

Intra-firm Trade and Trade Growth of Korean Manufacturing Firms

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Preliminary version

Abstract

We investigate the role of intra-firm trade – cross-border flows of goods and services between related firms – in transmitting global trade shocks to trade growth during the 2008-2009 trade collapse and recent trade slowdown since 2012. Using firm-level data of Korean manufacturing sector for the period of 2006-2015, we examine how intra-firm trade contributed via extensive and intensive margins to trade growth by conducting accounting decomposition and difference-in-differences regression analysis. We find that intra-firm trade played a significant role in transmitting global shocks to within-firm trade growth although the role of arm's length trade seems to be larger for aggregated trade growth. As a transmission channel, extensive margin is more important for export with greater vulnerability during crisis while intensive margin is more important for import during crisis. Finally, the negative contribution of intra-firm trade to within-firm trade growth turns out larger during recent trade slowdown than during trade collapse.

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Keywords: Intra-firm Trade, Global Financial Crisis, Trade Slowdown, Firm-level Data

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1. Introduction

Korea's trade growth has continually been above the world's average, even during the recent global financial crisis in 2008-2009 that led to trade collapse. In 2008-2009, the world recorded -11% for average growth of trade, while South Korea scored -3.5%.¹ However, in 2014 and 2015, Korea's trade growth plummeted below the world average, scoring 1.8% and 0.9% while the world average rates were 3.4% and 3% in 2014 and 2015, respectively. To explain what led the different pattern of Korea's trade growth during these global trade trends, we examine the role of intra-firm trade in transmitting the global macroeconomic shocks to Korea's trade.

As multinational enterprises (MNEs) become more prevalent with growth of foreign direct investment, the importance of intra-firm trade – flows of goods and services between parents and their affiliates or among affiliates – in international trade also rapidly increased. In Korea's trade, intra-firm trade accounts for approximately 31% on average over the period 2006-2015.² What makes intra-firm trade important is not only its non-trivial size in total trade but its different reaction to macroeconomic shocks compared to that of arm's length trade – trade between unrelated parties.

There are two possibilities of different responses between intra-firm and arm's length trade to global macroeconomic shocks. One is that intra-firm trade is more responsive to shocks as trade between affiliates is more flexibly adjustable without substantial costs due to their relationship while trade between independent firms is relatively hard to adjust in the short-term due to contract constraints. In this case, therefore, intra-firm trade may facilitate the transmission of global shocks to trade. The other possibility is that intra-firm trade is more resilient to macroeconomic shocks because trade between affiliates is less exposed to uncertainty in holding inventories in response to demand shocks (Escaith et al. (2010), Lanz and Miroudot (2011)). In this second case, therefore, intra-firm trade may mitigate the transmission of shocks.

Although the question whether intra-firm trade is more responsive or resilient to

¹ Trade growth rate is calculated based on the trade (export+import) of goods and services with constant US dollar of 2010, and the data is sourced from World Development Indicators of World Bank.

² Author's calculation using Survey of Business Activities. See Table 1.

macroeconomic shocks is an important issue, there has not been enough evidence on it due to data limitation on intra-firm trade. Several studies use U.S. Census Bureau trade data (Bernard et al., 2009; Lanz and Miroudot, 2011; Lakatos and Ohnsorge, 2017) since it is the only publicly available transaction-level data for intra-firm trade with a comprehensive set of partner countries. Except those a few, it is hard to find studies on the role of intra-firm trade in transmitting macroeconomic shocks using micro data for other countries. In this regard, this paper is the first empirical study using non-US countries' firm-level data on the role of intra-firm trade in transmitting global shocks to the best of our knowledge.

Using Korean firm-level data over the period 2006-2015, we conduct two empirical analyses, accounting decomposition and regression analysis. We particularly consider trade growth during two global trade shocks – global trade collapse in 2008-2009 and global trade slowdown in 2012-2015.³ Our results from accounting decomposition and regression analysis reveal that intra-firm trade significantly contributed to export and import growth, but with different pattern in terms of intensive and extensive margin during those two global trade shocks.

First, we investigate the overall pattern using the accounting decomposition. Comparison between aggregated intra-firm and arm's length trade shows that arm's length trade played a relatively larger role in import collapse during trade collapse in 2009 and trade slowdown since 2012. As for intra-firm trade, decomposition reveals that decreases in intra-firm export and import in 2009 is attributable to extensive margin, but decrease in intra-firm import during trade slowdown is mainly due to intensive margin.

Second, we specifically examine contribution of intra-firm trade to within-firm trade growth using difference-in-differences regression analysis extended from Behrens et al. (2013). We find that firms with high intra-firm export ratio have significantly lower export growth during both trade collapse and trade slowdown periods, mainly due to extensive margin. As for import, firms with high intra-firm import ratio have significantly lower import growth only during trade slowdown period, largely due to intensive margin.

³ We define the years of 2012-2015 as the period of global trade slowdown in our analysis. Although the slowdown lasts until the year of 2016, data of 2016 was not available at the time of our analysis. Some studies include the years of 2010 and 2011 as post-crisis trade slowdown, but those years saw quick rebound of trade growth after global trade collapse. Since 2012, world real trade growth has declined to around 3%, less than half of the average of previous three decades before global financial crisis according to World Economic Outlook of IMF(2016).

The remainder of this paper is organized as follows: section 2 reviews literature and introduces more detailed background of related discussion. Section 3 describes data with aggregate-level and industry-level data separately. Section 4 shows empirical analysis including accounting decomposition and regression analysis results, followed by conclusion in section 5.

2. Related Literature

Although intra-firm trade has been receiving growing attention, there has not been enough research on the role of intra-firm trade in transmitting global shocks using micro data due to data limitation.⁴ The seminal empirical study on different response of intra-firm trade to macroeconomic shocks compared to arm's length trade is Bernard et al. (2009). Using transaction-level US trade data⁵, they find that export with related parties declined less than arm's length trade among US export to Asia during the 1997 Asian financial crisis, in both extensive and intensive margins. For more recent period, however, Lanz and Miroudot (2011) find that US intra-firm and arm's length export both declined by the same rates during the global financial crisis even though intra-firm import declined slightly less than arm's length imports. They further show that resilience of intra-firm trade and arm's length trade to global financial crisis differs across industries and partner countries. Therefore, there is not yet a consensus on which type of trade between intra-firm and arm's length trade is more resilient to crisis.

On the other hand, Lakatos and Ohnsorge (2017) find that arm's length trade, rather than intra-firm trade, is the main driver for the post-crisis slowdown in US trade growth. Using trade data from U.S. Census Bureau for the period of 2002-2014, they explain it based on compositional effects; arm's length trade more heavily depends on those sectors that have weakened after crisis, and economic growth of emerging and developing countries, where arm's length trade is more concentrated, has been slowed down sharply after the crisis.

⁴ Although the focus is different from ours, Corcos et al. (2013) examine determinants of intra-firm trade using French firm data in 1999. They find that the capital- and skill-intensive firms are more likely to choose intra-firm sourcing, and more productive firms are also more likely to engage in intra-firm trade. For the theoretical background of the determinants of intra-firm trade, refer to Antràs (2003), Antràs and Helpman (2004).

⁵ Linked/Longitudinal Firm Trade Transaction database used in Bernard et al. (2009) provides information on individual US trade transactions to US firms with HS10 digit code product, value, destination or source country with specifying whether the transaction occurs between related parties or at arm's length.

These studies provide empirical evidence on the role of intra-firm (or arm' length) trade in transmitting global shocks, but it only shows the U.S. case and none of studies yet provides evidence using micro data for non-U.S. countries to the best of our knowledge.

Our study is also related to literature that investigates the role of global supply chain and vertical integration in trade collapse because substantial fraction of intra-firm trade is considered as a part of vertical integration. Regarding global supply chain and vertical integration, there are also two different views on their role in trade collapse.

Numerous researchers argue that trade within global supply chain and vertical integration facilitates the transmission of shocks during crisis. Bems et al. (2009, 2011) show that final demand of U.S. and EU affects other countries through international supply networks during the 2008-09 crisis, suggesting that vertical integration plays an important role in transmitting shocks to trade. Escaith et al. (2010) also show that supply chain contributed to the overshooting of trade elasticity during the 2008-09 crisis through composition effect and bullwhip effect. The compositional effect takes place as the demand shock has a greater impact on vertically integrated sectors with high concentration of consumer durables and investment goods than other sectors. The bullwhip effect takes place as final demand shock amplifies along the supply chain as upstream firms hold more inventories due to larger uncertainty in demand than downstream firms. Furthermore, Constantinescu et al. (2015) point to maturing of global value chain as an important structural factor for post-crisis trade slowdown. Timmer et al. (2016) also find that the negative contribution of production fragmentation in global import intensity has increased during trade slowdown period.

In contrast, some scholars argue that trade within vertical integration is more resilient during crisis because firms within vertical integration tend to protect their established relationship against shocks. Altomonte and Ottaviano (2009) show that Central and Eastern Europe countries' (CEECs) trade with Germany and Italy decreased much less than their trade with France and UK during the global financial crisis because vertical integration is stronger with large share of intermediate goods in the former than the latter.

Furthermore, Behrens et al. (2013) investigate the source of 2008-09 trade collapse using Belgium firm-product-destination level data and find that there is no significant decline in cross-border trade in Belgium during 2008-09. Their research suggests that the trade collapse during the 2008-09 crisis could be heterogeneous across countries from the micro-level data

perspectives. Even though their study does not include intra-firm trade as a transmission channel of crisis, we extend their empirical model by including intra-firm trade ratio in constructing our regression analysis framework.

In Korea, there has been no attempt to examine the role of intra-firm trade in transmitting global shocks even though a growing body of literature investigates determinants of intra-firm trade using Korean firm-level data. Ha (2009) investigates determinants of intra-firm trade of multinational corporations using Korean firm-level data for the years of 2004 and 2007. Ha and Lee (2011, 2016) also examines the determinants of intra-firm trade between Korean parent firms with its foreign affiliates using firm-level data provided by Korean Export Import Bank for the period of 2000-2005 and 2004-2008, respectively. They find that intra-firm trade tends to be negatively associated with the royalty payment, the period of affiliates' presence in host countries, but positively associated with the market size of the host country. In addition, Chun et al. (2017), using Korean and Japanese manufacturing firms' data, finds that intra-firm trade is largely skewed to a small number of large multinational firms and the input-output relation between parent and affiliates is weak. Using Korean manufacturing firm-level data in 2007, Cho et al. (2014) further find that MNEs' global sourcing strategies – outsourcing and insourcing – are complementary, suggesting that MNEs' tend to operate multiple sourcing strategies to adjust their gain from bargaining power and price risk for inputs.

3. Data Description

Our main data is obtained from Survey of Business Activity (SBA) provided by Statistics Korea. The SBA, an annual survey data for all firms with capital value greater than 0.3 billion won and employees more than 50, not only includes each firm's total values of export and import, but also the export and import with its related parties such as parent firms, subsidiaries, and affiliated firms.⁶ Using this information, we can distinguish between firm's trade with related parties (intra-firm trade) and trade with the third parties (arm's length trade). Besides trade-

⁶ In SBA, related parties of a firm include its parent company, subsidiaries, and affiliated companies. A parent firm owns the firm's equity share more than 50% of the capital; subsidiaries are defined as those firms of which the firm owns the equity share more than 50% of the capital; and affiliated companies are defined as those of which the firm has equity share more than 20%.

related information, the dataset provides firm-level information on industry code, revenue, number of employees, financial assets and liabilities, expenditure, investment, foreign capital share and so on. The availability of the data ranges from 2006 to 2015, covering the global financial crisis as well as recent periods of trade slowdown. While SBA data covers all industries including services, our analysis will only focus on manufacturing sector highly engaged in export and import activities.

3.1. Aggregate Data Description

In the manufacturing sector, firms' trade with their related parties takes non-trivial parts in total trade illustrated in Figure 1 and Table 1. As shown in column (1) in Table 1, the share of aggregated intra-firm export value in total export is approximately 31% on average between 2006 and 2015. In total import shown in column (4), the share of aggregated intra-firm import value is 31% on average for the same period.

In terms of growth rate, intra-firm export growth tends to be more volatile than total export growth until 2011 as shown in column (2) and (3). However, the pattern changes after 2011 where total export shows negative growth rates continuously while intra-firm export shows positive or smaller negative growth rates between 2012 and 2015. On the other hand, as shown in column (5) and (6), intra-firm import growth tends to be less volatile and move together with total import growth until 2011. The pattern, however, changes after 2011, as the two move in the opposite direction.

Figure 1. Total trade value vs. Intra-firm trade value (tril. Won)

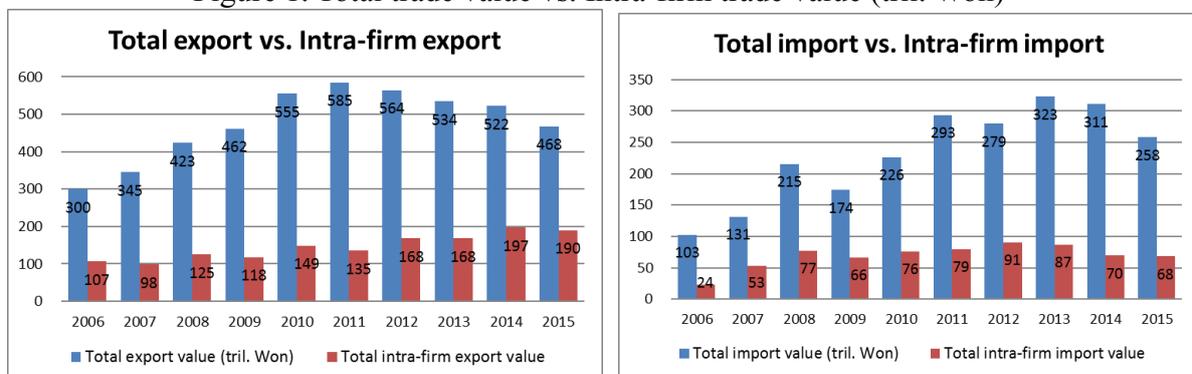


Table 1. Total trade and intra-firm trade and their growth (%)

Year	share of intra-firm export in total export	Total export growth	Intra-firm export growth	share of intra-firm import in total import	Total import growth	Intra-firm import growth
	(1)	(2)	(3)	(4)	(5)	(6)
2006	35.6			23.0		
2007	28.5	15.1	-7.9	40.5	28.1	125.0
2008	29.5	22.6	26.9	35.9	64.0	45.5
2009	25.5	9.1	-5.8	38.2	-19.4	-14.3
2010	26.8	20.1	26.3	33.7	30.2	14.9
2011	23.1	5.4	-9.1	27.1	29.6	4.4
2012	29.8	-3.6	24.4	32.4	-4.6	14.0
2013	31.5	-5.2	0.1	26.9	15.5	-4.1
2014	37.7	-2.3	16.9	22.4	-3.7	-19.8
2015	40.5	-10.3	-3.6	26.4	-17.0	-2.3
average	30.8			30.7		

The number of firms engaged in intra-firm trade is also non-trivial relative to the total number of firms. As shown in Table 2, firms engaged in intra-firm export accounts for 28% of all exporting firms on average, equivalent to 17% of all firms in the sample. In column (3), the number of intra-firm exporters as a share of exporting firms reached 32% in 2009, but decreased to 24% in 2011 and remains at 24% in 2015. As for imports, firms engaged in intra-firm import account for 28% of importing firms on average, equivalent to 13% of all firms. As shown in column (5), the number of intra-firm importers as a share of importing firms reached 32% in 2009, but decreased to 15% in 2015.

Table 2. Number of firms with intra-firm trade

Year	All firms	Exporting firms	Intra-firm exporters	Importing firms	Intra-firm importers
	(1)	(2) (share (2)/(1))	(3) (share (3)/(2), (3)/(1))	(4) (share (4)/(1))	(5) ((share (5)/(4), (5)/(1))
2006	5,961	3,283 (0.55)	838 (0.26, 0.14)	2,353 (0.39)	583 (0.25, 0.10)
2007	5,820	3,474 (0.60)	949 (0.27, 0.16)	2,595 (0.45)	714 (0.28, 0.12)
2008	5,760	3,474 (0.60)	1,023 (0.29, 0.18)	2,613 (0.45)	757 (0.29, 0.13)
2009	5,465	3,554 (0.65)	1,129 (0.32, 0.21)	2,832 (0.52)	910 (0.32, 0.17)
2010	5,305	3,341 (0.63)	909 (0.27, 0.17)	2,346 (0.44)	678 (0.29, 0.13)
2011	5,736	3,442 (0.60)	816 (0.24, 0.14)	2,461 (0.43)	562 (0.23, 0.10)
2012	6,054	3,659 (0.60)	890 (0.24, 0.15)	2,605 (0.43)	628 (0.24, 0.10)
2013	5,981	3,699 (0.62)	955 (0.26, 0.16)	2,642 (0.44)	650 (0.25, 0.11)
2014	5,949	3,706 (0.62)	979 (0.26, 0.16)	2,706 (0.45)	682 (0.25, 0.11)
2015	5,693	4,623 (0.81)	1,090 (0.24, 0.19)	4,768 (0.84)	735 (0.15, 0.13)

Table 3 presents average of individual firm's intra-firm export and import as a share of the firm's total trade for those firms engaged in intra-firm trade. In column (1), the average share of intra-firm export is approximately 47.6%. In column (2), the intra-firm import as a share of the firm's total import is 57% on average. Even though the share dramatically decreased in

2015, the high share of intra-firm trade suggests that intra-firm exporters and importers tend to depend their trade largely on transactions with their related parties.

Table 3. Average intra-firm trade as a share of individual firms' total trade

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Intra-firm export / total export (for individual intra-firm exporters)										
(1)	0.49	0.46	0.48	0.47	0.50	0.48	0.47	0.47	0.47	0.41
Intra-firm import / total import (for individual intra-firm importers)										
(2)	0.58	0.60	0.62	0.61	0.59	0.54	0.56	0.53	0.56	0.38

In sum, the description of data reveals that intra-firm trade accounts for approximately one thirds of total trade in manufacturing sector while its contribution in trade growth varies over time. In terms of number of firms, over one fourth of exporting or importing firms are engaged in intra-firm trade. Moreover, once engaged in intra-firm trade, firm's dependence on intra-firm trade accounts for almost a half of their total exports and over a half of their imports on average.

3.2. Industry-level Data Description

In this section, we exhibit industry-level data description with more details. Table 4 presents top-5 industries in trade value as of 2015 and their intra-firm trade share. In exports, (26) Electronic Components, Computers, Radio, TV and Communications Equipment industry ranked highest in export value, with its intra-firm export reaching 74% as a share of the industry's total export in 2015. Before the global financial crisis, the share was about 55% in 2006, but dropped to 23% just after the crisis in 2009. (30) Motor Vehicles industry, the second highest ranked industry in export value, had 57% share in its intra-firm export in 2009, decreased to 44% in 2015. These top two industries with largest export values also have the highest intra-firm export share. Such condition, however, is not necessary. (20) Chemical Materials and Products, (19) Coke and Petroleum Products, (31) General Transportation Equipment industries exhibit relatively low intra-firm export shares despite ranking high in total export value.

For Imports, (26) Electronic Components, Computers, Radio, TV and Communications Equipment industry also has the largest import value. Although its share of intra-firm import decreased to 24% in 2009 but increased to 69% in 2012 and 53% in 2015. The second highest ranked industry in import value as of 2015 is (19) Coke and Petroleum Products industry with

its intra-firm import share at 55% in 2009 and decreasing to 41% in 2012. However, the other three industries with largest import value – (20) Chemical Materials and Products, (24) Basic Metal Products, (31) General Transportation Equipment –have low intra-firm import share.

Table 4. Top 5 industries in export value and their intra-firm export share (tril. Won, ratio)

		2006		2009		2012		2015	
		Export		Export		Export		Export	
		Export value	Intra-firm share						
26	Electronic Components, Computers, Radio, TV and Communication Equipment	112.3	0.55	89.3	0.23	148.3	0.63	163.8	0.74
30	Motor Vehicles	50.5	0.54	52.9	0.57	85.1	0.41	83.6	0.44
20	Chemical Materials and Products	22.0	0.14	40.7	0.07	66.1	0.11	48.9	0.12
31	General Transportation Equipment	30.8	0.03	66.8	0.02	53.3	0.05	53.3	0.03
19	Coke and Petroleum Products	18.4	0.15	40.2	0.00	80.0	0.01	34.2	0.23
		Import		Import		Import		Import	
		Import value	Intra-firm share						
26	Electronic Components, Computers, Radio, TV and Communication Equipment	28.6	0.44	28.0	0.24	54.3	0.69	61.8	0.53
19	Coke and Petroleum Products	12.0	0.03	36.8	0.55	87.5	0.41	51.9	0.46
20	Chemical Materials and Products	11.0	0.16	16.4	0.13	30.2	0.07	34.0	0.07
24	Basic Metal Products	22.0	0.07	24.3	0.20	31.7	0.05	34.0	0.03
31	General Transportation Equipment	3.7	0.02	6.4	0.23	24.8	0.07	16.7	0.04

Notes: Top 5 industries with the highest export or import value as of 2015.

Table 5 shows top5 industries in terms of the number of exporters and importers and their intra-firm trader shares. The industry with the largest number of exporting and importing firms is (29) Other Machinery and Equipment industry and its number of intra-firm traders as a share of trading firms reached the highest at 27% for exporters and 31% for importers in 2009 but decreased to 21% for exporters and 16% for importers in 2015. Other four industries with high share of exporters and importers such as (26) Electronic Components, Computers, Communication Equipment industry, (30) Motor Vehicles industry, (20) Chemical Materials and Products industry, and (22) Rubber and Plastic Products industry also exhibit similar pattern, where the share peaked in 2009 but decreased in 2015.

Table 5. Top 5 industries of number of traders and their intra-firm trader share (number, ratio)

	Export				Import			
	2006	2009	2012	2015	2006	2009	2012	2015
(29) Other Machinery and Equipment								
Number of trading firms	441	473	483	641	284	351	319	630
Number of intra-firm traders	91	127	114	136	63	109	83	100
(Share of intra-firm traders)	(0.21)	(0.27)	(0.24)	(0.21)	(0.22)	(0.31)	(0.26)	(0.16)
(26) Electronic Components, Computers, Radio, TV and Communication Equipment								
Number of trading firms	525	560	507	605	401	462	372	588
Number of intra-firm traders	174	238	155	188	111	186	103	135
(Share of intra-firm traders)	(0.33)	(0.43)	(0.31)	(0.31)	(0.28)	(0.40)	(0.28)	(0.23)
(30) Motor Vehicles								
Number of trading firms	370	408	439	593	206	255	239	568
Number of intra-firm traders	114	182	144	173	73	129	86	112
(Share of intra-firm traders)	(0.31)	(0.45)	(0.33)	(0.29)	(0.35)	(0.51)	(0.36)	(0.20)
(20) Chemical Materials and Products								
Number of trading firms	246	276	279	352	190	238	226	355
Number of intra-firm traders	82	90	78	102	63	82	55	63
(Share of intra-firm traders)	(0.33)	(0.33)	(0.28)	(0.29)	(0.33)	(0.34)	(0.24)	(0.18)
(22) Rubber and Plastic Products								
Number of trading firms	224	239	249	314	142	152	160	310
Number of intra-firm traders	69	81	73	76	44	53	47	44
(Share of intra-firm traders)	(0.31)	(0.34)	(0.29)	(0.24)	(0.31)	(0.35)	(0.29)	(0.14)

Notes: Top 5 industries with the largest number of exporters or importers as of 2015.

4. Empirical Analysis

We conduct two types of empirical analyses: accounting decomposition and regression analyses. In the accounting decomposition, we investigate overall pattern of trade growth along with intra-firm and arm's length trade growth, decomposing them into intensive and extensive margins. In the regression analysis, we particularly examine contribution of intra-firm trade to within-firm trade growth using difference-in-differences regression.

4.1. Decomposition: Intensive vs. Extensive Margins

In this section, we decompose annual trade growth into intensive margin – changes in trade value due to firms that continually participate in trade – and extensive margin – changes in trade value due to firms that newly start or quit exporting. Then, we apply the decomposition separately to intra-firm trade and arm's length trade.

4.1.1. Export Decomposition

Table 6 reports annual changes in total export and its decomposition results from 2006 to 2015. Total trade growth sustains positive growth rate until 2011, even during the global financial crisis with 9% in 2009. However, beginning in 2012, total export growth rate turned negative and decreased to -10% in 2015. This trade decline goes along with global trade slowdown period and appears more serious than the decline during the global financial crisis.

Decomposition of trade growth into extensive and intensive margins shows that total export growth was mostly attributable to intensive margin only except for 2011. Contribution of continuing firms' export growth was the main source of the total export growth while firms entering or exiting made relatively minor contribution. When the total export growth significantly decreased (0.23 to 0.09) due to impact of global financial crisis from 2008 to 2009, however, we note that the extensive margin has been relatively increased (0.004 to 0.015) while the intensive margin decreased (0.221 to 0.076).

Table 6. Aggregate Export Growth: intensive vs. extensive margin

Year	Change of export value (tril. Won)	Export growth rate (ΔA)	Change of export due to entry and exit of firms		Growth rate of extensive margin (ΔB)	Change of export due to continuing firms		Growth rate of intensive margin (ΔC)
	(A)	(ΔA)	(B)	(B/A)	(ΔB)	(C)	(C/A)	(ΔC)
2007	45.27	0.15	21.88	0.48	0.073	23.39	0.52	0.078
2008	77.91	0.23	1.47	0.02	0.004	76.44	0.98	0.221
2009	38.60	0.09	6.56	0.17	0.015	32.04	0.83	0.076
2010	92.81	0.20	2.26	0.02	0.005	90.55	0.98	0.196
2011	29.92	0.05	34.53	1.15	0.062	-4.60	-0.15	-0.008
2012	-21.04	-0.04	-2.52	0.12	-0.004	-18.52	0.88	-0.032
2013	-29.51	-0.05	25.73	-0.87	0.046	-55.25	1.87	-0.098
2014	-12.15	-0.02	3.03	-0.25	0.006	-15.18	1.25	-0.028
2015	-53.91	-0.10	2.41	-0.004	0.000	-54.15	1.004	-0.104

Table 7 presents decomposition results for intra-firm and arm's length export separately. Intra-firm export growth appears more volatile than arm's length export. While arm's length export shows a pattern that sustains positive growth until 2011 and turns to negative after 2011, intra-firm export repeats decreasing and increasing every other year. This pattern might suggest that intra-firm trade is more flexibly adjustable than arm's length trade.

During the global financial crisis period 2008-2009, intra-firm export decreases by 6% due to negative extensive margin while arm's length export sustains positive growth due to intensive margin. This suggests that intra-firm export was more responsive to global financial crisis than arm's length export because extensive margin in intra-firm export was vulnerable to shocks during the trade collapse.

On the contrary, during trade slowdown period of 2012-2015, arm's length export turns to negative leading the total export growth decreases while intra-firm export mostly sustains positive growth rates. The negative growth of arm's length export was largely due to intensive margin, similar to total export growth.

This pattern found in Table 7 implies that firms' export with related parties was more responsive to the global financial crisis than the arm's length export, lowering the total export growth during the crisis. At the same time, intra-firm export was also more responsive in recovering after crisis, showing much higher growth in 2010 than arm's length export. This result suggests that MNEs' export decision on intra-firm export can be made more flexibly in response to macroeconomic shocks, compared to arm's length trade, facilitating the transmission of shocks. This is consistent with the argument that vertical integration facilitates the transmission of global shocks. (Bems et al., 2009, 2011)

Table 7. Intra-firm and Arm's length Export Growth: intensive vs. extensive margin

Year	Change in export value (tril. Won)	Export growth rate	Change of export due to entry and exit of firms		Growth of extensive margin	Change of export due to continuing firms		Growth of intensive margin	
	(A)	(ΔA)	(B)	(B/A)	(ΔB)	(C)	(C/A)	(ΔC)	
Intra-firm export	2007	-8.49	-0.08	16.96	-2.00	0.159	-25.45	3.00	-0.238
	2008	26.48	0.27	0.02	0.00	0.000	26.46	1.00	0.269
	2009	-7.27	-0.06	-10.73	1.48	-0.086	3.46	-0.48	0.028
	2010	30.96	0.26	8.15	0.26	0.069	22.81	0.74	0.194
	2011	-13.45	-0.09	-4.23	0.31	-0.028	-9.22	0.69	-0.062
	2012	32.94	0.24	26.46	0.8	0.196	6.48	0.2	0.048
	2013	0.22	0.00	6.54	29.36	0.039	-6.31	-28.36	-0.038
	2014	28.35	0.17	12.37	0.44	0.074	15.98	0.56	0.095
	2015	-7.02	-0.04	-13.74	1.96	-0.070	6.72	0.96	0.034
Arm's length export	2007	53.76	0.28	18.88	0.35	0.098	34.88	0.65	0.181
	2008	51.43	0.21	2.53	0.05	0.010	48.89	0.95	0.198
	2009	45.87	0.15	-1.39	-0.03	-0.005	47.26	1.03	0.158
	2010	61.85	0.18	4.29	0.07	0.012	57.56	0.93	0.167
	2011	43.37	0.11	40.30	0.93	0.099	3.07	0.07	0.008
	2012	-53.98	-0.12	-3.36	0.06	-0.007	-50.62	0.94	-0.113
	2013	-29.74	-0.08	23.20	-0.78	0.059	-52.93	1.78	-0.134
	2014	-40.50	-0.11	-22.63	0.56	-0.062	-17.87	0.44	-0.049
	2015	-46.89	-0.14	-6.04	0.13	-0.019	-40.85	0.87	-0.126

In contrast, during the period of trade slowdown that started in 2012, the pattern of intra-firm and arm's length trade movement has changed. Arm's length trade was more severely affected than intra-firm trade since 2012. This contrasting pattern between intra-firm and arm's length export before and after 2012 suggests that responsiveness of the two types of export are significantly different. Intra-firm export appears more flexible and responsive to temporary shocks such as financial crisis, but more resilient to structural or persistent shocks such as global trade slowdown.

4.1.2. Import Decomposition

Table 8 presents aggregate import growth and its decomposition into intensive and extensive margins. The change in import value underscores the dramatic impact the global financial crisis in 2009 has had on imports than exports. Total import value increased by 25% and 64% in 2007 and 2008 respectively but plummeted by 19% in 2009. After the crisis, import growth rebounded by 30% in 2010 and 2011, but the growth rate turns negative in 2012 and plummets to -17% in 2015. The decomposition into extensive and intensive margin shows that intensive margin mainly contributed to the import drop in 2009 and 2015.

Table 8. Aggregate Import Growth: intensive vs. extensive margin

Year	Change of import value (tril. Won)	Import growth rate	Change of import due to entry and exit of firms		Growth rate of extensive margin	Change of import due to continuing firms		Growth rate of intensive margin
	(A)	(ΔA)	(B)	(B/A)	(ΔB)	(C)	(C/A)	(ΔC)
2007	28.81	0.28	33.01	1.15	0.32	-4.20	-0.15	-0.04
2008	84.01	0.64	9.60	0.11	0.07	74.41	0.89	0.57
2009	-41.75	-0.19	8.38	-0.20	0.04	-50.14	1.20	-0.23
2010	52.36	0.30	-5.70	-0.11	-0.03	58.06	1.11	0.33
2011	66.98	0.30	54.72	0.82	0.24	12.26	0.18	0.05
2012	-13.58	-0.05	-22.13	1.63	-0.08	8.55	-0.63	0.03
2013	43.17	0.15	40.56	0.94	0.15	2.61	0.06	0.01
2014	-11.87	-0.04	8.63	-0.73	0.03	-20.50	1.73	-0.06
2015	-52.77	-0.17	0.35	-0.01	0.001	-53.11	1.01	-0.17

Total import growth is separated into intra-firm and arm's length import in Table 9. The intra-firm import growth tends to be less volatile than arm's length import. In 2009, intra-firm import decreased by 14% while arm's length import decreased by 22%. However, the decline of intra-

firm import in 2009 is due to extensive margin while that of arm's length imports due to intensive margin.

For the period of global trade slowdown from 2012 to 2015, the pattern shows that both intra-firm and arm's length import declined largely due to decreases in intensive margin. In 2014, intra-firm import decreased by 20%, which is larger than the drop in 2009, while arm's length import decreased by 21%, which is slightly less than its drop in 2009. This suggests that intra-firm import was more responsive to global trade slowdown than to global trade collapse in 2009.

Table 9. Intra-firm and Arm's length Import Growth: intensive vs. extensive margin

Year	Change of import value (tril. Won)	Import growth rate	Change of import due to entry and exit of firms		Growth rate of extensive margin	Change of import due to continuing firms		Growth rate of intensive margin	
	(A)	(ΔA)	(B)	(B/A)	(ΔB)	(C)	(C/A)	(ΔC)	
Intra-firm import	2007	29.53	1.25	19.71	0.67	0.83	9.82	0.33	0.42
	2008	24.17	0.45	2.39	0.10	0.04	21.78	0.90	0.41
	2009	-11.05	-0.14	-14.35	1.30	-0.19	3.30	-0.30	0.04
	2010	9.87	0.15	-0.44	-0.04	-0.01	10.31	1.04	0.16
	2011	3.34	0.04	-1.90	-0.57	-0.02	5.25	1.57	0.07
	2012	11.16	0.14	-1.13	-0.10	-0.01	12.29	1.10	0.15
	2013	-3.72	-0.04	13.41	-3.60	0.15	-17.13	4.60	-0.19
	2014	-17.22	-0.20	2.06	-0.12	0.02	-19.28	1.12	-0.22
	2015	-1.61	-0.02	-8.68	5.40	-0.12	7.07	-4.40	0.10
Arm's length import	2007	-0.72	-0.01	8.82	-12.17	0.11	-9.54	13.17	-0.12
	2008	59.85	0.77	16.28	0.27	0.21	43.57	0.73	0.56
	2009	-30.70	-0.22	-4.03	0.13	-0.03	-26.68	0.87	-0.19
	2010	42.49	0.40	11.69	0.28	0.11	30.81	0.72	0.29
	2011	63.63	0.42	55.91	0.88	0.37	7.72	0.12	0.05
	2012	-24.74	-0.12	-17.25	0.70	-0.08	-7.50	0.30	-0.04
	2013	46.89	0.25	32.65	0.70	0.17	14.25	0.30	0.08
	2014	5.35	0.02	9.67	1.81	0.04	-4.32	-0.81	-0.02
	2015	-51.16	-0.21	20.66	-0.40	0.09	-71.82	1.40	-0.30

4.2. Regression Analysis

In this section, we conduct regression analysis extending the empirical model by Behrens et al. (2013). While the decomposition analysis above shows overall patterns of intra-firm and arm's length trade with their intensive and extensive margins, regression analysis here focuses on contribution of intra-firm trade to within-firm trade growth.

4.2.1. Model Specification

Based on the model of Behrens et al. (2013), the estimation equation is constructed as equation (1). The dependent variable is the export (import) growth rate of firm i for industry j between two consecutive years, t and $t+1$.

$$\Delta X_{ij}^t = \alpha_{ij}^t + D_j + D^t + \beta_1' Z_{ij}^{t-1} + \beta_2' Z_{ij}^{t-1} TC^t + \varepsilon_{ij}^t \quad (1)$$

$$\text{where } \Delta X_{ij}^t = \ln X_{ij}^{t+1} - \ln X_{ij}^t$$

TC_t is the variable indicating the year of the global financial crisis in 2009, or the period of the recent trade slowdown, 2012-2015. We run the regression model separately for each shock, the financial crisis and the recent trade slowdown. For analyzing the effect of the global financial crisis, the observed period is from 2007 to 2009. The period of 2007-2008 correspond to the pre-treatment period and the period of 2008-2009 is considered as post-treatment period. On the other hand, the sample years for analyzing the effect of the recent trade slowdown are between 2007 and 2015. The period of 2007-2012 corresponds to the pre-treatment period and the period of 2012-2015 is considered as post-treatment period. Other independent variables (Z^{t-1}_{ij}) include the firm characteristics such as firm size, financial status, ownership, and productivity in the previous year to address simultaneity issue between firm characteristics. D_t and D_j are time and industry fixed effects, respectively. ε_{ij}^t indicates the error term, and we estimate the regressions with cluster-robust standard errors. Firm characteristic variables are interacted with TC_t for identifying the differential changes during global financial crisis and global trade slowdown. The β_1 indicates the effect of variables during all observed years whereas the β_2 measures the additional impact of variables during the financial crisis or recent trade slowdown.

All firm characteristics (Z^{t-1}_{ij}) are binary variables that is equal to 1 if the value is greater than the sectoral median for each variable or equal to zero otherwise. As Behren et al. (2013) explained, by using binary variables instead of continuous one, we can include more firms in the sample with reducing the bias due to measurement error and potential outliers. Also, the binary variables make it clearer to interpret the regression coefficients in comparing the contribution of the different firm characteristics to changes in trade value.

Firm characteristic variables included in Z^{t-1}_{ij} and their summary statistics are listed in Table 10. These variables are selected based on the explanation in Behrens et al. (2013). The number

of employees(\ln_worker) that represents size of the firm is converted into logarithm. Productivity is total factor productivity (TFP) estimated using Olley and Pakes (1996) methodology that uses investment as a proxy for unobservable productivity shocks. According to literature that points to global value chain, financial friction, and inventory capacity as causes of global trade collapse, we also include the following variables as in Behrens et al. (2013). The share of intermediates over revenue ($int2rev$), the share of exports over revenue ($exp2rev$), and the share of imports over intermediates ($exp2int$), and the exports times imports over revenue (va_chain) are included as proxies for each firm's involvement in global value chain. The external finance dependence (ext_fin_dep) measured as investment minus operating profits over investment, and the share of liabilities (shr_liab) measured as financial liabilities over assets are proxy variables for firms' financial structure. Share of inventory over revenue (shr_inv_rev) is included as a proxy variable for inventory capacity. Foreign ownership is measured as 1 if foreign capital share is over 50%. MNE is dummy variable that is one if a firm has foreign affiliates or a foreign parent. The variables of our interest are the share of intra-firm export over total export and the share of intra-firm import over total import. The share of the number of intra-firm traders over the total number of firms for the previous year is also included for controlling industry-level concentration of intra-firm trade.

Table 10. Variable description and summary statistics

Variable	Description	Mean	Standard deviation
\ln_worker	value=1 if the number of worker is greater than sample median	.590	.491
tfp	value=1 if total factor productivity is greater than sample median	.634	.482
$int2rev$	value=1 if share of intermediates over turnover is greater than sample median	.592	.492
$exp2rev$	value=1 if share of exports over turnover is greater than sample median	.626	.484
$imp2int$	value=1 if share of imports over intermediates is greater than sample median	.711	.453
va_chain	value=1 if value added chain measured by export times imports over turnover ($(exp*imp)/revenue$) is greater than sample median	.742	.438
ext_fin_dep	value=1 if investment minus operating profits over investments is greater than sample median	.611	.488
shr_liab	value=1 if financial liabilities over assets(financial total / financial asset) is greater than sample median	.588	.492
shr_inv_rev	value=1 if share of stock over turnover (financial asset inventory / revenue) is greater than sample median	.590	.492
$foreign50$	value=1 if foreign capital ownership over 50		
MNE	Value=1 if a firm has affiliates or a parent abroad		
int_exp_r	value=1 if share of intra-firm export over export is greater than sample median	.432	.495
int_imp_r	value=1 if share of intra-firm import over export is greater than sample median	.421	.494
$N_int2exp$	Number of intra-firm trade over all export firms	.383	.392
$N_int2imp$	Number of intra-firm trade over all import firms	.428	.540

4.2.2. Regression Results

Table 11 presents estimation result for baseline equation (1) with export of all firms in column (1) and (2) and that of only with continuing firms in column (3) and (4). In this table, we include interaction terms with 2009 crisis dummy for all explanatory variables. In all columns, firms with large number of workers, high share of imports in intermediates, and high share of inventory in revenue tend to have significantly higher export growth rate, while firms with high export to revenue ratio tend to have significantly lower export growth rate. As for the intra-firm export ratio, column (1) and (3) show contrasting results; firms with high intra-firm export ratio have lower export growth by 36.7% compared to firms with low intra-firm export ratio among all firms but higher export growth by 37.2% among continuing firms. In addition, column (2) further shows that the negative effect of intra-firm export ratio for all firms is particularly during the trade collapse in 2008-2009, meaning that firms with high intra-firm export ratio have significantly lower export growth mostly due to entry or exit of firms (extensive margin). However, (3) and (4) show that firms with high intra-firm export ratio that stay in the sample throughout the entire sample period have significantly higher export growth by 37.2~40% regardless of crisis (intensive margin).

As for the trade collapse in 2009, column (2) and (4) further show what factors significantly play a role in bring trade collapse in Korea's export at the firm-level as in Behrens et al. (2013). Column (2) shows that firms with high export to revenue ratio, high external finance dependence, and high intra-firm export ratio have significantly lower export growth rate mostly through extensive margin. Column (4) shows that firms with high export and import share in revenue have lower export growth in 2009. In addition, MNE tend to have significantly higher export growth rate for both all firms and continuing firms in 2009.

Table 11. Export growth during global financial crisis

Variables	(1)	(2)	(3)	(4)
	All firms		Continuing firms	
	Dependent variable: dln_exp			
L.ln_worker_h	0.418*** (0.0972)	0.339*** (0.117)	0.175** (0.0680)	0.208** (0.0859)
L.tfp_h	0.0499 (0.0846)	0.0474 (0.104)	-0.0384 (0.0559)	-0.0113 (0.0727)
L.int2rev_h	0.0671 (0.0852)	0.0111 (0.107)	0.00740 (0.0548)	-0.0374 (0.0750)
L.exp2rev_h	-2.726*** (0.108)	-2.610*** (0.131)	-1.515*** (0.0892)	-1.565*** (0.123)
L.imp2int_h	0.553*** (0.128)	0.466*** (0.144)	0.215** (0.0912)	0.144 (0.104)
L.va_chain_h	-0.423*** (0.144)	-0.261 (0.208)	0.0821 (0.112)	0.303 (0.184)
L.ext_fin_dep_h	0.0838 (0.0823)	0.162 (0.107)	0.0291 (0.0572)	0.0508 (0.0783)
L.shr_liab_h	0.0873 (0.0899)	0.107 (0.0902)	0.0652 (0.0635)	0.0738 (0.0637)
L.shr_inv_rev_h	0.347*** (0.0930)	0.380*** (0.115)	0.186*** (0.0622)	0.231*** (0.0820)
L.foreign50	-0.421 (0.431)	-0.447 (0.448)	-0.0429 (0.213)	0.0200 (0.221)
L.int_exp_r_h	-0.367*** (0.129)	-0.163 (0.160)	0.373*** (0.0743)	0.400*** (0.0947)
L.N_int2exp	-1.153 (0.884)	-0.812 (0.938)	-0.414 (0.620)	-0.0939 (0.656)
L.MNE	0.108 (0.104)	-0.0937 (0.120)	0.0832 (0.0692)	0.00768 (0.0811)
y09=1 x L.ln_worker_h		0.0677 (0.130)		-0.0942 (0.0876)
y09=1 x L.tfp_h		-0.0470 (0.118)		-0.0842 (0.0842)
y09=1 x L.int2rev_h		0.0955 (0.122)		0.0962 (0.0902)
y09=1 x L.exp2rev_h		-0.275** (0.128)		0.0744 (0.130)
y09=1 x L.imp2int_h		0.235 (0.233)		0.253 (0.176)
y09=1 x L.va_chain_h		-0.323 (0.281)		-0.458** (0.231)
y09=1 x L.ext_fin_dep_h		-0.220* (0.128)		-0.0686 (0.0910)
y09=1 x L.shr_inv_rev_h		-0.0983 (0.124)		-0.0977 (0.0881)
y09=1 x L.foreign50		-0.00550 (0.226)		-0.0985 (0.108)
y09=1 x L.int_exp_r_h		-0.568*** (0.168)		-0.0756 (0.106)
y09=1 x L.N_int2exp		-0.914 (0.602)		-0.748* (0.452)
y09=1 x L.MNE		0.568*** (0.186)		0.174* (0.0980)
Constant	-0.789 (1.599)	-0.787 (1.605)	-0.00240 (0.295)	-0.0604 (0.319)
Observations	15839	15839	6795	6795
R-squared	0.102	0.105	0.115	0.118
Number of firm_id	6,474	6,474	2,265	2,265

Notes: Clustered-robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 12 presents regression results for export growth with interaction terms for the trade slowdown period 2012-2015. Column (1) and (2) are results with all firms, (3) and (4) are with continuing firms. Column (1) and (3) includes the entire sample period 2007-2015, but (2) and (4) includes only period 2010-2015 to exclude the period until global financial crisis. For the period before 2012, firms with high import to intermediates ratio, and inventory to revenue ratio tend to have significantly higher export growth rate, while firms with high export to revenue ratio and greater number of intra-firm exporting firms in the cohort tend to have significantly lower export growth rate.

As for the intra-firm export ratio variable of our interest, results show a contrasting pattern between all firms and continuing firms. Column (1) and (2) show that firms with higher intra-firm export ratio tend to have significantly lower export ratio for the period before 2012 (by -44% for 2007-2012 and -60% for 2010-2012), and the high intra-firm export ratio firms' export growth rate becomes significantly much lower for the period after 2012 (by -71% compared to 2007-2012 and -75% compared to 2010-2012). However, column (3) and (4) show that continuing firms with high intra-firm export ratio have significantly higher export growth by 27.4% and 24.6% on average for the period 2007-2015 and 2010-2015, respectively. These contrasting results suggest that the negative export growth by firms with higher intra-firm export ratio is mainly due to extensive margin, and this negative growth by extensive margin is intensified during the trade slowdown period after 2012.

Table 12. Export growth during recent trade slowdown

	(1) All firms		(3) Continuing firms	
	2007-2015	2010-2015	2007-2015	2010-2015
	Dependent variable: <i>dln_exp</i>			
L.ln_worker_h	0.337*** (0.0661)	0.370*** (0.109)	0.0718 (0.0498)	0.0571 (0.0899)
L.tfp_h	0.182*** (0.0571)	0.303*** (0.0977)	0.0347 (0.0421)	0.128* (0.0736)
L.int2rev_h	-0.0154 (0.0571)	-0.128 (0.0953)	0.00713 (0.0384)	-0.00950 (0.0719)
L.exp2rev_h	-2.747*** (0.0756)	-3.345*** (0.125)	-1.212*** (0.0744)	-1.406*** (0.119)
L.imp2int_h	0.307*** (0.0834)	0.311** (0.130)	0.179*** (0.0676)	0.0664 (0.103)
L.va_chain_h	0.100 (0.0962)	0.387** (0.151)	-0.0143 (0.0890)	0.413*** (0.148)
L.ext_fin_dep_h	0.0726 (0.0548)	0.131 (0.0912)	0.0571 (0.0400)	0.0104 (0.0762)
L.shr_liab_h	0.0683 (0.0515)	0.0462 (0.0778)	0.118*** (0.0352)	0.221*** (0.0528)
L.shr_inv_rev_h	0.256*** (0.0610)	0.167* (0.0986)	0.153*** (0.0429)	0.192** (0.0781)
L.foreign50	-0.128 (0.134)	0.0134 (0.196)	-0.166** (0.0770)	-0.112 (0.133)
L.int_exp_r_h	-0.441*** (0.0847)	-0.598*** (0.141)	0.274*** (0.0490)	0.246*** (0.0884)
L.N_int2exp	-1.221*** (0.309)	-1.748*** (0.494)	-0.551*** (0.208)	-1.512*** (0.502)
L.MNE	0.0161 (0.0695)	-0.0711 (0.166)	0.0258 (0.0507)	0.00707 (0.109)
y1215=1 x L.ln_worker_h	-0.316*** (0.0734)	-0.284*** (0.0973)	0.0594 (0.0437)	0.182** (0.0747)
y1215=1 x L.tfp_h	-0.00365 (0.0706)	-0.0629 (0.0992)	-0.0434 (0.0455)	-0.0597 (0.0716)
y1215=1 x L.int2rev_h	0.00122 (0.0736)	0.0982 (0.102)	0.0216 (0.0483)	0.0229 (0.0748)
y1215=1 x L.exp2rev_h	0.844*** (0.0843)	1.222*** (0.119)	0.161** (0.0785)	0.0557 (0.114)
y1215=1 x L.imp2int_h	-0.171 (0.105)	-0.177 (0.139)	-0.0704 (0.0784)	0.00411 (0.0998)
y1215=1 x L.va_chain_h	0.604*** (0.121)	0.387** (0.164)	0.133 (0.109)	-0.310** (0.153)
y1215=1 x L.ext_fin_dep_h	-0.0781 (0.0714)	-0.0955 (0.0987)	-0.0189 (0.0459)	0.0742 (0.0770)
y1215=1 x L.shr_inv_rev_h	-0.147** (0.0691)	-0.106 (0.0938)	0.0952** (0.0433)	0.119 (0.0728)
y1215=1 x L.foreign50	0.175 (0.110)	0.126 (0.174)	0.101* (0.0606)	0.112 (0.127)
y1215=1 x L.int_exp_r_h	-0.713*** (0.109)	-0.751*** (0.150)	-0.0527 (0.0596)	-0.0222 (0.0936)
y1215=1 x L.N_int2exp	1.102*** (0.328)	1.562*** (0.505)	0.350 (0.213)	1.270** (0.509)
y1215=1 x L.MNE	0.0505 (0.0908)	0.0694 (0.141)	-0.0433 (0.0468)	-0.102 (0.0891)
Constant	0.876 (1.196)	1.390 (2.093)	0.763*** (0.173)	1.380*** (0.242)
Observations	47948	32109	10368	8535
R-squared	0.070	0.075	0.103	0.131
Number of firm_id	8,237	7,019	1,152	1,707

Notes: Clustered-robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 13 presents regression results for import growth including interaction terms with global financial crisis in 2008-2009. Column (1) and (2) include all firm in the sample, but column (3) and (4) include only continuing firms firm the entire sample period 2007-2015. In both samples, firms with greater involvement in value added chain (measured by export times import over revenue), high external finance dependence, high inventory to revenue ratio, and high intra-firm import ratio tend to have significantly higher import growth rate, while firms with high intermediate to revenue ratio and high export to revenue ratio tend to have significantly lower import growth rate.

For the period of trade collapse in 2008-2009, those firm characteristics that significantly affect firm's import growth are total factor productivity and involvement in value added chain. In column (2) and (4), firms with high total factor productivity and high export and import to revenue ratio have significantly lower import growth rate during the crisis. Intra-firm import ratio has no significant additional effect on import growth during trade collapse, suggesting that firms with high intra-firm import ratio tend to have higher import ratio regardless of crisis.

Table 14 presents regression results for import growth with interaction terms for the trade slowdown period 2012-2015. Column (1) and (2) shows results with all firms, and column (3) and (4) shows results with only continuing firms. For each sample, we report results of entire sample period 2007-2015 and post-crisis period 2010-2015 separately. In both samples, firms with high total factor productivity, high external finance dependence, high inventory to revenue ratio, and high intra-firm import ratio have significantly higher import growth before 2012, while firms with high intermediate to revenue ratio, and import to intermediate ratio have significantly lower import growth ratio before 2012. For the period 2012-2015, firms with greater involvement in value chain and high intra-firm import ratio have significantly lower import growth compared to the period 2007-2011.

As for the intra-firm import ratio, it is confirmed that firms with high intra-firm import ratio have significantly higher import growth similarly to the results in benchmark regression in Table 14. However, a stark difference is that the import growth rate for firms with high intra-firm import ratio has been significantly lowered during trade slowdown period 2012-2015 compared to the period before 2012, whereas it has not been significantly changed during trade collapse in 2008-2009 compared to pre-crisis period. Also, comparison between all firms and

Table 13. Import growth during global financial crisis

VARIABLES	(1)	(2)	(3)	(4)
		All firms	Continuing firms	
	Dependent variable: dln_imp			
L.ln_worker_h	0.0806 (0.102)	0.111 (0.127)	0.0524 (0.105)	0.0426 (0.137)
L.tfp_h	0.155* (0.0919)	0.293*** (0.111)	0.0921 (0.0981)	0.231* (0.121)
L.int2rev_h	-0.299*** (0.0824)	-0.207* (0.108)	-0.282*** (0.0865)	-0.199* (0.119)
L.exp2rev_h	-0.121 (0.103)	-0.141 (0.129)	-0.183* (0.109)	-0.183 (0.145)
L.imp2int_h	-1.975*** (0.192)	-2.245*** (0.258)	-2.002*** (0.221)	-2.499*** (0.318)
L.va_chain_h	0.700*** (0.201)	1.239*** (0.268)	0.599** (0.233)	1.288*** (0.303)
L.ext_fin_dep_h	0.178** (0.0790)	0.241** (0.107)	0.179** (0.0846)	0.209* (0.119)
L.shr_liab_h	-0.0304 (0.0932)	-0.0306 (0.0936)	-0.0544 (0.101)	-0.0480 (0.102)
L.shr_inv_rev_h	0.455*** (0.0987)	0.387*** (0.119)	0.412*** (0.101)	0.366*** (0.127)
L.foreign50	-0.0356 (0.244)	-0.0697 (0.254)	-0.149 (0.223)	-0.0795 (0.233)
L.int_imp_r_h	0.392*** (0.111)	0.396*** (0.140)	0.381*** (0.113)	0.298** (0.147)
L.N_int2imp	-0.0345 (1.019)	-0.130 (1.083)	0.207 (1.105)	0.230 (1.187)
L.MNE	-0.102 (0.102)	-0.112 (0.122)	-0.102 (0.113)	-0.153 (0.138)
y09=1 x L.ln_worker_h		-0.0605 (0.125)		0.0289 (0.141)
y09=1 x L.tfp_h		-0.291** (0.118)		-0.289** (0.129)
y09=1 x L.int2rev_h		-0.206* (0.123)		-0.183 (0.139)
y09=1 x L.exp2rev_h		0.0211 (0.147)		-0.0226 (0.165)
y09=1 x L.imp2int_h		0.441 (0.296)		0.925*** (0.356)
y09=1 x L.va_chain_h		-0.879*** (0.310)		-1.110*** (0.360)
y09=1 x L.ext_fin_dep_h		-0.151 (0.133)		-0.0852 (0.152)
y09=1 x L.shr_inv_rev_h		0.125 (0.122)		0.0899 (0.137)
y09=1 x L.foreign50		0.00906 (0.144)		-0.108 (0.153)
y09=1 x L.int_imp_r_h		0.0150 (0.161)		0.184 (0.173)
y09=1 x L.N_int2imp		0.143 (0.632)		0.0148 (0.691)
y09=1 x L.MNE		-0.0491 (0.147)		0.0685 (0.160)
Constant	-0.0962 (0.450)	-0.125 (0.456)	-0.133 (0.470)	-0.154 (0.475)
Observations	6276	6276	4290	4290
R-squared	0.075	0.082	0.075	0.083
Number of firm_id	2,902	2,902	1,430	1,430

Notes: Clustered-robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 14. Import growth during recent trade slowdown

	(1)	(2)	(3)	(4)
Sample firm:	All firms		Continuing firms	
Sample period:	2007-2015	2010-2015	2007-2015	2010-2015
Variables	Dependent variable: dln_imp			
L.ln_worker_h	0.147** (0.0593)	0.416*** (0.0947)	-0.0565 (0.0978)	0.110 (0.158)
L.tfp_h	0.221*** (0.0511)	0.296*** (0.0746)	0.165* (0.0879)	0.352*** (0.125)
L.int2rev_h	-0.198*** (0.0472)	-0.215*** (0.0707)	-0.344*** (0.0735)	-0.250** (0.118)
L.exp2rev_h	-0.0275 (0.0568)	-0.0984 (0.0886)	-0.206** (0.0899)	-0.136 (0.143)
L.imp2int_h	-1.499*** (0.0946)	-1.455*** (0.124)	-1.248*** (0.179)	-1.495*** (0.226)
L.va_chain_h	0.403*** (0.101)	0.0914 (0.134)	0.330 (0.212)	0.123 (0.291)
L.ext_fin_dep_h	0.0925** (0.0439)	0.0803 (0.0729)	0.147** (0.0735)	0.281** (0.112)
L.shr_liab_h	0.103** (0.0429)	0.141** (0.0628)	-0.0467 (0.0747)	0.0897 (0.101)
L.shr_inv_rev_h	0.377*** (0.0534)	0.296*** (0.0783)	0.323*** (0.0858)	0.160 (0.131)
L.foreign50	-0.0374 (0.0733)	-0.0530 (0.108)	-0.0501 (0.113)	-0.0831 (0.150)
L.int_imp_r_h	0.356*** (0.0602)	0.366*** (0.0912)	0.292*** (0.0945)	0.303** (0.133)
L.N_int2imp	-0.385 (0.239)	-0.315 (0.323)	0.0550 (0.331)	-0.171 (0.650)
L.MNE	-0.0302 (0.0552)	-0.179 (0.111)	-0.00946 (0.0894)	-0.292 (0.180)
y1215=1 x L.ln_worker_h	0.0215 (0.0544)	-0.113 (0.0725)	0.0343 (0.0796)	0.0585 (0.125)
y1215=1 x L.tfp_h	0.00278 (0.0533)	-0.00466 (0.0693)	0.0300 (0.0792)	-0.189 (0.115)
y1215=1 x L.int2rev_h	-0.0984* (0.0540)	-0.105 (0.0751)	-0.0227 (0.0845)	-0.154 (0.129)
y1215=1 x L.exp2rev_h	0.0525 (0.0636)	0.111 (0.0894)	0.191* (0.0979)	0.128 (0.138)
y1215=1 x L.imp2int_h	0.421*** (0.109)	0.239* (0.132)	0.327* (0.188)	0.151 (0.226)
y1215=1 x L.va_chain_h	-0.380*** (0.117)	-0.0793 (0.144)	-0.466* (0.237)	-0.298 (0.282)
y1215=1 x L.ext_fin_dep_h	-0.0241 (0.0518)	0.0280 (0.0741)	-0.130 (0.0884)	-0.222* (0.114)
y1215=1 x L.shr_inv_rev_h	-0.00558 (0.0562)	0.0604 (0.0726)	-0.143* (0.0817)	-0.0803 (0.123)
y1215=1 x L.foreign50	0.0208 (0.0581)	0.0235 (0.0900)	-0.0140 (0.0858)	-0.0333 (0.135)
y1215=1 x L.int_imp_r_h	-0.131* (0.0718)	-0.132 (0.0955)	-0.227** (0.100)	-0.119 (0.135)
y1215=1 x L.N_int2imp	0.238 (0.240)	0.151 (0.323)	-0.0183 (0.313)	0.169 (0.639)
y1215=1 x L.MNE	0.0280 (0.0605)	0.110 (0.0904)	0.119 (0.0896)	0.121 (0.144)
Constant	0.0826 (0.201)	1.014*** (0.278)	0.0276 (0.440)	0.559 (0.463)
Observations	18157	11881	4221	4150
R-squared	0.071	0.090	0.074	0.107
Number of firm_id	4,489	3,754	469	830

Notes: Clustered-robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

continuing firms reveals that import growth change associated with intra-firm ratio during trade slowdown is larger in intensive margin than in extensive margin.

The main results for intra-firm trade are summarized in Table 15. In export growth, high intra-firm export ratio is associated with lower export growth for all firms while it is associated with positive export growth for continuing firms. This result implies that the negative effect is mainly due to extensive margin, exit and entry of firms, but the positive effect is mainly due to intensive margin by continuing firms. The negative extensive margin is pronounced in 2009 compared to pre-crisis period, and it is further pronounced during trade slowdown in 2012-2015 compared to the period before 2012, whereas intensive margin does not exhibit additional changes during trade collapse or trade slowdown.

In import growth, high intra-firm import ratio is associated with higher import growth for both all firms and continuing firms. During trade collapse, there is no significant changes in the relationship between intra-firm import-ratio and import growth, but there is a significant decrease of import growth for high intra-firm import ratio firms during trade slowdown in 2012-2015 compared to the period 2007-2011. In addition, this decrease of association between intra-firm import ratio and import growth is more intensified by intensive margin rather than extensive margin.

Table 15. Effect of intra-firm export and import during economic crisis

Dependent variable:			Export growth		Import growth	
TC	Sample period		Intra-firm export ratio	Intra-firm export ratio x TC	Intra-firm import ratio	Intra-firm import ratio x TC
Trade collapse in 2009	2007-2009 ¹⁾	All firms	-0.367***		0.392***	
			-0.163	-0.568***	0.396***	0.015
		Continuing firms	0.373***		0.381***	
			0.400***	-0.076	0.298***	0.184
Trade slowdown in 2012-2015	2007-2015 ²⁾	All firms	-0.441***	-0.713***	0.356***	-0.131*
		Continuing firms	0.274***	-0.053	0.292***	-0.227**
	2010-2015 ²⁾	All firms	-0.598***	-0.751***	0.366***	-0.132
		Continuing firms	0.246***	-0.022	0.303***	-0.119
	2012-2015 ²⁾	All firms	-1.364***		0.398***	
		Continuing firms	0.303***		0.466***	

* 1) 2008-2009 financial crisis 2) 2012-2015 recent trade slowdown

Notes: Full regression results for the period 2012-2015 summarized in the last two rows are reported in appendix table A2 and A3.

5. Conclusion

In this paper, we investigate how intra-firm trade contributed to the changes in trade growth of Korean manufacturing firms during the trade collapse in 2008-2009 and the recent trade slowdown in 2012-2015. Using firm-level data of Korean manufacturing sector for the period of 2006-2015, we assess contribution of intra-firm trade to trade growth by separating intensive and extensive margins based on accounting decomposition and regression analysis.

First, we see the overall pattern based on the accounting decomposition. Comparing between intra-firm and arm's length trade, arm's length trade played a larger role in import collapse in 2009 and trade slowdown since 2012. For intra-firm trade, decomposition reveals that decreases in intra-firm export and import in 2009 is attributable to extensive margin, but decrease in intra-firm import during trade slowdown is mainly due to intensive margin.

Second, we specifically assess contribution of intra-firm trade to within-firm trade growth using difference-in-difference regressions. We find that firms with high intra-firm export ratio have significantly lower export growth during both trade collapse and trade slowdown periods, mainly due to extensive margin. As for import, firms with high intra-firm import ratio have significantly lower import growth only during trade slowdown period, largely due to intensive margin.

Our finding provides new evidence on the role of intra-firm trade in transmitting global trade shocks to trade growth using firm-level data. Our results suggest that intra-firm trade played a significant role in transmitting global shocks to within-firm trade growth although the role of arm's length trade seems to be larger for aggregated trade growth. Also, as a transmission channel, extensive margin is more important for export with greater vulnerability during crisis while intensive margin is more important for import during crisis. Finally, the negative contribution of intra-firm trade to within-firm trade growth turns out to be more serious during recent trade slowdown than during trade collapse.

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Appendix

Table A1. Number of MNEs in the sample

Year	All firms (1)	MNEs (2)
2006	5,961	2,619
2007	5,820	2,727
2008	5,760	1,134
2009	5,465	1,204
2010	5,305	1,223
2011	5,736	1,249
2012	6,054	1,325
2013	5,981	1,395
2014	5,949	1,422
2015	5,693	1,424

Notes: MNEs are defined as firms with their parents or subsidiaries abroad.

Table A2. Export growth during recent trade slowdown

	(1) All firms	(2) Continuing firms
Sample firms:		
Sample period:	2012-2015	
Variables	Dependent variable: \ln_exp	
L.ln_worker_h	-0.135 (0.162)	0.291*** (0.0748)
L.tfp_h	0.153 (0.113)	0.0657 (0.0549)
L.int2rev_h	0.0470 (0.104)	-0.0144 (0.0487)
L.exp2rev_h	-0.783*** (0.114)	-1.334*** (0.0674)
L.imp2int_h	0.119 (0.118)	0.101* (0.0543)
L.va_chain_h	0.813*** (0.129)	-0.0473 (0.0624)
L.ext_fin_dep_h	-0.0347 (0.107)	0.167*** (0.0532)
L.shr_liab_h	-0.295** (0.136)	0.303*** (0.0729)
L.shr_inv_rev_h	0.00992 (0.125)	0.331*** (0.0673)
L.foreign50	0.0864 (0.147)	-0.0676 (0.0690)
L.int_exp_r_h	-1.364*** (0.163)	0.303*** (0.0736)
L.N_int2exp	-0.00548 (0.152)	-0.309*** (0.0970)
L.MNE	0.166 (0.298)	-0.322*** (0.121)
Constant	1.018* (0.587)	0.810*** (0.273)
Observations	16915	7758
R-squared	0.036	0.134
Number of firm_id	6,138	2,586

Notes: This table is supplementary for Table 13, and key results in this table is summarized in Table 16.

Clustered-robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A3. Import growth during recent trade slowdown

	(1)	(2)
Sample firms:	All firms	Continuing firms
Sample period:	2012-2015	
Variables		
L.ln_worker_h	0.345*** (0.106)	0.254** (0.111)
L.tfp_h	0.312*** (0.0841)	0.227*** (0.0874)
L.int2rev_h	-0.341*** (0.0726)	-0.354*** (0.0779)
L.exp2rev_h	0.0895 (0.0755)	0.0878 (0.0794)
L.imp2int_h	-1.286*** (0.0984)	-1.308*** (0.107)
L.va_chain_h	-0.156* (0.0858)	-0.144 (0.0886)
L.ext_fin_dep_h	0.142** (0.0721)	0.0955 (0.0717)
L.shr_liab_h	0.329*** (0.105)	0.350*** (0.113)
L.shr_inv_rev_h	0.314*** (0.0928)	0.268*** (0.101)
L.foreign50	-0.0677 (0.0807)	-0.0793 (0.0798)
L.int_imp_r_h	0.398*** (0.110)	0.466*** (0.110)
L.N_int2imp	-0.0689 (0.105)	0.0911 (0.0949)
L.MNE	-0.138 (0.164)	-0.132 (0.175)
Constant	1.028** (0.436)	1.309*** (0.400)
Observations	6559	4608
R-squared	0.116	0.126
Number of firm_id	3,029	1,536

Notes: This table is supplementary for Table 15, and key results in this table is summarized Table 16. Clustered-robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A4. Industry Classification: KSIC 2-digit

KSIC code	Manufacturing Sector
10	Food Products
11	Beverages
12	Tobacco
13	Textile Products
14	Apparel
15	Leather Products and Footwear
16	Wood and Wood Products
17	Pulp, Paper Products
18	Publications
19	Coke and Petroleum Products
20	Chemical Materials and Products
21	Drugs and Pharmaceuticals
22	Rubber and Plastic Products
23	Non-metallic Mineral Products
24	Basic Metal Products
25	Processed Metal Products
26	Electronic Components, Computers, Radio, TV and Communication Equipment
27	Medical Appliances, Precision and Optical Instruments
28	Electric Instruments
29	Other Machinery and Equipment
30	Motor Vehicles
31	General Transportation Equipment
32	Furniture Products
33	Other Industrial Products