IMPACT OF KOREA-ASEAN FTA ON THE TECHNOLOGY LEVEL OF KOREAN MANUFACTURING FIRMS

By

BAE, Yunjin

THESIS

Submitted to
KDI School of Public Policy and Management
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ABSTRACT

IMPACT OF KOREA-ASEAN FTA ON THE TECHNOLOGY LEVEL OF KOREAN MANUFACTURING FIRMS

By

Yunjin Bae

Recently FTA is greatly contributing to enhancement of world trade by bilateral tariff reduction. Korea has made numbers of FTAs with major economies in the world; among them, Korea-ASEAN FTA is of greatest importance to Korea since ASEAN is one of its major trade partners. There have been studies which expected that not only the trade size between the two economies would enlarge but also productivity of Korean manufacturing sector would increase. Yet these studies bear limitations that they are qualitative as well as ex ante. This paper quantitatively measured the impact of tariff reduction by Korea-ASEAN FTA on R&D expenditure and TFP, as proxies for their technology level, of Korean manufacturing firms using the OLS regression analysis; as a result, it appeared that the reduced tariff of ASEAN toward Korea had contributed to Korean manufacturing firms to decrease their R&D spending but to increase their TFP.

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INTRODUCTION

Free Trade Agreement (FTA) is a bilateral agreement to abolish trade barriers of member countries aiming at mutual benefit from liberalization of goods and service trade. Recently FTA is greatly contributing to enhancement of world trade as it has become the main form of Regional Trade Agreement (RTA). As of October 2014, there are 393 RTAs recognized by World Trade Organization (WTO) and 222 among them are FTAs about goods trade.[1] Those FTAs as well as RTAs have increased rapidly since 1995 when WTO was established, as most of these agreements were ratified after 1995.[2]

FTA requires eliminating not only tariff barriers but also non-tariff barriers (NTBs). Member countries are obliged to apply preferential tariff rates that are lower than most-favored-nation-rates (MFN rates) to each other under FTA. At the same time, they are required to implement policy modifications to reduce NTBs which include protection of intellectual property rights, electronic commerce, environmental and labor standard, dispute settlement, technical regulation, certification process, etc. Thus FTA is a comprehensive agreement governing the aspects that directly or indirectly influence economic activities of member countries, resulting in the outstanding expansion of world trade.

A. Research Background

[1] "FTAs in the World: Current Status," Korea International Trade Association, online, Ministry of Trade, Industry, and Energy of Korea, Korean Governmental FTA Portal(http://www.fta.go.kr), 31 December 2014.
[2] Ibid.

TRADE LIBERALIZATION OF KOREA THROUGH FTA

Korean economy has been significantly depending on trade; in 2013, the ratio of exports and imports to Gross National Income (GNI) was 105.9% and the export was as large as 55% of GNI.[3] Moreover, such a trend is likely to be continued as export keeps increasing.[4] Thus, Korean government has been taking an active role in trade liberalization, particularly through FTAs in order to secure its competitiveness in the overseas market, hence accelerating economic growth engine through expansion of foreign trade.

Korea has entered into 15 FTAs until December 2014, 10 among which are in effect.[5] In 2013, it was estimated that Korea is facing the market with the size of 13.3 trillion dollars in total by effectuation of its FTAs.[6] There are total 53 countries or economic blocs with which Korea has made an FTA agreement; major partners include the United States (US), the European Union (EU), China, and the Association of Southeast Asian Nations (ASEAN). Besides, it is currently discussing FTA with Indonesia, Mexico, MERCOSUR, Malaysia, Israel, and Gulf Cooperation Council (GCC) as well as trilateral FTA with China and Japan. In addition, Korea is also negotiating with ASEAN, China, Japan, Australia, New Zealand, and India for Regional Comprehensive Economic Partnership (RCEP).

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[3] "Export, Import, and GNI of Korea," Bank of Korea National Accounts, online, Statistics Korea, Korean Statistical Information Service, 26 March 2014.
[4] Institute for International Trade. *Trade Brief no. 70, Recent Trend and Growth of Korean Trade.* Seoul: Korea International Trade Association, 2014. (pp.1)
[5] Korea Trade-Investment Promotion Agency. *Global Market Report. 15-003*. Seoul: Korea Trade-Investment Promotion Agency, 2015.
[6] Institute for International Trade. *Trade Brief no. 70, Recent Trend and Growth of Korean Trade.* Seoul: Korea International Trade Association, 2014. (pp.3)

Table 1 List of FTAs Korea Has Progressed until December 2014[7]

Progression Phase	Partners	Note
Effectuated (10)	Chile (April 2004)	The first FTA of Korea
	Singapore (March 2006)	Preliminary to Korea-ASEAN FTA
	European Free Trade Association, EFTA (September 2006)	Preliminary to Korea-EU FTA
	ASEAN (June 2007)	
	India (January 2010)	
	EU (July 2011)	
	Peru (August 2011)	
	US (March 2012)	
	Turkey (May 2013)	Trade in goods only
	Australia (December 2014)	
Settled (6)	Canada	
	Colombia	
	Turkey	Additional liberalization of trade in services and investment
	China	Largest trade partner of Korea (as of 2013)
	New Zealand	
	Vietnam	
Negotiating (3)	Indonesia	
	Korea- China-Japan	
	RCEP	
Negotiation temporarily halted (3)	Japan	Halted in 2004
	Mexico	Halted in 2008
	GSC	Halted in 2009; 3rd largest trade partner of Korea (as of 2013)
Preliminary study (4)	MERCOSUR	
	Israel	
	Central America	
	Malaysia	Upgrade of Korea-ASEAN FTA

TRADE BETWEEN KOREA AND ASEAN: Before Korea-ASEAN FTA (~2006)

ASEAN is an economic, social and cultural association of which 10 member countries are Brunei Darussalam, Cambodia, Indonesia, Laos,

[7] "FTAs of Korea: Current Status," Ministry of Trade, Industry, and Energy of Korea, online, Ministry of Trade, Industry, and Energy of Korea, Korean Governmental FTA Portal(http://www.fta.go.kr), 31 December 2014

Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. It was first established in 1967 with 5 countries: Indonesia, Philippines, Singapore, and Thailand; and became to have 10 countries as now in 1999 after gradual expansion of its membership. By means of the high growth rate over 7% during 1980s and 1990s, nowadays it has become one of the largest emerging economies with its population around five hundred million.

ASEAN became a major trade partner of Korea from 1990s when its member countries began to achieve rapid economic growth.[8] Trade with ASEAN had been occupying approximately 10% of total trade of Korea in terms of value since late 1990s.[9] Yet, trade size between Korea and ASEAN had increased since 2001; trade value was approximately doubled to $61,809 million in 2006 from $32,375 million in 2001 and so were export and import to ASEAN (Figure 1). Moreover, Korea had increased its amount of trade surplus in the same period in addition to maintaining its trade surplus toward ASEAN. The amount of trade surplus of Korea was expanded more than four times, to $2,324 million from $523 million, during the six years.

Table 2 shows the major trading goods between the two economies in 2006. According to the table, semiconductor was the largest traded goods with more than 20% of total trade value. Besides, Korea mainly exported articles of petroleum and parts of vessels while imported natural gas and crude petroleum.

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[8] Ministry of Foreign Affairs of Korea, and Korea Institute for International Economic Policy. *Korea-ASEAN FTA Summary*. Seoul: Ministry of Foreign Affairs of Korea, 2007. (pp. 78)
[9] Ibid.

Figure 1 Annual Trade Value between Korea and ASEAN, 2005-2011[10]

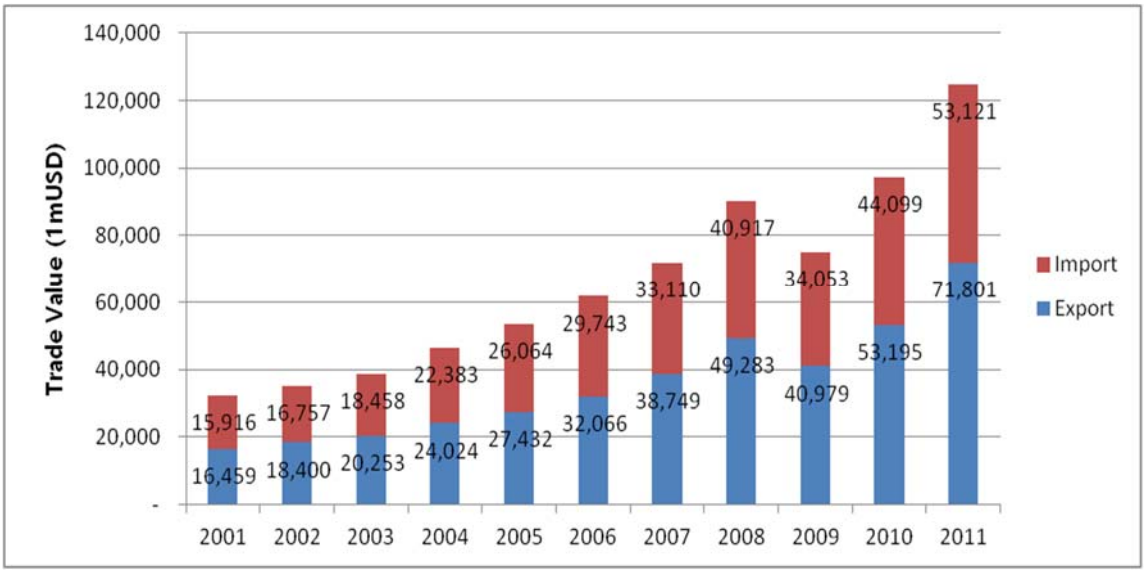


Table 2 Major Trading Goods between Korea and ASEAN (2006)[11] **(unit: 1mUSD, %)**

Rank	Product	Export		Product	Import	
		Value	Ratio		Value	Ratio
1	Semiconductor	7,188	22.4	Semiconductor	6,427	21.6
2	Articles of petroleum	3,731	11.6	Natural gas	4,911	16.5
3	Vessel, ocean structure and part of vessel, ocean structure	1,347	4.2	Crude petroleum	3,573	12.0
4	Steel flate-rolled products	1,477	4.6	Articles of petroleum	955	3.2
5	Wireless Communication apparatus	1,614	5.0	Coal	974	3.3
6	Synthetic resin	1,039	3.2	Computer	1,492	5.0
7	Knitted fabrics	780	2.4	Byproducts of forest	729	2.5
8	Automobile	903	2.8	Wood	695	2.3
9	Computer	806	2.5	Copper ore	763	2.6
10	Articles of copper	679	2.1	Articles of copper	453	1.5

[10] "Annual Trade Value between Korea and ASEAN," Korea Trade Statistics by Standard International Trade Classification (SITC) by Korea International Trade Association, online, Statistics Korea, Korean Statistical Information Service, 05 Feb 2015

[11] "Major Trading Goods between Korea and ASEAN in 2006," Korea Trade Statistics by 3-digit Ministry of Trade and Industry(MTI) code, online, Korea International Trade Association, K-Stat Database (http://stat.kita.net/), 05 Feb 2015

OVERVIEW OF KOREA-ASEAN FTA

The government officials of Korea and ASEAN agreed to strengthen economic cooperation between those two political entities in a summit meeting held in October 2003; consequently, it was followed by five-time joint studies about the effectiveness of Korea-ASEAN FTA during 2004. Through the research it was revealed that Korea and ASEAN will benefit from economic liberalization, hence need for tariff elimination as well as trade and invest facilitation. The official discussion to settle down FTA began in November 2004 aiming at reaching the agreement within two years.

In February 2005 the representatives from Korea and 10 ASEAN countries opened negotiations for the first time in Jakarta, Indonesia. After a 10-month talk, Korea and ASEAN countries except Thailand went into an agreement surrounding freeing up goods trade. Finally Korea-ASEAN FTA was settled in August 2006 by signature of each head of state. Thailand, of which domestic circumstances prevented it from participating in the summit, did not ratify the agreement.

Although Korea-ASEAN FTA has been taking effect since June 2007, it was effective not in all ASEAN countries but in 5 countries including Singapore, Indonesia, Malaysia, Vietnam, and Myanmar. Later, it became effective in Philippines, Brunei Darussalam, Laos, and Cambodia in 2008, and after official urging for effectuation from Korean government it came into effect in Thailand in 2010. Still, as of early 2015, it is being discussed from 2013 to further decrease in tariff rates and to expand coverage.

Having a free-trade agreement with ASEAN has significant meaning to

Korea since ASEAN has been a major trade partner of Korea as previously described. Moreover, it is also because the purchasing power of ASEAN as well as its importance as an export market is being emphasized as it is recovering from the foreign exchange crisis in mid-1990s, thus Korea-ASEAN FTA is expected to greatly facilitate Korean corporations to enter into ASEAN market.[12]

TARIFF ELIMINATION SCHEDULE OF KOREA-ASEAN FTA AND ITS EFFECT

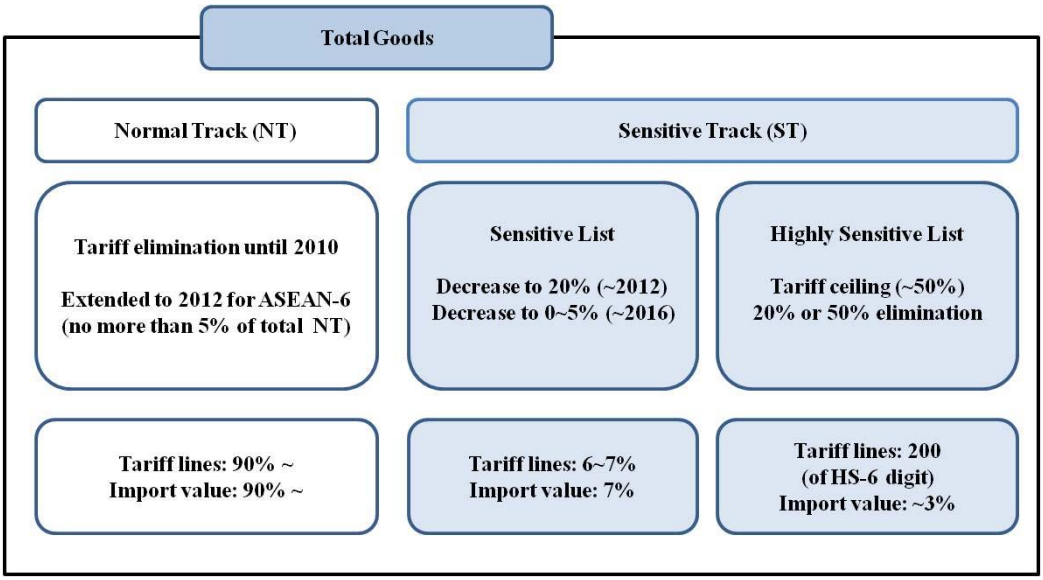
It was agreed between Korea and ASEAN through Korea-ASEAN FTA that those two parties should completely eliminate tariffs for 90% of goods; the deadline for completion is 2010 for Korea, 2012 for ASEAN-6 (Brunei Darussalam, Indonesia, Philippines, Malaysia, Singapore, and Thailand), and 2020 for other ASEAN countries called CLMV (Cambodia, Laos, Myanmar, and Vietnam). The FTA also assured that there would be an additional agreement for the rest of the goods in 2012, and it is now being processed.

Goods are classified as Normal Track (NT) and Sensitive Track (ST) voluntarily by each country according to their relative importance, and the schedule for tariff elimination differs from NT to ST. (Figure 2) In detail, NT includes at least 90% of all goods that are subjected to tariff as well as 90% of total import value from each party in 2004, while ST cannot exceed

[12] Ministry of Foreign Affairs of Korea, and Korea Institute for International Economic Policy. *Korea-ASEAN FTA Summary*. Seoul: Ministry of Foreign Affairs of Korea, 2007.(pp. 14)

10% of all goods and of total import value from each party. Yet it is allowed for CLMV countries to neglect the limit for import value to establish their own ST, regarding their relatively low economic development status.

Figure 2 Tariff Elimination Schedule for NT & ST[13]



Note: Figure 2 applies for Korea and ASEAN-6; CLMV follows an alleviated version.

Korea-ASEAN FTA has led to expansion of the total trade size as well as trade surplus of Korea (Figure 1). Trade size between two economies was enlarged for 25.5% in 2008 which was one year after Korea-ASEAN FTA was effectuated, in comparison with trade increment of 16.3% in 2007. In particular, export to ASEAN was increased by 27.2%, greater than that of 2007 which was approximately 19%. The size of trade between Korea and ASEAN had grown up to $ 12.5 billion until 2011 which was more than twice of trade size in 2005, despite of Global Financial Crisis in 2008. Plus, Korea ran a trade surplus as much as $ 18.7 billion in 2011, significantly expanded

[13] Ministry of Foreign Affairs of Korea, and Korea Institute for International Economic Policy. *Korea-ASEAN FTA Summary*. Seoul: Ministry of Foreign Affairs of Korea, 2007. (pp. 44)

from $ 2.3 billion in 2006.

Such a noteworthy increment in Korean export to ASEAN may have been resulted from the manufacturing sector where Korea has been maintaining comparative advantage (Table 3). Table 3 shows that top 10 products in which trade surplus of Korea is largest mostly correspond to major export goods of Korea to ASEAN in table 2. It is likely to be caused by tariff elimination of ASEAN toward Korean for steel products and automobiles due to the FTA.[14] Thus, it is worth investigating the effect of Korea-ASEAN FTA on Korean manufacturing firms.

Table 3 Major Products where Korea is Running Trade Surplus (2007-2011, accumulated)[15]

(Unit: 1000USD)

Rank	Product	Trade Surplus
Total		**48,707,624**
1	Articles of petroleum	35,116,682
2	Vessel, ocean structure and part of vessel, ocean structure	22,197,091
3	Steel flate-rolled products	14,355,948
4	Synthetic resin	7,493,971
5	Automobile	7,056,919
6	Knitted fabrics	6,851,364
7	Flat display and sensor	4,604,951
8	Wireless Communication apparatus	4,510,309
9	Gold, silver, or platinum	2,921,260
10	Synthetic rubber	2,485,800

[14] Ministry of Foreign Affairs of Korea, and Korea Institute for International Economic Policy. *Korea-ASEAN FTA Summary*. Seoul: Ministry of Foreign Affairs of Korea, 2007.(pp. 53)

[15] "Major Products where Korea is Running Trade Surplus 2007-2011 ," Korea Trade Statistics by 3-digit Ministry of Trade and Industry(MTI) code, online, Korea International Trade Association, K-Stat Database (http://stat.kita.net/), 05 Feb 2015

B. Literature Review

TARIFF REDUCTION AND PRODUCTIVITY

Along with its importance as a trade partner of Korea, Korea-ASEAN FTA was expected to raise productivity of the manufacturing sector; Choi *et al* (2003) showed that it is likely to increase production of the automobile industry of Korea by analyzing the effect of liberalization of goods and service sector between Korea and ASEAN.[16] Moreover, there is another study estimated that Korea-ASEAN FTA would boost production of textiles and transportation machineries, assuming that tariffs are completely eliminated.[17] However, those studies are not based on the actual contents of Korea-ASEAN FTA but based on the projection. According to Ko's study in 2007, it may greatly enhance production of the textile industry, automobile industry, chemical industry, steel industry and metalworking industry after the tariff elimination schedule has been fully implemented.[18]

These results are well corresponding to the study of Madsen (2007) that showed international trade may raise technology spillover and thus increase total factor production (TFP); the paper suggested technology imports through trade have been responsible for 200% increase in TFP and also they have contributed to TFP convergence among the OECD

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[16] Choi, Nak-kyun, Sun-chan Pak, and Chang-Soo Lee, *Analysis of the Trade Negotiation Options in the East Asian Context.* Seoul: Korea Institute for International Economic Policy, 2003.

[17] Yoo, Tae-hwan, and Sung-il Bae, "A CGE Analysis of the Economic Effects of FTAs between Korea and its Main Trading Partners," *Korea Trade Review* 32(2) (2007): 421-441.

[18] Ko, Jonghwan, "Analysis of Economic Impacts of Agreement on Trade in Goods under the Korea-ASEAN FTA," *International Area Studies Review* 11(3) (2007): 387-417.

countries[19]. Hence it is likely that productivity increase following Korea-ASEAN FTA is related to technological innovation which is concomitant with enhanced trade due to tariff elimination.

TARIFF REDUCTION AND TECHNOLOGY INNOVATION

It has been continuously studied that tariff reduction and trade liberalization particularly in the export market may contribute to increase of productivity of exporting firms[20] [21] [22], yet there are few papers directly investigated the linkage between tariff reduction and technology innovation. Still, Xu and Wang (2000)[23] as well as Madsen (2007) empirically showed that trade is likely to be an important channel of international technology diffusion, implying that tariff reduction causing expansion of freer trade may lead to the advanced technology.

There also have been papers indicating such technology improvement may contribute to productivity increment. Keller (2002) estimated contribution of Research and Development (R&D) on the productivity increase through trade from an industry-level data covering more than 65 percent of global manufacturing outputs and R&D expenditures over 1970-

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[19] Madsen, Jakob B, "Technology spillover through trade and TFP convergence: 135 years of evidence for the OECD countries." *Journal of International Economics* 72(2) (2007): 464-480.

[20] Tybout, James, Jamie De Melo, and Vittorio Corbo, "The Effects of Trade Reforms on Scale and Technical Efficiency: New Evidence from Chile," *Journal of International Economics* 31(3) (1991): 231-250.

[21] Van Biesebroeck, Johannes, "Exporting Raises Productivity in Sub-Saharan African Manufacturing Firms," *Journal of International Economics* 67(2) (2005): 373-391.

[22] De Loecker, Jan, "Do Exports Generate Higher Productivity? Evidence from Slovenia," *Journal of International Economics* 73(1) (2007): 69-98.

[23] Xu, Bin, and Jianmao Wang, "Trade, FDI, and International Technology Diffusion," *Journal of Economic Integration* 15 (4) (2000): 585-601.

1991; about 50 percent of productivity increments was due to R&D, 60 percent of which increments accrued from domestic R&D expenditures and the rest from those of foreign.[24] This result corresponds to study of Wakelin (2001), which analyzed that R&D expenditures have a significant positive role on productivity growth of manufacturing firms.[25] In summary, these results altogether suggest that tariff reduction may induce productivity increase through technology advancement, which is achieved by the enlarged R&D expenditure.

Bustos (2009) theorized that FTA may facilitate technological development by elimination of tariff and proved with empirical evidences of MERCOSUR on technology level of Argentinean firms.[26] Her model suggested that as trade becomes more liberalized, more productive firms make higher revenue and thus they are the only ones that remain in the export market paying the fixed costs, as in Melitz's model.[27] Moreover, export revenues increase as trade costs fall by reduced tariffs, so that more firms in the export market would choose to upgrade technology as the benefit of upgrading is proportional to revenues while the cost is fixed. In addition, the model also implied that tariff reduction may cause firms in the middle range in terms of productivity to enter the export market and to adopt the new technology, yet may not affect firms in the lower and upper

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[24] Keller, Wolfgang, "Trade and the Transmission of Technology," *Journal of Economic growth* 7(1) (2002): 5-24.

[25] Wakelin, Katharine, "Productivity Growth and R&D Expenditure in UK Manufacturing Firms," *Research Policy* 30(7) (2001): 1079-1090.

[26] Bustos, Paula, "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinean Firms," *The American Economic Review* 101(1) (2011): 304-340.

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

ranges.

Using the Ordinary Least-Square (OLS) analysis, she showed that the technology spending (ST: sum of whole expenditure spent on product and process innovation, such as R&D expenditure, patent fee, software-purchasing costs and so on.) of Argentinean firms increased after tariff reduction of Brazil according to MERCOSUR. In detail, using the regression formula, $\Delta \log ST_{1996\text{-}1992} = \alpha + \beta_1 \Delta Tariff_{Brazil} + \beta_2 \Delta Tariff_{Argentina} + \varepsilon$, her study presented that change of Brazilian tariff toward Argentina showed a negative relationship with ST of Argentinean firms, but the change of Argentinean tariff was statistically insignificant with respect to the same variable. Furthermore, her study confirmed that Brazil's tariff reduction reinforced the technology intensity of Argentinean firms' production; it revealed that the technology spending increased more than the labor spending, meaning that firms were actually changing their technology, and not just expanding all factors proportionally.

Overall, all of these researches suggest that trade liberalization through tariff reduction may induce technological innovation as well as higher productivity, providing an insight of the effectiveness of trade policies directing market integration and liberalization at firm-level performance. Yet those studies which quantitatively measure the ex post effect of Korea-ASEAN FTA on technology level of Korean firms barely exist in spite of its economic importance; neither of those investigated the effect on R&D expenditure or technological innovation. This paper is one of the first studies in Korea that analyzed how tariff reduction following Korea-ASEAN FTA influenced on R&D activity of Korean manufacturing

sector.

RESEARCH METHODS

A. Research Purpose and Key Question

The objective of this study is to elucidate the impact of Korea-ASEAN FTA on technological level of Korean manufacturing firms. To be specific, it is to investigate how tariff of ASEAN countries toward manufactured goods imported from Korea affected R&D activity and productivity of Korean firms. R&D activity and productivity of firms are extrapolated from their R&D expenditures and TFP, respectively. Thus, the key question delivered in this study is whether tariff reduction toward manufactured goods in Korea-ASEAN FTA increased i) R&D expenditure; ii) TFP of Korean manufacturing firms, and the OLS analysis was used to solve the question.

B. Research Hypothesis and the Source of Data

Taking advantage of Bustos' paper, this study hypothesized that tariff reduction due to Korea-ASEAN FTA would have increased the technology level including both R&D expenditure and TFP of Korean manufacturing firms by facilitating them to spend more on R&D, since their revenue may have increased as the export cost was decreased.

Variables were set as following to verify the hypothesis; i) the independent variable was established as the change of effectively applied

tariff of ASEAN countries toward ASEAN from 2008 to 2011. The member of ASEAN was limited to 5 member countries including Singapore, Indonesia, Malaysia, Vietnam, and Myanmar in this study as the trade size between other members is negligible. The target period begins from 2008, considering the time-lag between FTA effectuation and actual decision-making of firms; it also ends in 2011 since Korea effectuated FTAs with US and EU which are second and third largest trade partner in 2012 that may alter the firms' behavior in later periods; ii) R&D spending and TFP were selected as dependent variables showing the technological level of Korean firms due to data availability. TFP of each firm was calculated from its annual total sales (Y), number of employees (L), and tangible assets (K), substituting into the formula $Y=AK^{\alpha}L^{1-\alpha}$ where A denotes TFP and $\alpha=1/3$.

For OLS analysis a regression formula was established as below, modeled after Bustos' study: $\Delta \log R\&D_{2011-2008} = \alpha + \beta_1 \Delta Tariff_{ASEAN} + \beta_2 \Delta Tariff_{Korea} + \varepsilon$, $Tariff_{ASEAN}$ and $Tariff_{Korea}$ denoting.for the effectively applied (AHS) tariff of ASEAN and Korea, respectively. The change of AHS tariff of Korea was included as a control variable to handle the effect from import-sector competition, as well as sales, number of employees, and R&D intensity in firm level. For the tariff data, World Integrated Trade Solution (WITS) of World Bank was used as a source; Annual Survey of Business Activities by Korean Statistics Bureau was used for R&D expenditure and factors for calculating TFP in firm level.

RESULTS

A. OLS Analysis for the Relationship between the R&D Expenditure and the Tariff Level of ASEAN toward Korean Manufactured Goods

It was analyzed through the simple OLS method that how tariff change of ASEAN due to Korea-ASEAN FTA influenced on R&D expenditure of Korean manufacturing firms (Table 4). First, $\Delta Tariff_{ASEAN}$ was calculated as following: for the year 2008 and 2011, AHS tariff rates of the target ASEAN countries (Singapore, Indonesia, Malaysia, Vietnam, and Myanmar) based on the HS-8-digit were re-calculated according to 2-digit ISIC rev.3 classification, specifically from ISIC 15 to 36 which belong to the manufacturing sector, and were simply averaged for five countries in each sector using WITS. Then those of 2008 were subtracted from that of 2011, which resulted in the change of AHS tariff rates of ASEAN of manufacturing sectors ($\Delta Tariff_{ASEAN}$). It was not able to determine weighted average of tariff levels for ASEAN countries using export weight due to the partial lack of data. $\Delta Tariff_{Korea}$ was obtained using the same procedure.

Next, the panel data of R&D expenditure of Korean firms was established. There were total 1719 firms in the manufacturing sector which had positive export values both in 2008 and 2011. After they were arranged through ISIC 2-digit classification their R&D expenditures of the two years were extracted to build a firm-level

dataset. Additionally initial R&D intensity of each firm was calculated as the ratio of R&D spending to annual sales, which was included as a control variable with initial employment as the number of employees as well as sales per worker in 2008.

Table 4 shows the result. First, the change of ASEAN tariff showed a significant positive relationship with the change of R&D spending of Korean manufacturing firms, meaning that firms may have spent less on R&D as they faced lower tariffs from ASEAN. Secondly, the change of Korean tariff did not show any significant relationship. Such relationships were maintained regardless of addition of control variables.

Table 4 OLS analysis for the relationship between the R&D spending and the tariff level between ASEAN and Korea

	ΔLog(R&D)		
$\Delta Tariff_{ASEAN}$	0.100151***	0.103519***	0.102900***
$\Delta Tariff_{Korea}$ (toward ASEAN)	-0.002843	-0.006091	-0.004804
R&D $Intensity_{2008}$	-0.000049***	-.0.000054***	-0.000054***
Log(Sales per $worker_{2008}$)		-0.133447***	-0.125014***
Log($Employment_{2008}$)			-0.016944
Observations	1719	1719	1719
R-squared	0.05	0.06	0.06

Note: *: P<0.10; **: P<0.05; ***: P<0.01

B. OLS Analysis for the Relationship between TFP and the Tariff Level of ASEAN toward Korean Manufactured Goods

It was analyzed through the simple OLS analysis that how tariff change of ASEAN due to Korea-ASEAN FTA influenced on TFP of Korean manufacturing firms (Table 5). Tariff data, $\Delta Tariff_{ASEAN}$ and $\Delta Tariff_{Korean,}$ was processed as same as above in part A. The firm-level TFP panel dataset was prepared as following: from 1719 firms which had export sales both in 2008 and 2011, their annual sales (Y), tangible assets (K), and the number of employees (L) of those two years were extracted. As the next TFP(A) was calculated from those data, assuming a Cobb-Douglas production function $Y=AK^{\alpha}L^{1-\alpha}$ with $\alpha=1/3$.

Table 5 OLS analysis for the relationship between TFP and the tariff level between ASEAN and Korea

	ΔLog(A)		
$\Delta Tariff_{ASEAN}$	-0.051070***	-0.047003***	-0.044080***
$\Delta Tariff_{Korea}$ (toward ASEAN)	-0.003310	-0.007230	-0.013300
R&D Intensity$_{2008}$	0.000022**	0.000002	0.000050
Log(Sales per worker$_{2008}$)		-0.161087***	-0.196130***
Log(Employment$_{2008}$)			0.079887***
Observations	1719	1719	1719
R-squared	0.009	0.06	0.07

Note: *: P<0.10; **: P<0.05; ***: P<0.01

Table 5 shows the result of analysis. First, the change of ASEAN tariff showed a significant negative relationship with the change of TFP spending of Korean manufacturing firms, implying that firms may have had higher productivity as they faced lower tariffs from ASEAN. Secondly, the change of Korean tariff did not show any significant relationship as in part A. Such relationships were maintained regardless of addition of control variables.

C. Discussion

Using the OLS analysis, the impact of tariff reduction of ASEAN both on the technology level and productivity of Korean manufacturing firms was investigated. The result showed that while TFP was increased, R&D expenditure was decreased which was in contrary to Bustos's study about MERCOSUR. The contrast may have arisen from the different natures of variables representing the technology level used in each study; I used R&D expenditure as a proxy, whereas she used total innovation spending, called ST, on product and process innovation, including R&D expenditure, patent fee, and software & hardware purchase cost. As R&D requires long-term financial decisions compared to technology transfer or making a purchase of new equipments, it is less likely that R&D expenditure would be affected compared to ST during the relatively short period. Moreover, the sample period of this study, 2008-2011, is corresponding to the global financial crisis; thus it may have incurred Korean firms, which are highly dependent on external demand rather than

internal demand, further decreasing their R&D investment which bears high opportunity costs given the negative prospect for their total export revenues during the next several years. Therefore, likewise Bustos's study, it seems necessary to expand the sample period and the current variable from R&D expenditure to total innovation spending to fully indicate the technology level.

In contrary, TFP of Korean manufacturing firms showed a significant negative relationship with tariff change of ASEAN, implying that TFP has increased as tariff was being reduced. This result accords with previous literatures presenting that trade liberalization may have positive impact on firms' productivity, as well as with Bustos's study following Melitz's model. Yet, this study revealed that TFP and R&D expenditure do not coincide with each other, as opposed to her study. It seems that the broad characteristics of TFP, which is not limited to technical productivity only, incurred such dissimilarity. TFP, as the Solow residual, has been known that it includes both technological efficiency and non-technological factors such as market power[28] or allocation of production factors[29]. Additionally, it has been investigated that market power or firm size are more significantly related to TFP growth than R&D expenditure among Korean manufacturing firms.[30] Thus TFP increase of Korean firms following tariff reduction of ASEAN may be the consequence of change in

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[28] Foster, Lucia, John Haltiwanger, and Chad Syverson, "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?," *American Economic Review* 98(1) (2008): 394–425.

[29] Hsieh, Chang-Tai, and Peter J. Klenow, "Misallocation and manufacturing TFP in China and India," *National Bureau of Economic Research* (2007): No. w13290

[30] Kim, Jong Il, Gyu Ho Wang, and Su Young Jung, "On the determinants of Productivity in Korean Manufacturing Sectors," *Korean Industrial Organization Research* 9(1) (2001): 1:34.

factors governing non-technological efficiency caused by market expansion through lowering the trade barrier. Alternatively, given the characteristic of the sample period it is likely that firms have chosen to invest to enhance technical efficiency with lower risk and shorter time-lag such as licensing-in; therefore their TFP has been raised.

CONCLUSION

The study investigated the impact of Korea-ASEAN FTA on technological level of Korean manufacturing firms by OLS analysis between the change of effectively applied tariff of ASEAN countries and R&D expenditure of Korean firms, showing that R&D expenditure was decreased as the tariff level of ASEAN decreases. Yet, TFP was increased during the same period, when the same regression formula was used except for the dependent variable changed from R&D expenditure to TFP. The latter coincides with previous studies about TFP and FTA.

These results may imply that the TFP-increasing effect of Korea-ASEAN FTA did not arise from R&D activity; in spite of FTA firms did not increase their R&D expenditure to the level which is in correspondence with increased productivity, which is in opposite of what Bustos has previously suggested. It seems that firms may have chosen not to invest in R&D which has high risk and is time-consuming, as the sample period was during the global financial crisis. Instead, firms may have chosen to invest in productivity-raising activities with lower risk and shorter time-lag such as licensing-in. Therefore a further research including these alternative channels of technology upgrade and longer time period both before and after the sample period used in the study is needed to resolve remaining questions.

Still, there are plenty of rooms in terms of policy implication that the result of this study can be applied for. First, the study implies that trade liberalization through FTA can enhance domestic industrial competence. Particularly it would be able to function as a means of an industry-restructuring policy to trim out so-called 'Zombie Firms', which are highly inefficient, debt-ridden companies.[31] Those 'Zombies' has been pointed out as the main factor of the slowdown of Japanese economy during the lost decades, as they survived by receiving financial support from banks instead of being driven out of the market, which eventually hindered market competition. Hoshi and Kim (2013) showed that the zombies increased among small-and-medium enterprises (SMEs) of Korea 2004-2010, after the mid-2000s when Korean banks began to expand their credit loan to SMEs; they estimated that zombie firms possess around 10-15% of total firms in the manufacturing sector during the period.[32] The study revealed that the higher is the ratio of zombie firms within the industry, the lower are the entry ratio, exit ratio, and TFP growth of the industry. Overall it seems that zombie firms are damaging the vitality of Korean national economy, which is a serious problem regarding the downhill of internal and external economic conditions from 2008. Therefore it is necessary to improve industrial competitiveness by eliminating those incompetent, unproductive firms. The result of this study that FTA may contribute to TFP growth of Korean manufacturing sector is shedding a light on how to restore the healthy market to Korean economy; by further FTAs as well as other means of trade liberalization, it may be able to raise overall productivity of Korean firms and to drive out zombies from the economy.

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[31] Ahearne, Alan G., and Naoki Shinada, "Zombie firms and economic stagnation in Japan," *International Economics and Economic Policy* 2(4) (2005): 363-381.

[32] Hoshi, Takeo, and Younghoon Kim, "Macroprudential Policy and Zombie Lending in Korea," *Asian Bureau of Finance and Economic Research Working Papers* (2013).

Secondly, following the previous policy discussion, this study provides an empirical evidence to guide the trade policy of Korea. Korea has been pushing ahead with trade liberalization through concluding FTAs with various economies since 2003, yet there has been continuous domestic objection against such a policy direction. Recently Korean government requested the National Assembly for the effectuation of FTA with China, Vietnam (expansion of Korea-ASEAN FTA), and New Zealand. This study clearly implies that such expansion of free-trade area would be beneficial to enhance firms' productivity; it is likely that tariff reduction following those FTAs will induce the manufacturing sector, the main sector of Korean economy, to improve TFP according to the result.

Finally, the result also suggests that it needs to provide incentives for open innovation to highly productive exporting firms to sustain their productivity increment. Chesbrought (2003) defined a term 'open innovation' as an innovation activity that involves active bilateral transfer between internal and external sources of new technology.[33] As a counterpart, if a firm solely relies on its internal R&D activity as a source of its new technology it can be classified as 'closed innovation.' This study concluded from the results that TFP increment of manufacturing firms was not a direct outcome of R&D activity but seemingly from alternative routes with lower burden. Recently, it was shown that open-innovation activity of Korean firms had significant positive impact on their export performance, whereas closed-innovation activity did not.[34] Therefore, apart from current science and technology policies focusing on domestic tax benefits for firms' own R&D activities, a novel innovation

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[33] Chesbrough, Henry W., *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press, 2003.

[34] Kim, Gwi-Ok, "An Empirical Study on the Factors Influencing the Innovations of Korea's Exporting Companies and Export Performance," *International Commerce and Information Review* 14(2) (2012): 201-225.

policy which suggests a legitimate guideline to smoothen global technology transfer and licensing-in by inclusion of sophisticated acts for intellectual property rights in future FTAs is needed.

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