger than domestic plants. This result is almost the same as Bernard, et al. (2007).

Table 1: Descriptive statistics: globalized plants vs. domestic plants

Variable	Observation	Mean	Std.Dev.	Min	Max
Globalized plants	287				
ln (Plant's employee)		1.34	0.51	0	2.59
ln(Firm's employee)		13.18	1.68	7.50	18.32
Firm's labor productivity		4.36	0.43	1.39	6.19
R&D intensity 1-15%		0.72	0.45	0	1
R&D intensity over15%		0.02	0.15	0	1
Domestic plants	1557				
ln (Plant's employee)		0.83	0.50	0	2.52
ln(Firm's employee)		11.18	1.91	0.69	18.93
Firm's labor productivity		4.09	0.52	-0.07	7.10
R&D intensity 1-15%		0.32	0.47	0	1
R&D intensity over15%		0.01	0.10	0	1

Source: Yokohama City SMEs Survey

[3]We cannot distinguish each type of global activities, such as exporters, FDI firms, within this data set.

Table 2: Distribution statistics of spillovers

The number of other plants	[1] All industries-same country	[2] Same industry-all countries	[3] Same industry-same country
0	1636	45	1508
0-10	0	385	69
10-20	0	274	64
20-30	0	127	52
30-40	2	81	35
40-50	4	581	22
50-60	0	0	28
60-70	5	0	18
70-80	0	351	18
80-90	6	0	7
90-100	0	0	4
over 100	191	0	19

Source: Source: Yokohama City SMEs Survey

Table 2 presents distribution statistics of spillovers. Columns 1, 2 and 3 show country-specific spillovers, industry specific spillovers and country-industry specific spillovers, respectively. Variables for each spillover are defined as the number of other plants in the city as mentioned in Section 2. Several notable differences among variables of spillovers emerge from this table. First, the amount of country specific spillovers is extremely limited. For 89% of the observations, there are no neighboring plants which transact with the same destinations. Thus about 90% of plants cannot get spillovers in this case. We must also note, however, that plants receive country — specific spillover from 191 other plants if all industries are combined. Second, the industry specific spillovers is biggest. Contrary to country-specific spillovers, most plants can get this type of spillovers. Finally, country-industry specific spillovers is in the intermediate rage.

4 Regression specification

This paper estimates the following specification relating the probability that the plant i transacting country j in industry k with various characteristics, industry and destinations dummies.

$$\Pr(Y > 0) = \alpha + \beta\, Spillover_{ijk} + \gamma_1\, R\&D(1-15\%) + \gamma_2\, R\&D(over 15\%) + \delta_2\, ln(Employees) + \delta_3\, Country\, Dummy + \delta_4\, Industry\, Dummy + \epsilon_{ijk} \quad (2)$$

Included on the right-hand side are the spillovers, two types of R&D intensity dummies (1-15% and over 15%), the log of a firm's labor productivity, the log of a plant's size in the number of employee, destination dummy and industry dummy . The error term is expressed by ϵ. Since Tomiura (2007b) find that firms active in R&D tend to export, R&D dummies are included. Further, as accumulated evidence such as Bernard and Jensen (1999) and Bernard, et al. (2007) have established that firms which active in foreign markets including exporters and importers are larger, more productive. Plant's employee and labor productivity are also included. The agglomeration variables are considered to be exogenous for each firm. Firms cannot choose the number of other plants in their regions. The causality seems to be running from agglomeration to each firm's global activities, not the other way around. However cross-section estimates should not be interpreted as showing the direction of causality.

The sign of the explanatory variables are expected to have following signs. First, *Spillover* is positively related with the probability of the plants' global activities. Plants which have more external sources are likely to engage in foreign markets. Second, as previous research such as Tomiura (2007b) have established that firms active in R&D tend to export, the signs of R&D are supposed to be positive. Finally accumulated evidence such as Bernard and Jensen (1999) and Bernard, et al. (2007) shows that exporter, FDI firms and foreign outsourcers are more productive and large in terms of size. Thus, labor productivity and employee size are supposed to have a positive influence on global activities.

5 Estimation results

5.1 Basic results

This section reports our estimation results. The results from the specification explained in the previous section are first reported. The results disaggregated by plant size classes or sectors will be shown next[4]. The equation is estimated by logit. The following findings are worth noting.

Columns 1 and 2 present the estimates based on the specification used in previous studies. Plants' size and firms' productivity are significantly and positively related with the plants' global activities while controlling for destinations and industry. These results are consistent with wide previous studies such as Bernard and Jensen (1999) and Mayer and Ottaviano (2007).

Column 3 adds R&D intensity dummies. While R&D intensity in the 1-15% is statistical significant, R&D intensity over 15% is not significantly associated with plants' global activities. The plants with extremely high R&D intensive might be venture labo plants, which R&D activities without extensively engaging in sales and other business activities.

Columns 4, 5 and 6 add spillover variables. They are all positive and statistically significant, confirming Greenaway and Kneller (2008) and Koenig, et al. (2011). Directional and industrial agglomeration might offer opportunities for reducing sunk entry costs. In addition, the coefficient of country-industry specific spillovers is the biggest among the three types of spillovers (the coefficient is 0.077). Industry specific spillovers are the second-largest (the coefficient is 0.023). Country specific spillovers are the smallest (the coefficient is 0.014). This

[4]Disaggregation by region within the city is also tried, but no significant difference is found. Appendix Table 2 and 3 report the regional clarification and these results. This is possibly due to limited variation across regions within a city district.

Table 3: Basic estimation results

Variables	[1]	[2]	[3]	[4]	[5]	[6]
All industries-same country				0.014		
(country specific spillover)				[2.45]**		
Same industries-all countries					0.023	
(industry specific spillover)					[8.86]***	
Same industires-same countries						0.077
(country-industry specific spillover)						[4.02]***
ln(plant's employee)	1.834	1.191	1.095	1.174	0.860	1.077
	[13.99]***	[6.30]***	[5.77]***	[5.93]***	[3.38]***	[4.89]***
ln(firm's labor productivity)		0.821	0.806	0.869	1.105	0.755
		[4.28]***	[4.14]***	[4.37]***	[4.74]***	[3.59]***
R&D intensity 1-15%			0.553	0.550	0.678	0.398
			[2.78]***	[2.77]***	[2.51]**	[1.90]*
R&D intensity over 15%			0.356	0.328	0.328	0.156
			[0.72]	[0.65]	[0.55]	[0.30]
Constant	-3.670	-7.523	-7.626	-8.830	-9.470	-8.142
	[-21.34]***	[-9.03]***	[-9.00]***	[-8.71]***	[-8.54]***	[-8.55]***
Pseudo R^2	0.509	0.5175	0.5218	0.5247	0.6931	0.5808
Observation	1844	1844	1844	1844	1844	1844

Note: The asterisks ***, ** and * denote the statistical significance at 1%, 5% and 10%, respectively. Z statistics are in parentheses.

order of impact of spillovers is consistent with Koenig et al. (2010). However these magnitude of estimated coefficient β are far smaller than those of other typical determinants of overseas operations. This fact implies that a plant's internal characteristics are more important than external networks.

5.2 Regression disaggregated by plant size classes

Table 4 reports the logit estimation results from three sub-samples disaggregated by plant size. Large plants are defined by plants with the number of employee over 100, while middle-sized plants with that between 20 and 100. Small plants are plants with less than 20. The noteworthy findings are as follows.

First, the lager coefficients of agglomeration variables are, the smaller plant size is. For example, the coefficient of country-industry specific spillovers is the biggest in the small plants (the coefficient is 0.133). The magnitudes decrease as the plants size is bigger. A likely interpretation for this finding is that large plants overcome entry barriers to overseas business without the outside source of information. They have plenty technological advantages over competitors in foreign markets. In other words, agglomeration benefits are crucial for small-sized plants to engage in global businesses.

Second, the effect of R&D intensity on the global activities is not evident in large-sized plants. The statistical significance of R&D-sales ratio vanishes if the author concentrates on the variation within large-sized plants. This result is consistent with some previous work. For example, Nassimbeni (2001) reported that the export propensity of small firms is strictly linked to their innovation ability. Also, this interpretation may reflect the fact that the magnitudes of productivity are small in small-sized plants.

5.3 Regressions disaggregated by sectors

Since the effect of agglomeration is likely to vary across sectors, Table 5 reports the sector-specific estimation results. The plants are classified into three sectors: Supplier-dominated sector, Scale-intensive sector and Science-based sector, which are based on the taxonomy of Pavitt (1984). The list of industries is provided in Appendix. This table implies that the magnitude of agglomeration is apparently different among three sectors. For example, the coefficient of country-industry specific spillovers is the biggest in Science-based sector, while the coefficient of industry specific spillovers is the biggest in Scale-intensive sector. In addition, the coefficient of country-industry specific spillovers is not evident in Supplier-dominated sector. The plant size is more important for that sector to engage in foreign markets. This cross-sectoral contrasts seems plausible. For example, setting up textile factory in developing countries costs a lot. Thus the magnitudes of the number of employee are larger in Supplier-dominated sector than in the other sectors.

6 Concluding remarks

This paper examines how external networking and internal plants' characteristics are related with plants' global activities. External networking is measured by the number of other plants in the same area while internal plants' characteristics are represented by firms' productivities and R&D intensities. The major findings are threefold. First, agglomeration is positively related to the plant's global activities. Second, spillovers on plants' decisions to engage in global activities are the strongest when other plants located nearby are in the same industry and traded with the same countries. Third, the smaller plant is, the larger coefficients of agglomeration variables are.

The findings of this paper have important policy implications. Global activities of plants clearly not only rely on plants' self-contained characteristics such as R&D spending, size, productivity and industry but also on external networks. Especially, the effect of agglomeration on global activities cannot be ignored for small and medium-sized plants. Public support to facilitate connection with other plants should be emphasized when we discuss the policy for SMEs. However, in order to detect specific policy recommendations, these results should be supplemented with other data, for example those capturing transactions between plants. As micro-data or inter-plant transaction are not publicly available, the research of this issue is left for further work.

Table 4: Estimation disaggregated by firm-size classes

	Large plants			Mid-sized plants			Small plants		
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
All industries-same country	0.09			0.023			0.036		
(country specific spillover)	[1.08]			[2.22]**			[3.40]***		
Same industries-all countries		0.018			0.022			0.028	
(industry specific spillover)		[3.26]***			[8.08]***			[5.18]***	
Same industires-same countries			0.045			0.079			0.133
(country-industry specific spillover)			[1.92]*			[2.57]***			[4.03]***
ln(firm's labor productivity)	1.921	1.869	1.898	0.994	1.139	0.740	0.871	0.973	0.593
	[3.06]***	[2.53]**	[2.81]***	[2.29]**	[2.23]**	[1.98]**	[3.14]***	[3.13]***	[1.18]
R&D intensity 1-15%	0.300	-0.240	0.242	0.860	0.765	0.658	0.781	1.327	0.639
	[0.88]	[-0.59]	[0.75]	[2.24]**	[1.59]	[1.65]*	[1.90]*	[2.72]***	[1.18]
R&D intensity over 15%	0.667	0.744	1.203	0.528	-0.508	0.222	-0.929	0.378	-0.857
	[0.61]	[0.49]	[1.13]	[0.66]	[-0.45]	[0.25]	[-0.69]	[0.30]	[-0.50]
Pseudo R^2	0.504	0.626	0.537	0.482	0.686	0.555	0.587	0.715	0.676
Observation	283	283	283	495	495	495	1066	1066	1066

Note: The asterisks ***, ** and * denote the statistical significance at 1%, 5% and 10%, respectively. Z statistics are in parentheses.

Table 5: Sector-specific estimation results

	Supplier-dominated sector			Scale-intensive sector			Science-based sector		
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
All industries-same destinations	-0.012			0.006			0.182		
(country specific spillover)	[-0.29]			[0.45]			[1.64]		
Same industries-all destinations		0.029			0.028			0.021	
(industry specific spillover)		[3.66]***			[5.49]***			[5.12]***	
Same industires-same destinations			1.449			0.170			0.208
(country-industry specific spillover)			[1.38]			[4.55]***			[4.59]***
Employee between 10 and 30	2.878	2.075	2.264	0.265	-0.042	-0.147	0.451	-0.124	-0.086
	[2.25]**	[1.17]	[0.79]	[0.62]	[-0.06]	[-0.33]	[1.03]	[-0.20]	[-0.13]
Employee over 30	3.076	3.225	2.688	0.939	1.333	0.164	1.479	0.920	0.878
	[2.54]**	[1.88]*	[0.91]	[1.96]**	[2.18]**	[0.19]	[3.81]***	[1.94]	[1.71]
ln(firm's labor productivity)	0.558	1.235	-0.507	1.154	1.261	1.181	0.934	1.353	0.775
	[0.80]	[1.58]	[-0.68]	[2.87]***	[1.98]**	[2.79]***	[2.84]***	[3.42]***	[2.06]**
R&D intensity 1-15%	1.627	1.720	1.655	0.836	1.255	1.028	1.100	1.520	0.656
	[1.94]*	[1.98]**	[2.23]**	[2.29]**	[2.26]**	[2.20]**	[3.09]***	[3.06]***	[1.25]
R&D intensity over 15%							0.594	0.451	0.279
							[0.87]	[0.56]	[0.29]
Pseudo R^2	0.5164	0.7108	0.7472	0.4227	0.6987	0.5722	0.5535	0.7024	0.6875
Observation	365	365	365	641	641	641	484	484	484

Note: The asterisks ***, ** and * denote the statistical significance at 1%, 5% and 10%, respectively. T statistics are in parentheses.

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Appendix Sectoral clarification and other regressions

The sectoral definition for Table 5 is based on Pavitt (1984) and as follows. Industries included in the supplier-dominated sector are leather and fur, printing and publishing, pulp and paper, furniture and fixture, timber and wooden products, apparel, textiles, beverage, tobacco, and feed, and food manufacturing. The scale-intensive sector is comprised of transport equipment, nonferrous metals, iron and steel, ceramic, stone, and clay, rubber, plastics, and petroleum and coal products. Included in the science-based sector are precision instrument, electric machinery, general machinery, fabricated metal, and chemical. The miscellaneous manufacturing is excluded from the three sectors.

Table A1: Sectoral clarification

Sector	Industry
Supplier-dominated sector	leather and fur, printing and publishing, pulp and paper, furniture and fixture, timber and wooden products apparel, textiles, beverage, tobacco, feed, food manufacturing
Scale-intensive sector	transport equipment, nonferrous metals, iron and steel, ceramic, stone and clay, rubber, plastics, and petroleum, coal products
Science-based sector	precision instrument, electric machinery, general machinery, fabricated metal, chemical

Table A2: Regional clarification

Region	Ward
North	Kouhoku, Aoba, Turumi, Tsuzuki, Midori
East	Nshi, Naka, Hodogaya, Minami, Kanagawa
West	Asahi, Seya, Izumi, Midori, Totsuka
South	Kanazawa, Isogo, Sakae, Konan

Table A3: Estimation results disaggregated by region within the city

Variables	[1]	[2]	[3]
All industries-same country	0.002		
(country specific spillover)	[0.57]		
Same industries-all countries		0.022	
(industry specific spillover)		[1.09]	
Same industires-same countries			-0.003
(country-industry specific spillover)			[-0.51]
ln(plant's employee)	1.563	1.640	1.571
	[6.06]***	[6.19]***	[6.08]***
ln(firm's labor productivity)	0.352	0.352	0.355
	[4.20]***	[4.20]***	[4.25]***
R&D intensity 1-15%	-0.087	-0.083	-0.086
	[-0.59]	[-0.56]	[-0.58]
R&D intensity over 15%	-0.191	-0.198	-0.235
	[-0.29]	[-0.30]	[-0.35]
Constant	-7.285	-7.589	-7.319
	[-7.80]***	[-7.82]***	[-7.86]***
Pseudo R^2			
Observation	1843	1843	1843

Note: The asterisks ***, ** and * denote the statistical significance at 1%, 5% , and 10%, respectively. Z statistics are in parentheses.

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Chapter 3

「Extensive and intensive margins of adjustments in Japan’s exports after the Great East Japan Earthquake 2011」

Chapter 3

Extensive and intensive margins of adjustments in Japan's exports after the Great East Japan Earthquake 2011

Abstract

This paper analyzes the impact of the Great East Japan Earthquake 2011 on Japanese export. Using monthly data for Japanese exports at the most disaggregated level, the paper decomposes the fall of exports into the extensive and the intensive margins. Our major findings are threefold. First, most of exports in disaster areas' products decline sharply due to the Earthquake. Second, the declines of exports in the disaster areas' products are explained mainly by the intensive margin. Third, the variations of exports in the food industry are mainly explained by the extensive margin.

Key words: Extensive margin, Intensive margin, Disaster

1. Introduction

On March 11, 2011, the most powerful earthquake recorded in Japan with a 9.0 magnitude, occurred off the coast of Miyagi prefecture in Tohoku region. It triggered a destructive tsunami that hit the area on the coast of Tohoku region. The

Earthquake seriously affected the Japanese economy. Although Tohoku region represented only 6.4% of Japan's GDP in 2008, GDP from April to June in 2011 plunged by 2.1% compared to the same period in the previous year. Export also declined by 8.1% in the same period. Many firm located in Tohoku region suffer from the earthquake and tsunami. Some stopped their business temporary, and some filed for bankruptcy. The shock wounded the production networks and had a negative effect not only on these firms but also on firms connected with these firms in the supply chain network. Especially, firms in automobile and electronic industries which assemble many components suffer severe effect from the disaster. For example, Nikon Corp. and Murata Manufacturing Co., Ltd. stopped their factories and were not able to supply key parts of mobile phone to other makers[1]. International production networks transmitted the negative shocks from Japan to all over the world. Researchers in international trade and the policy makers interest in the cause of the serious decline of the export. How the effect of disaster spread the economy is important issue. The aim of this paper is to decompose the fall of exports into extensive and intensive margins to use monthly data for Japanese bilateral exports at the most disaggregated level and examine which margins contribute to the decline.

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[1] Japanese electrical company stopped their business due to Great East Japan Earthquake 2011, as illustrated in The Asahi Shinbun dated March15, 2011.

Recent research in international trade emphasizes the importance of extensive margins for understanding the overall pattern of world trade, as well as how to respond to specific events such as trade liberalization. Bernard et, al. (2009) use detailed US trade statistics to provide a broad overview of how the margins of trade contribute to differences in imports and exports. They define the extensive margin as the number of firms that trade with the country and the number of products trade with the country, while they define the intensive margin as the average value of trade per firm-product. They find that variation in imports and exports across trading partners is primarily due to extensive margins, while variation in trade across one-year intervals is dominated by the intensive margin. Also, they investigate the behavior of US exports and imports around the 1997 Asian financial crisis. The intensive margin accounts for the majority of the export declines and import increase around the crisis. Other works such as Levchenko et, al. (2010), Behrens et, al. (2010) and Ito (2010) show similar results of margins after Global Financial Crisis 2008 using U.S., France and Japanese trade data, respectively. Ito (2010) use Japanese trade statistics to investigate how the Financial Crisis affects the decline of imports and exports in Japan. The paper finds that variation in imports and exports after the Financial Crisis is explained by the intensive margin.

The financial crisis has dissimilar features with the disaster such as earthquake and tsunami, which generated different adjustments in production networks and international trade. Although both events have negative impact on the economy, the financial crisis is primarily a demand shock due to drastic drops of goods. Thus, the fall of exports is mainly explained by the intensive margin. On the other hand, the disaster is a supply shock due to the devastation of production firms located in damaged areas. It wounds firms' forward and backward linkage which these firms are included and affect overall production networks.

The previous research to come to close the aim of this paper is Ando and Kimura (2010). They decompose the fall and recovery of Japanese export into the extensive margin and the intensive margin in Global Financial Crisis 2008 and Great East Japan Earthquake 2011. They classify trade goods based on the type of goods such as final products and intermediates and confirm the stability of production networks in East Asia. However they do not distinguish them between products produced in Tohoku area and other goods. To evaluate the effect of the Earthquake, this paper connects traded products with other regional production data and examines which margins contribute to the decline of export among products in Tohoku area.

The rest of this paper is organized as follows. Section 2 describes patterns of Japanese exports after the Earthquake. Section 3 provides the methodology and reports results. Section 4 closes with final remarks.

2. Fluctuation of Japan's economy after the Earthquake

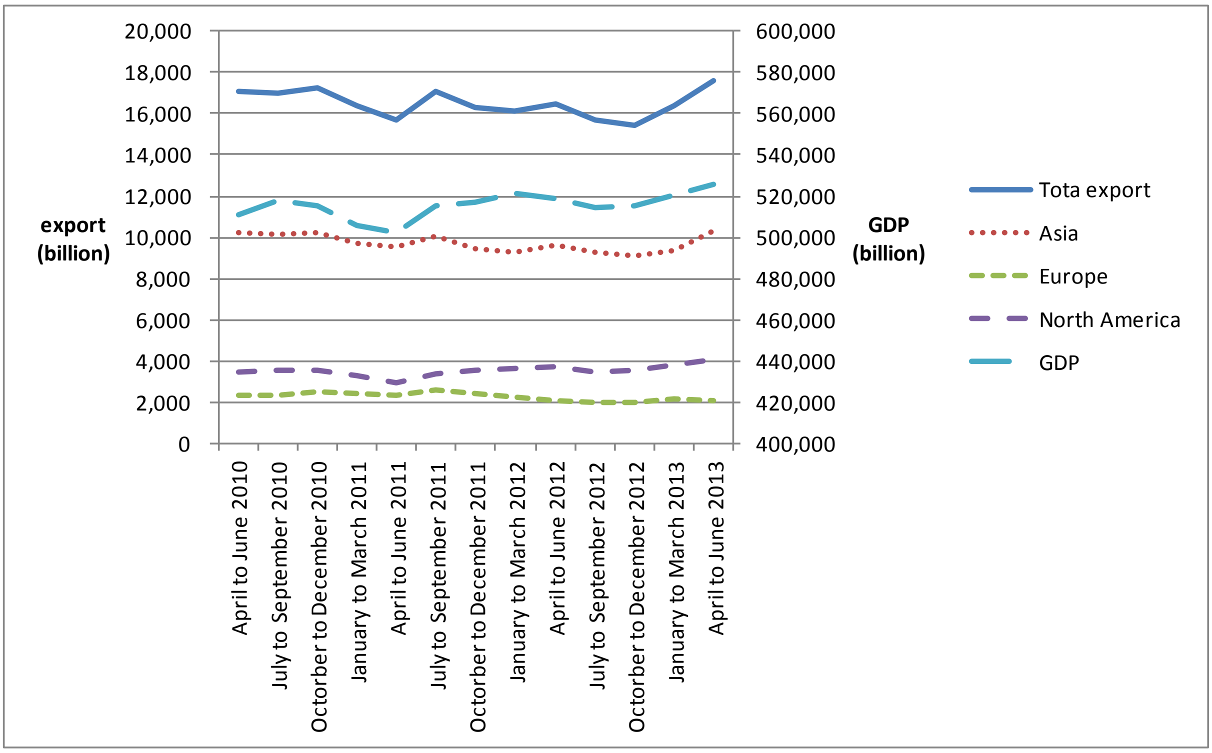
The Great East Japan Earthquake 2011 resulted in more than 15,000 human lives lost and almost 4,000 people remain missing. It affected firms located in Tohoku region. The research company reports that the number of firms which the earthquake and tsunami case failed is about 1,139 during two years after the earthquake[2]. This number is about 3.4 times as many as the Han-Shin Awaji Earthquake. It further prompted critical nuclear power plant accidents in Fukushima prefecture. Because of radioactive releases, a large number of local residents have been forced to evacuate. A part of the foods have not been able to be shipped. The uncertainty of electric power supply marked a severe blow, which also had a negative effect on manufacturing firms located in Kanto region.

Japan's GDP from April to June in 2011 plunged by 2.1% compared to the same period in the previous year while exports dropped by 8.1% as illustrated in Figure 1. Exports returned to former level in the next quarter, however. Export from July to September in 2011 was just 1% below compared to the same period in the previous year. The impact of earthquake was substantive but it was temporary. Ando and Kimura (2012) report similar results. They compare the Global Financial Crisis with the Great East Japan Earthquake and show that the Global financial Crisis has huge and prolonged impacts while the Earthquake has much smaller and more temporary impact. Thus this paper will focus on export data from March to June in

[2] Teikoku Databank, Ltd. released " Bankruptcy due to the Great East Japan Earthquake 2011, "on March, 20, 2013.

2011 in the subsequent sections.

Figure 1. Japanese GDP and export by region



3. Decomposition to extensive and intensive margins

3.1. Decomposition framework

This section explains the decomposition framework of export. The decomposition approach used in this paper is proposed by Bernard et, al. (2007). They define the extensive margin as the number of firms that trade with the country and the number of products trade with the country, while they define the intensive margin as the average value of trade per firm-product. According to the approach, this paper divides export value V at time period t into the number of traded product n, the number of countries per product $\bar{c}$ and the average value of export per product-country $\bar{v}$ [3]. When Δ indicates time difference from previous time period, the change of export value is decomposed as follow.

$$\Delta V_t = \Delta n_t \Delta \bar{c}_t \Delta \bar{v}_t \qquad (1)$$

We evaluate the contribution of margins for export value using following equation (2) which is logarithmically-transformed equation (1).

$$ln(\Delta V_t) = ln(\Delta n_t \Delta \bar{c}_t \Delta \bar{v}_t)$$

$$ln(\Delta V_t) = ln(\Delta n_t) + ln(\Delta \bar{c}_t) + ln(\Delta \bar{v}_t) \qquad (2)$$

Here, this paper regards the first two right-hand side variables in equation (2) as the extensive margin while we regards last right-hand side variable as the intensive margin[4].

Data used in this paper are extracted from Japanese customs data. The monthly data for Japanese bilateral exports by products and destination countries are available from the Trade Statistics of Japan, the Ministry of Finance. It is the most disaggregated trade data (9-digit HS code) in Japan. To deal with seasonality, ΔV

[3] Decomposing the export value into the number of exporter and average value of export per firm is impossible due to data limitation.
[4] Kehoe and Ruhl (2013) propose a methodology for studying changes in bilateral commodity trade due to goods not exported previously or exported only in small quantities. Since the aim of this paper is to examine the effect of the Earthquake on the margins, we follow Bernard et, al. (2007).

is calculated from the ratio of the same period in the previous year.

3.2. Basic result

This section reports the basic results. Table 1 show changes in total export, the number of goods and countries in Japan during the fall of period and the same period in previous year. Table 2 shows the result of decomposition of total export using the equation (2).

The results provide two notable findings. First, the fall of export is mainly explained by the intensive margin. For example, total exports in April 2011 decline by 13.3% compared to the same time in the previous year. The intensive margin in this period (-10.9%) comprises 82% of this decline. The same can be seen in May 2011. This result is consistent with Ando and Kimura (2012), while they focus on the contrast between final goods and intermediates. They find that the intensive margin in April 2011 comprises 53% of the decline. Second, in March and June 2011, the extensive margin is larger than the intensive margin although the decline of total exports is slightly low. Though the intensive margin is positive (0.8%) in June 2011, the extensive margin is negative (-2.4%). As a result, the total export decreases compared to last year.

Table 1. Japanese total export, the number of exported products and countries

Year	Month	Products	Country	Total export
2010	3	5050	216	6,000,424
2010	4	5002	211	5,889,744
2010	5	4967	212	5,308,604
2010	6	4993	213	5,867,219
2011	3	5004	213	5,858,517
2011	4	4961	206	5,156,647
2011	5	4890	206	4,759,297
2011	6	4960	208	5,774,613

Notes: The original data of total export are in millions of yen.

Table 2. Decomposition of changes in Japanese total export

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-2.4%	-0.9%	-0.5%	-1.0%
2010-2011	4	-13.3%	-0.8%	-1.6%	-10.9%
2010-2011	5	-10.9%	-1.6%	-1.3%	-8.1%
2010-2011	6	-1.6%	-0.7%	-1.7%	0.8%

3.2. Results of typical products

This section reports the results of typical products[5]. First, the author identifies the main industries in the disaster area using the Industrial Statistic which are garnered by the Ministry of Economy, Trade and Industry. This paper chooses 9 regions (Senshio, Kamaishi, Ishinomaki, Miyako, Souma, Iwaki, Ofunato･Takata, Furukawa and Ryoban) because these areas are located in the coast in Tohoku region

[5] The results disaggregated by ports are provided in Appendix.

Table 3. The main industries in Tohoku region and their HS codes

Region	Shipment rank	Industrial statistics No.	Industry	HS code
Senshio	1	1711	Petroleum product	2709～2713
Senshio	2	1511	Offset printing	48
Senshio	3	2221	Steel	72
Kamaishi	1	2231	Hot-rolled sheet steel	72
Kamaishi	2	2523	Oil pressure and air pressure machine	8412
Kamaishi	3	2671	Semiconductor	8541
Ishinomaki	1	1421	Paper	48
Ishinomaki	2	1061	Strengthening animal forage	1213,1214
Ishinomaki	3	0926	Processed fish	1604
Miyako	1	2823	Connectors and switches	8535,8536
Miyako	2	1222	Plvwood	44
Miyako	3	0926	Processed fish	1604
Souma	1	3142	Aircraft engine	8409
Souma	2	1422	Cardboard	48
Souma	3	2319	Other nonferrous metal	74~84
Iwaki	1	3013	Radio communication equipment	8527
Iwaki	2	3113	Automobile component	87
Iwaki	3	3034	Printing machine	8443
Ofunato･Takata	1	2121	Cement manufacturing	2523
Ofunato･Takata	2	0919	Stock farm product	23
Ofunato･Takata	3	0925	Processed fish	1604
Furukawa	1	2821	Resistors and condenser	8532,8533
Furukawa	2	2851	Transformer	850431
Furukawa	3	2443	Metal door and sash	4414～4421
Ryoban	1	3011	Cable communication machine	8517,8518
Ryoban	2	2922	Electrical equipment for internal combustion engine	8501,8502
Ryoban	3	3021	Video equipment	8521

and suffered the most extensive damage from tsunami and the earthquake. Second, the author assigns each industry HS code at the most disaggregated level (9 digit). Table 3 shows the main industries in the disaster area and their assigned HS codes[6].

According to Table 3, the main industries in the disaster area can be classified into the following five industries: the electronic equipment industry (Connectors and switch, Radio communication equipment, Printing machine, Resistors and condenser, Transformer, Cable communication machine, Video equipment), the automobile industry (Automobile component, Electrical equipment for internal combustion engine, Oil pressure and air pressure machine, Aircraft engine), the metal industry (Steel, Other nonferrous metal, Hot-rolled sheet steel, Plvwood), the food industry (Processed fish, Strengthening animal forage, Stock farm product) and the others (Petroleum product, Offset printing). This classification is almost the same as that of Fujita and Hamaguchi (2011).

This paper follows the decomposition approach used in subsection 3.1 to understand patterns of export changes by typical products after the earthquake. Table 4 to Table 46 show monthly changes in the number of products and country and total export by the above product and their results of the decomposition. The following findings are worth noting.

First, most of the export values decline sharply. For example, the processed fish, the automobile component and the cable communication machine decrease by 57%,

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[6] This paper focuses on the main product in the 9 regions, while the alternative focuses on the product of which the share of 9 regions in high in Japan might be informative.

37% and 25% in average, respectively. These ratios are far higher than ratio of overall Japanese export decline (7%). The result means that the main industries in Tohoku region suffered severe damage from tsunami and the Earthquake. Especially, more severe losses were experienced by the electronic equipment industry and the automobile industry since these industries particularly depended on key parts and basic materials produced in the disaster-affected area. Failures of parts and materials delivery from this area have forced many manufacturers across the country to suspend their operations as well. That is why the decline is larger than the average ratio although Tohoku region represented only about 6% of Japan's GDP[7].

Second, the declines of export values are explained mainly by intensive margin though some results are mixed. For example, the intensive margin of the automobile component in April 2011 (-72.8%) consists of almost 100% of the decline of the export value in this period (-72.3%). The intensive margin of the cable communication machine in April 2011 (-38.2%) consists of 139% of the decline of the export value in this period (-27.9%). Although this outcome is differs from the prediction, it might suggest that more detailed data which contain the supply chain and intra-firm transactions are need to ascertain the effect of the Earthquake on margins.

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7 Some export values of products such as the offset printing, the oil pressure and air pressure machines and papers did not fall. It is possible that the shipment of these products of Tohoku region is too small in Japan not to affect overall export values in Japan.

Third, the variation of exports in the food industries is explained by intensive margins. For instance, the decline of the export value in April 2011 (-30.4%) in the stock farm product is almost explained by the extensive margin in this period (-30.2%). The same can be seen in the processed fish. This result might come from the nuclear power plant accidents in Fukushima. Because of radioactive releases, a part of plants and fishes had not been able to be shipped. The decline of the extensive margin did be reflected on this specific situation not on the destruction of the supply chain.

Table 4. Original data of petroleum products (HS code: 2709~2713)

Year	Month	Products	Country	Total export
2010	3	22	63	74,189,718
2010	4	22	63	98,034,064
2010	5	23	57	87,887,034
2010	6	24	60	61,739,823
2011	3	23	68	97,694,936
2011	4	23	70	48,939,176
2011	5	24	59	90,453,157
2011	6	23	66	115,929,478

Notes: The original data of total export are in thousands of yen.

Table 5. Decomposition of petroleum products (HS code: 2709~2713)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	27.5%	4.4%	3.2%	19.9%
2010-2011	4	-69.5%	4.4%	6.1%	-80.0%
2010-2011	5	2.9%	4.3%	-0.8%	-0.6%
2010-2011	6	63.0%	-4.3%	13.8%	53.5%

Table 6. Original data of offset printing (HS code: 48)

Year	Month	Products	Country	Total export
2010	3	111	92	26,752,289
2010	4	114	84	28,486,177
2010	5	111	82	25,204,135
2010	6	112	82	27,525,099
2011	3	144	99	39,859,827
2011	4	144	97	36,820,264
2011	5	143	91	33,133,494
2011	6	147	101	37,608,129

Table 7. Decomposition of offset printing (HS code: 48)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	39.9%	26.0%	-18.7%	32.5%
2010-2011	4	25.7%	23.4%	-9.0%	11.3%
2010-2011	5	27.4%	25.3%	-14.9%	16.9%
2010-2011	6	31.2%	27.2%	-6.4%	10.4%

Table 8. Original data of the steel (HS code: 72)

Year	Month	Products	Country	Total export
2010	3	371	99	296,294,931
2010	4	370	85	288,070,248
2010	5	358	85	298,645,010
2010	6	359	88	318,262,285
2011	3	371	86	322,696,474
2011	4	365	86	285,753,074
2011	5	352	82	277,808,087
2011	6	367	85	297,049,975

Table 9. Decomposition of the steel (HS code: 72)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	8.5%	0.0%	-14.1%	22.6%
2010-2011	4	-0.8%	-1.4%	2.5%	-2.0%
2010-2011	5	-7.2%	-1.7%	-1.9%	-3.6%
2010-2011	6	-6.9%	2.2%	-5.7%	-3.4%

Table 10. Original data of oil pressure and air pressure machines (HS code: 8412)

Year	Month	Products	Country	Total export
2010	3	6	73	10,439,999
2010	4	6	61	10,549,831
2010	5	6	66	9,643,339
2010	6	6	65	11,787,012
2011	3	4	74	13,789,111
2011	4	7	73	14,820,637
2011	5	6	67	13,545,385
2011	6	7	81	14,262,148

Table 11. Decomposition of oil pressure and air pressure machines (HS code: 8412)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	27.8%	-40.5%	41.9%	26.5%
2010-2011	4	34.0%	15.4%	2.5%	16.0%
2010-2011	5	34.0%	0.0%	1.5%	32.5%
2010-2011	6	19.1%	15.4%	6.6%	-2.9%

Table 12. Original data of the semiconductor (HS code: 8541)

Year	Month	Products	Country	Total export
2010	3	18	68	92,596,885
2010	4	18	66	97,497,790
2010	5	18	66	90,428,957
2010	6	18	68	96,296,170
2011	3	18	64	92,857,217
2011	4	18	66	91,496,893
2011	5	18	67	82,957,744
2011	6	18	62	89,897,008

Table 13. Decomposition of the semiconductor (HS code: 8541)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	0.3%	0.0%	-6.1%	6.3%
2010-2011	4	-6.4%	0.0%	0.0%	-6.4%
2010-2011	5	-8.6%	0.0%	1.5%	-10.1%
2010-2011	6	-6.9%	0.0%	-9.2%	2.4%

Table 14. Original data of papers (HS code: 48)

Year	Month	Products	Country	Total export
2010	3	111	92	26,752,289
2010	4	114	84	28,486,177
2010	5	111	82	25,204,135
2010	6	112	82	27,525,099
2011	3	144	99	39,859,827
2011	4	144	97	36,820,264
2011	5	143	91	33,133,494
2011	6	147	101	37,608,129

Table 15. Decomposition of papers (HS code: 48)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	39.9%	26.0%	-18.7%	32.5%
2010-2011	4	25.7%	23.4%	-9.0%	11.3%
2010-2011	5	27.4%	25.3%	-14.9%	16.9%
2010-2011	6	31.2%	27.2%	-6.4%	10.4%

Table 16. Original data of strengthening animal forages (HS code: 1213,1214)

Year	Month	Products	Country	Total export
2010	3	2	2	3036
2010	4	1	1	209
2010	5	2	2	3554
2010	6	0	0	0
2011	3	0	0	0
2011	4	0	0	0
2011	5	0	0	0
2011	6	0	0	0

Table 17. Original data of processed fish (HS code: 1604)

Year	Month	Products	Country	Total export
2010	3	1	4	48,175
2010	4	1	2	13,714
2010	5	2	6	82,493
2010	6	1	5	49,726
2011	3	3	2	9,142
2011	4	2	4	26,947
2011	5	2	5	32,925
2011	6	2	5	34,130

Table 18. Decomposition of processed fish (HS code: 1604)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-166.2%	109.9%	-179.2%	-96.9%
2010-2011	4	67.5%	69.3%	0.0%	-1.8%
2010-2011	5	-91.8%	0.0%	-18.2%	-73.6%
2010-2011	6	-37.6%	69.3%	-69.3%	-37.6%

Table 19. Original data of connectors and switches (HS code: 8535, 8536)

Year	Month	Products	Country	Total export
2010	3	1	62	20,705,206
2010	4	1	58	21,509,403
2010	5	1	56	19,995,769
2010	6	1	61	20,807,947
2011	3	1	57	19,404,753
2011	4	1	61	20,535,823
2011	5	1	61	16,222,931
2011	6	1	63	18,957,655

Table 20. Decomposition of connectors and switches (HS code: 8535, 8536)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-6.5%	0.0%	-8.4%	1.9%
2010-2011	4	-4.6%	0.0%	5.0%	-9.7%
2010-2011	5	-20.9%	0.0%	8.6%	-29.5%
2010-2011	6	-9.3%	0.0%	3.2%	-12.5%

Table 21. Original data of other nonferrous metals (HS code: 74~83)

Year	Month	Products	Country	Total export
2010	3	286	127	154,104,127
2010	4	288	120	153,499,272
2010	5	287	119	145,444,347
2010	6	291	125	144,155,604
2011	3	283	124	163,684,454
2011	4	288	126	140,766,514
2011	5	290	116	127,326,803
2011	6	288	124	140,592,089

Table 22. Decomposition of other nonferrous metals (HS code: 74~83)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	6.0%	-1.1%	-1.3%	8.4%
2010-2011	4	-8.7%	0.0%	4.9%	-13.5%
2010-2011	5	-13.3%	1.0%	-3.6%	-10.8%
2010-2011	6	-2.5%	-1.0%	0.2%	-1.7%

Table 23. Original data of aircraft engines (HS code: 8409)

Year	Month	Products	Country	Total export
2010	3	7	136	56,715,770
2010	4	7	134	60,091,109
2010	5	7	133	50,017,416
2010	6	7	143	58,759,750
2011	3	7	143	58,139,232
2011	4	7	144	60,538,323
2011	5	7	140	46,369,552
2011	6	7	141	60,143,973

Table 24. Decomposition of aircraft engines (HS code: 8409)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	2.5%	0.0%	5.0%	-2.5%
2010-2011	4	0.7%	0.0%	7.2%	-6.5%
2010-2011	5	-7.6%	0.0%	5.1%	-12.7%
2010-2011	6	2.3%	0.0%	-1.4%	3.7%

Table 25. Original data of other nonferrous metals (HS code: 74~84)

Year	Month	Products	Country	Total export
2010	3	286	127	154104127
2010	4	288	120	153,499,272
2010	5	287	119	145,444,347
2010	6	291	125	144,155,604
2011	3	283	124	163,684,454
2011	4	288	126	140,766,514
2011	5	290	116	127,326,803
2011	6	288	124	140,592,089

Table 26. Decomposition of Original data of other nonferrous metals (HS code: 74~84)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	6.0%	-1.1%	-1.3%	8.4%
2010-2011	4	-8.7%	0.0%	4.9%	-13.5%
2010-2011	5	-13.3%	1.0%	-3.6%	-10.8%
2010-2011	6	-2.5%	-1.0%	0.2%	-1.7%

Table 27. Original data of the radio communication equipment (HS code: 8527)

Year	Month	Products	Country	Total export
2010	3	8	41	1,266,697
2010	4	8	38	1,292,713
2010	5	6	41	945,846
2010	6	8	39	1,089,727
2011	3	7	42	1,099,088
2011	4	8	39	909,172
2011	5	8	44	925,118
2011	6	8	38	939,791

Table 28. Decomposition of the radio communication equipment (HS code: 8527)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-14.2%	-13.4%	15.8%	-16.6%
2010-2011	4	-35.2%	0.0%	2.6%	-37.8%
2010-2011	5	-2.2%	28.8%	-21.7%	-9.3%
2010-2011	6	-14.8%	0.0%	-2.6%	-12.2%

Table 29. Original data of automobile components (HS code: 87)

Year	Month	Products	Country	Total export
2010	3	133	200	1,147,765,974
2010	4	135	195	1,115,856,552
2010	5	131	201	931,948,875
2010	6	132	193	1,169,817,171
2011	3	135	198	897,005,770
2011	4	133	196	541,580,756
2011	5	133	190	630,591,557
2011	6	135	198	1,039,011,448

Table 30. Decomposition of automobile components (HS code: 87)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-24.7%	1.5%	-2.5%	-23.6%
2010-2011	4	-72.3%	-1.5%	2.0%	-72.8%
2010-2011	5	-39.1%	1.5%	-7.1%	-33.4%
2010-2011	6	-11.9%	2.2%	0.3%	-14.4%

Table 31. Original data of printing machines (HS code: 8443)

Year	Month	Products	Country	Total export
2010	3	16	90	112,995,773
2010	4	16	94	117,377,045
2010	5	17	86	115,864,136
2010	6	17	85	114,450,416
2011	3	14	91	97,200,475
2011	4	15	85	91,311,620
2011	5	15	81	96,037,998
2011	6	15	86	115,786,584

Table 32. Decomposition of printing machines (HS code: 8443)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-15.1%	-13.4%	14.5%	-16.2%
2010-2011	4	-25.1%	-6.5%	-3.6%	-15.0%
2010-2011	5	-18.8%	-12.5%	6.5%	-12.8%
2010-2011	6	1.2%	-12.5%	13.7%	0.0%

Table 33. Original data of cement manufacturing (HS code: 2523)

Year	Month	Products	Country	Total export
2010	3	5	25	2,639,594
2010	4	5	26	2,503,855
2010	5	5	28	2,965,637
2010	6	5	28	2,636,778
2011	3	5	24	2,068,135
2011	4	5	25	2,142,411
2011	5	5	26	2,798,979
2011	6	5	25	2,136,012

Table 34. Decomposition of cement manufacturing (HS code: 2523)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-24.4%	0.0%	-4.1%	-20.3%
2010-2011	4	-15.6%	0.0%	-3.9%	-11.7%
2010-2011	5	-5.8%	0.0%	-7.4%	1.6%
2010-2011	6	-21.1%	0.0%	-11.3%	-9.7%

Table 35. Original data of stock farm products (HS code: 23)

Year	Month	Products	Country	Total export
2010	3	9	26	622,448
2010	4	12	23	889,511
2010	5	10	28	680,423
2010	6	10	27	698,180
2011	3	10	23	556,580
2011	4	10	17	656,627
2011	5	7	21	517,549
2011	6	5	25	2,136,012

Table 36. Decomposition of stock farm products (HS code: 23)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-11.2%	10.5%	-22.8%	1.1%
2010-2011	4	-30.4%	-18.2%	-12.0%	-0.1%
2010-2011	5	-27.4%	-35.7%	6.9%	1.4%
2010-2011	6	-8.4%	0.0%	-20.5%	12.0%

Table 37. Original data of resistors and condensers (HS code: 8532, 8533)

Year	Month	Products	Country	Total export
2010	3	17	68	46,612,744
2010	4	17	66	48,505,171
2010	5	17	61	46,326,464
2010	6	17	68	50,394,748
2011	3	17	66	46,213,704
2011	4	17	68	48,141,073
2011	5	17	61	43,446,139
2011	6	17	69	46,748,347

Table 38. Decomposition of resistors and condensers (HS code: 8532, 8533)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-0.9%	0.0%	-3.0%	2.1%
2010-2011	4	-0.8%	0.0%	3.0%	-3.7%
2010-2011	5	-6.4%	0.0%	0.0%	-6.4%
2010-2011	6	-7.5%	0.0%	1.5%	-9.0%

Table 39. Original data of transformers (HS code: 850431)

Year	Month	Products	Country	Total export
2010	3	2	34	769,147
2010	4	2	29	651,711
2010	5	2	29	638,582
2010	6	2	31	896,120
2011	3	2	35	723,118
2011	4	2	26	829,341
2011	5	2	29	609,004
2011	6	2	33	626,960

Table 40. Decomposition of transformers (HS code: 850431)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-6.2%	0.0%	2.9%	-9.1%
2010-2011	4	24.1%	0.0%	-10.9%	35.0%
2010-2011	5	-4.7%	0.0%	0.0%	-4.7%
2010-2011	6	-35.7%	0.0%	6.3%	-42.0%

Table 41. Original data of cable communication machines (HS code: 8517, 8518)

Year	Month	Products	Country	Total export
2010	3	20	107	40,340,820
2010	4	20	92	40,004,654
2010	5	20	98	36,864,941
2010	6	20	91	42,445,873
2011	3	20	105	31,846,931
2011	4	20	102	30,268,820
2011	5	20	86	27,161,355
2011	6	20	100	35,511,109

Table 42. Decomposition of cable communication machines (HS code: 8517, 8518)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-23.6%	0.0%	-1.9%	-21.8%
2010-2011	4	-27.9%	0.0%	10.3%	-38.2%
2010-2011	5	-30.5%	0.0%	-13.1%	-17.5%
2010-2011	6	-17.8%	0.0%	9.4%	-27.3%

Table 43. Original data of electrical equipment for internal combustion engines (HS code: 8501, 8502)

Year	Month	Products	Country	Total export
2010	3	29	106	31,751,057
2010	4	28	102	28,727,510
2010	5	28	102	23,655,131
2010	6	28	105	33,988,419
2011	3	28	98	32,059,719
2011	4	29	97	28,285,953
2011	5	27	89	23,187,791
2011	6	28	106	25,613,370

Table 44. Decomposition of electrical equipment for internal combustion engines (HS code: 8501, 8502)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	1.0%	-3.5%	-4.3%	8.8%
2010-2011	4	-1.5%	3.5%	-8.5%	3.5%
2010-2011	5	-2.0%	-3.6%	-10.0%	11.6%
2010-2011	6	-28.3%	0.0%	0.9%	-29.2%

Table 45. Original data of video equipments (HS code: 8521)

Year	Month	Products	Country	Total export
2010	3	2	32	1,848,039
2010	4	2	33	1,778,439
2010	5	2	35	1,815,731
2010	6	2	32	2,334,118
2011	3	2	28	1,313,173
2011	4	2	24	713,066
2011	5	2	28	1,389,357
2011	6	2	31	1,631,271

Table 46. Decomposition of video equipments (HS code: 8521)

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-34.2%	0.0%	-13.4%	-20.8%
2010-2011	4	-91.4%	0.0%	-31.8%	-59.5%
2010-2011	5	-26.8%	0.0%	-22.3%	-4.5%
2010-2011	6	-35.8%	0.0%	-3.2%	-32.7%

4. Conclusion

This paper analyzes the impact of the Great East Japan Earthquake 2011 on Japanese export focusing on the change of the extensive and the intensive margins. Using monthly data for Japanese bilateral exports at the most disaggregated level, the paper decomposes the fall of exports into the extensive and the intensive margins. Our major findings are threefold. First, most of the export values in the disaster area decline sharply due to the Earthquake. Second, the declines of export values in the disaster areas' products are explained mainly by intensive margin. Third, the variations of exports in the food industry are mainly explained by the extensive margin. Examining the generality of the findings using other detailed data will be left to future studies. Especially, one will find it interesting to seek trade data which link with the intra-firm transactions and supply-chain.

Appendix. Exports disaggregated by ports

Table A1. Original data of Tokyo Narita airport

Year	Month	Products	Country	Total export
2010	3	2792	166	846,753,638
2010	4	2750	165	881,040,716
2010	5	2729	174	835,266,675
2010	6	2811	166	880,451,855
2011	3	2748	161	763,847,632
2011	4	2779	169	787,350,952
2011	5	2601	162	729,445,767
2011	6	2702	168	819,207,187

Table A2. Decomposition of Tokyo Narita airport

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-10.3%	-1.6%	-1.5%	-7.2%
2010-2011	4	-11.2%	1.0%	1.3%	-13.6%
2010-2011	5	-13.5%	-4.8%	-2.3%	-6.4%
2010-2011	6	-7.2%	-4.0%	5.2%	-8.4%

Table A3. Original data of Tokyo port

Year	Month	Products	Country	Total export
2010	3	2919	138	387,029,491
2010	4	2871	136	405,996,789
2010	5	2916	145	370,037,467
2010	6	2963	139	395,522,158
2011	3	2940	140	381,379,997
2011	4	2868	139	373,598,992
2011	5	2776	130	328,152,673
2011	6	2899	144	408,716,087

Table A4. Decomposition of Tokyo port

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-1.5%	0.7%	0.7%	-2.9%
2010-2011	4	-8.3%	-0.1%	2.3%	-10.5%
2010-2011	5	-12.0%	-4.9%	-6.0%	-1.1%
2010-2011	6	3.3%	-2.2%	5.7%	-0.3%

Table A5. Original data of Yokohama port

Year	Month	Products	Country	Total export
2010	3	3251	189	661,909,369
2010	4	3241	183	635,957,737
2010	5	3184	184	535,589,471
2010	6	3257	186	638,420,631
2011	3	3182	181	590,744,867
2011	4	3159	179	515,209,433
2011	5	3052	173	502,777,140
2011	6	3209	185	640,580,546

Table A6. Decomposition of Yokohama port

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-11.4%	-2.1%	-2.2%	-7.0%
2010-2011	4	-21.1%	-2.6%	0.4%	-18.8%
2010-2011	5	-6.3%	-4.2%	-1.9%	-0.2%
2010-2011	6	0.3%	-1.5%	0.9%	0.9%

Table A7. Original data of Kobe port

Year	Month	Products	Country	Total export
2010	3	3452	187	451,978,454
2010	4	3380	176	456,076,137
2010	5	3331	186	417,860,325
2010	6	3366	181	429,711,701
2011	3	3370	187	514,254,124
2011	4	3390	186	468,552,060
2011	5	3321	171	423,425,230
2011	6	3336	179	471,315,639

Table A8. Decomposition of Kobe port

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	12.9%	-2.4%	2.4%	12.9%
2010-2011	4	2.7%	0.3%	5.2%	-2.8%
2010-2011	5	1.3%	-0.3%	-8.1%	9.7%
2010-2011	6	9.2%	-0.9%	-0.2%	10.4%

Table A9. Original data of Kansai International Airport

Year	Month	Products	Country	Total export
2010	3	2318	147	362,757,687
2010	4	2265	142	374,995,750
2010	5	2275	147	358,147,668
2010	6	2293	144	372,655,909
2011	3	2374	149	403,213,944
2011	4	2335	147	400,709,413
2011	5	2229	153	328,244,707
2011	6	2281	152	372,513,495

Table A10. Decomposition of Kansai International Airport

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	10.6%	2.4%	-1.0%	9.2%
2010-2011	4	6.6%	3.0%	0.4%	3.2%
2010-2011	5	-8.7%	-2.0%	6.0%	-12.7%
2010-2011	6	0.0%	-0.5%	5.9%	-5.4%

Table A11. Original data of Osaka port

Year	Month	Products	Country	Total export
2010	3	3167	133	311,694,342
2010	4	3195	144	297,510,547
2010	5	3120	140	260,138,307
2010	6	3134	139	290,313,098
2011	3	3191	145	292,962,868
2011	4	3181	132	278,474,000
2011	5	3026	139	239,405,284
2011	6	3135	137	259,289,213

Table A12. Decomposition of Osaka port

Year	Month	$ln(\Delta V_t)$	$ln(\Delta n_t)$	$ln(\Delta \bar{c}_t)$	$ln(\Delta \bar{v}_t)$
2010-2011	3	-6.2%	0.8%	7.9%	-14.8%
2010-2011	4	-6.6%	-0.4%	-8.3%	2.1%
2010-2011	5	-8.3%	-3.1%	2.3%	-7.6%
2010-2011	6	-11.3%	0.0%	-1.5%	-9.9%

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Conclusion

This paper analyzes the relationship among globalization, firms and products using micro-data. In the 1st chapter, this paper finds that the globalization of firms which is measured by the foreign sales ratio has a positive link with *Span*, but is has a negative link with *Layer*. IT investment is also negatively link with *Layer*. In the 2nd chapter, this paper finds that agglomeration is positively related to the plants' global activities. Spillovers from other plants located nearby to a plant decision to engage in global activities are the strongest when they are in the same industry and trade with the same countries. The effect of the agglomeration is stronger in smaller plants. In the 3 rd chapter, this paper finds that most of exports in disaster areas' products decline sharply due to the Great East Japan Earthquake 2011 and the declines of exports in the areas' products are explained mainly by intensive margin. The variations of exports in the food industry are mainly explained by the extensive margin.

These finding are informative firm and product-level observations and offers new insight into the ways in which firms and their products respond to globalization. Change of firms' global activities and products has been intense and the role of firms and their products in the globalized world become more and more important. This paper fills a part of the gap between the theories and empirical evidences to understand the pattern of international trade well.