EAST ASIAN DEVELOPMENT NETWORK

EADN WORKING PAPER No. 57 (2012)

Learning-by-exporting and Introduction of New Products: Evidence from Plant-Product Data on Korean Manufacturing

(July 2012)

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The author appreciates helpful comments and suggestions from Kyoji Fukao, Fukunari Kimura, Jose Damijan, and the participants of EIIE(Empirical Investigations in International Economics) 7th Annual Conference in Ljubljana, Slovenia (June, 2010), ESRI(Economic and Social Research Institute) Seminar in Tokyo (July, 2010). Chang-Gyun Park graciously helped the author to learn propensity score matching technique. I also appreciate Robert E. Lucas Jr. and Nancy L. Stokey for helpful comments and encouragement for an early draft of this paper in SNU Conference in Honor of Lucas and Stokey, held in Seoul, September 2009. All errors are mine.

Abstract

Utilizing previously unexplored plant-product matched data on Korean manufacturing sector, this paper provides empirical evidence suggesting that exporting leads to the increase in productivity. In addition, this paper also provides some evidence suggesting that exporting promotes new product introduction which is one mechanism through which exporting increases productivity. These results are largely robust to the control of pre-exporting R&D intensity of plant, which indicates that the evidence documented in this paper is likely to be related to international knowledge spillovers. Finally, we find some evidence that absorptive capacity matters in enhancing productivity and promoting new product introduction with the help of knowledge gained through exporting activity.

I. Introduction

One of the most robust empirical findings from recent studies on firm's exporting behavior is that exporting firms are more productive than those firms that do not export. While a large number of subsequent studies have documented that the productivity premium of exporters relative to non-exporters is at least a consequence of self-selection of more productive firms into exporting activity, the evidence in favor of the other direction of causality, i.e., learning-by-exporting, is still considered to be inconclusive. [1] However, several recent studies utilizing more refined empirical methodology tend to find evidence in favor of learning-by-exporting, particular for developing countries. [2] In our view, this issue deserves further empirical investigations.

Meanwhile, some well-known theoretical models of trade and growth suggest that export market participation is likely to promote *both* firms' innovation activity *and* productivity growth. For example, in some open economy endogenous growth theories, such as Romer (1990) and Grossman and Helpman (1991), larger market size as well as enhanced competition associated with exporting strengthens the incentive of firms to innovate and, hence, promotes introduction of new or higher-quality products as well as growth of total factor productivity (TFP, henceforth).[3] In more recent heterogeneous firm theories of trade and innovation, such as Constantini and Melitz (2008) and Aw, Roberts, and Xu (2009), exporting can raise firm-level

[1] As a reflection of these developments, many theoretical models of heterogeneous firms have featured some form of self-selection mechanism, and analyzed the effects of liberalized trade (e.g., Melitz 2003, Bernard, Redding, and Schott 2007), without taking into account the possibility of learning-by-exporting. According to these models, trade liberalization can raise aggregate productivity by inducing resource reallocation across firms, i.e, the contraction and exit of low-productivity firms and the expansion and entry into export markets of high-productivity firms, even if there is no change in firm level productivity.

[2] Studies that find evidence in favor of learning-by-exporting include Girma, Greenaway, and Kneller (2002) for UK, Van Biesebroeck (2005) for Sub-Saharan African countries, De Loecker (2007) for Slovenia, Albornoz and Ercolani (2007) for Argentina, and Aw, Roberts, Xu (2009) for Taiwan.

[3] In Grossman and Helpman (1991), total factor productivity growth takes the forms of introduction of new product varieties or higher-quality products. In a closed economy context, Stokey (1988) shows that creative destruction process, i.e., introduction of new goods and dropping of old goods, which is driven by learning-by-doing, generates sustained growth of productivity.

productivity either directly through learning-by-exporting spillovers[4] or indirectly through promoting innovation.[5] Thus, these models also suggest that exporting can promote both innovation and productivity. Then, it is worth examining empirically whether exporting is indeed associated with better innovation outcome as well as faster productivity growth.

We pursue several objectives in this paper. Firstly, this paper examines empirically the learning-by-exporting hypothesis utilizing the plant level panel data (Survey of Mining and Manufacturing) on Korean manufacturing sector for the period from 1990 to 1998. Methodologically, this paper uses the propensity score matching technique explained by Becker and Ichino (2002) to estimate the effect of exporting on plant total factor productivity. This is a technique to mitigate the selection bias problem arising from endogenous export market participation. As will be discussed later, this paper provides strong and robust evidence in favor of learning-by-exporting. Secondly, using the same dataset and methodology as above, combined with previously unexplored plant-product matched dataset on Korean manufacturing, this paper aims to examine whether exporting promotes introduction of new products. In order to do so, we start by examining whether plants' exporting status is positively correlated with plant TFP and the measure of new product introduction, as well as measures of product destruction, adding, dropping, and product scope. Given the above theoretical models, examining the effect of exporting on innovation can be viewed as an effort to clarify the mechanism whereby exporting affects firm productivity, if it does. Finally, this paper attempts to

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[4] Constantini and Melitz (2008) do not incorporate this learning-by-exporting mechanism.

[5] In these models, exporting can raise firm productivity indirectly through innovation channel. Firstly, exporting can promote innovation. There are several possible mechanisms. One mechanism is that larger market size associated with exporting raises the profitability of successful innovation, which strengthens the incentive to innovate. Another mechanism is through learning-by-exporting effect. Enhanced productivity gained through knowledge spillovers through exporting reinforces the productivity-based self selection into innovation activity. Or, knowledge spillovers associated with exporting can raise the expected profitability of yet-to-be introduced products, as suggested by Bernard, Redding, and Schott (2006), which promotes innovation. Secondly, enhanced innovation outcome can increase firm productivity.

identify some plant characteristics which might be necessary or complementary to realize the potential gains from exporting.

This paper is related to the numerous studies that examine empirically at least some of the linkages among exporting, innovation (or R&D), and productivity. Specifically, there are large amount of empirical studies that scrutinize the causal relationship between exporting and productivity without considering explicitly the role of innovation. As mentioned above, while most studies support self-selection of more productive firms into exporting, the evidence on learning-by-exporting is mixed.[6] Similar previous studies exist for Korea, which include Aw, Chung, and Roberts (2000) and Hahn (2005). Aw, Chung, and Roberts (2000), using plant-level panel data on Korean manufacturing for three years spaced at five-year intervals, does not find evidence in favor of either self-selection or learning-by-exporting.[7] By contrast, Hahn (2005) finds some evidence suggestive of both selection and learning effect, following the methodologies of Bernard and Jensen (1999a, 1999b). In our view, however, both Aw, Chung, and Roberts (2000) and Hahn (2005) might suffer from uncontrolled self-selection problem in export market participation.

Recent empirical studies that explicitly take account for the role of innovation in productivity-export nexus includes, among others, Aw, Robert, and Xu (2009), Damijan, Kostevc, and Polanec (2008), Becker and Egger (2007), Cassiman and Martinez-Ros (2007), and Aw, Roberts, and Winston (2005), and Salomon and Shaver (2005). Among these studies, those that are most close to this paper are Salomon and Shaver (2005) and Damijan, Kostevc, and Polanec (2008).

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[6] Earlier studies that do not find learning-by-exporting effect include Clerides, Lach and Tybout (1998), Aw, Chung, Roberts (2000) (for Korea), and Bernard and Jensen (1999a). For an example of studies that finds evidence in favor of learning-by-exporting, see footnote 2. For a survey of this literature, see Greenaway and Kneller (2007).

[7] It differs from similar studies on other countries in that even the self-selection hypothesis is not supported. They argue that Korean government's investment subsidies tied to exporting activity rendered plant productivity a less useful guide on the decision to export.

Salomon and Shaver (2005) finds that exporting promotes innovation in Spanish manufacturing firms, using product innovation counts and patents applications, while Damijan, Kostevc, and Polanec (2008) finds, based on propensity score matching procedure and using innovation survey data, that exporting increases process innovation, not product innovation, for Slovenian manufacturing firms.

This paper is related to the emerging empirical literature that assesses the effect of trade or trade liberalization on product variety or product switching behavior. For example, Goldberg *et al.* (2010) examined empirically whether increased imported variety induced by trade liberalization has generated "domestic-variety-creation" effect. They find evidence that the increase in imported variety following trade reform in India in the early 1990s contributed to the expansion of domestic product variety. Bernard, Redding, and Schott (2010) examines the product switching behavior of multi-product firms using a firm-product data for the U.S., and shows that multi-product firms are more likely to add or drop a product. Another finding of their study is that multi-product firms are more likely to export than single-product firms, which suggests that firm's product choice is likely to be related to exporting. Although this paper focus on exporting

Compared with most previous studies, we think that one novelty of this paper comes from the fact that, in estimating the effect of exporting on innovation, this paper explicitly distinguishes between two types of product innovation: product innovations that are new to the plant (product adding) and those that are new to the Korean economy (new product introduction). The use of plant-product matched data used in this study allows us to measure these two types of product innovations separately, because we can tell whether a new product to the plant is also a new product to the aggregate economy or not. Our conjecture is that, in Korea's context, products that are new to the aggregate economy are likely to capture product cycle phenomenon or international knowledge spillovers. By contrast, products that are new only to the plant are likely to reflect imitation by domestic competitors or domestic knowledge diffusion. We expect that the former is more clearly related to exporting.

Although we examine the effect of exporting on new product introduction mainly as an effort to clarify the mechanism underlying the exporting-productivity linkage, examining this issue in Korea's case is particularly important. As well recognized, Korea is one of the few success countries that have continuously upgraded its product mix and narrowed the income gap with advanced countries by adopting an export-led or outer-oriented development strategy.[8] So, examining and clarifying whether and how exporting is related to new product introduction in the Korean case could provide valuable lessons on other developing countries that hope to catch-up with advanced countries.

This paper is organized as follows. The next section explains the dataset used in this paper. Section 3 carries out some preliminary analyses. Section 4 explains the methodology for our main empirical analysis. Section 5 provides main empirical results: the effect of exporting on TFP and new product introduction. Section 6 concludes.

II. Data

This study utilizes two data sets. The first one is the unpublished plant-level census data underlying the *Survey of Mining and Manufacturing* in Korea, which has been previously used by the author. The data set covers all plants with five or more employees in 580 manufacturing industries at KSIC (Korean Standard Industrial Classification) five-digit level. It is an unbalanced panel data with about 69,000 to 97,000 plants for each year from 1990 to 1998. For each year, the amount of exports as well as other variables related to production structure of

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[8] See Krueger (1997), for example.

plants, such as production, shipments, the number of production and non-production workers and the tangible fixed investment, are available. The exports in this data set include direct exports and shipments to other exporters and wholesalers, but do not include shipments for further manufacture.

The second data set is plant-product data set for the same period. For most plants covered in the plant-level census data, this dataset contains information on the value of shipments of each product produced by plants. It also has information on plant identification number that will be used to link this data set to the plant-level census data, as well as KSIC five-digit level industry code to which each plant belong. The product data is recorded in eight-digit product code which is made by combining the five-digit KSIC code to which the product belongs and the three-digit code based on the Statistics Office's internal product classification scheme. Each plant is assigned to a five-digit industry based on the industry matched with the product whose output share is the largest.

III. Preliminary Analyses

In the first part of this section, we provide some basic facts on new product introduction in Korean manufacturing sector.[9] In the second part, we examine cross-sectional correlations between plants' exporting status on the one hand, and plant TFP and the measured new product introduction, on the other. We also examine the correlations between exporting status and other measures related to plant's product choice, such as product destruction, product adding and dropping, and product scope.

[9] While we could have started by discussing the relationship between exporting and productivity in line with the logical structure of this paper, we chose to show first some facts on new product introduction, since this is the first paper that measures and analyses new product introduction utilizing previously unexploited plant-product matched data on Korea.

III.1 New Product Introduction: Some Basic Facts

How important is the creative destruction process—introduction of new products and destruction of old products—in understanding the growth of manufacturing sector in Korea? To answer this question, we start by examining some of the main features of out plant-product data. As shown in the first column of Table 1, the aggregate manufacturing shipment more than tripled between 1990 and 2000. Although the increase in aggregate shipment was accompanied by both the increase in the number of plants and the increase in average shipment per plant, the latter played a much bigger role, which more than doubled during the same period. The remaining columns of Table 1 show that virtually all of the increase in average shipment per plant came from the expansion of average shipment per product, rather than from the increase in average number of products per plant. While the average shipment per product more than doubled, the average number of products per plant hardly changed during the same period.

The distribution of plants according to the number of products produced is highly skewed and fairly stable over time. For every year during the period 1990-2000, more than three-fourth of the plants are single product plants. Plants that produce two products account for about fourteen percent of the plants and plants that produce three products about five percent. So, plants that produce three or less products account for more than 95 percent of the plants. Although there are some plants that produce more than 10 products, plants producing five or more products account for less than two percent of plants.

<Table 1> Basic Statistics of the Plant-Product Data

Year	Manufacturing shipments (trillion won)	Number of plants	Shipments per plant (million won)	Total number of products*	Average number of products per plant*	Average shipment per product* (million won)
1990	166.4	54725	3041.4	74932	1.37	2221.2
1991	193.1	57680	3348.0	81455	1.41	2370.8
1992	215.0	58143	3697.6	80355	1.38	2675.5
1993	234.0	68397	3552.5	94313	1.38	2576.3
1994	281.9	69645	4048.0	93568	1.34	3013.0
1995	343.2	73582	4664.8	100172	1.36	3426.5
1996	378.9	75053	5048.2	100812	1.34	3758.3
1997	408.6	71505	5713.8	97065	1.36	4209.2
1998	407.7	62458	6527.0	86215	1.38	4728.4
1999	457.4	71144	6429.6	96912	1.36	4720.0
2000	536.1	76287	7027.2	102193	1.34	5245.8

Note: * In this table, the total number of products is the sum of the number of products produced across plants, so that it is larger than the total number of products from the viewpoint of the aggregate manufacturing sector because the same product can be produced by multiple plants.

<Table 2> Distribution of Plants According to the Number of Products Produced

Year	Plants with					
	One product(%)	two products(%)	Three products(%)	Four products(%)	Five or more products(%)	Total products(%)
1990	42463 (77.6)	7735 (14.1)	2704 (5.0)	1040 (1.9)	783 (1.4)	54725 (100)
1992	44436 (76.4)	8730 (15.0)	3017 (5.2)	1149 (2.0)	811 (1.4)	58143 (100)
1994	54495 (78.3)	9853 (14.2)	3294 (4.7)	1276 (1.8)	727 (1.0)	69645 (100)
1996	59200 (78.9)	10233 (13.6)	3397 (4.5)	1244 (1.7)	979 (1.3)	75053 (100)
1998	48237 (77.2)	9075 (14.5)	3021 (4.8)	1158 (1.9)	967 (1.6)	62458 (100)
2000	60350 (79.1)	10379 (13.6)	3315 (4.4)	1236 (1.6)	1007 (1.3)	76287 (100)

At first glance, the above discussion might give one the impression that changes at product intensive margin, the growth of shipment per product, were much more important than changes at product extensive margin, creation and destruction products, in accounting for aggregate manufacturing shipment growth. As we will discuss below, however, the fairly stable product count distribution of plants masks a large amount of product creation and product destruction.

Table 3 shows the shares of product created and product destroyed, respectively, during four- and eight-year time interval in the Korean manufacturing sector. Here, a product created during a certain time interval is defined as the product which did not exist in the beginning year but made its appearance in the end year with positive shipments. A product destroyed is defined symmetrically. A continuing product is the product that existed in both years with positive shipments. The table shows that both product creation and product destruction explain a significant share of total number of products and total manufacturing shipments. During the eight-year period from 1990 to 1998, new products or products created accounts for 40.9 percent of number of products that existed in 1998. In terms of shipments, new products account for somewhat smaller share, 28.7 percent, of manufacturing shipments in 1998, suggesting that the average size of shipment for new products are smaller than continuing products. Comparing the two four-year sub-periods, we find that introduction of new products was more active during the period 1990-1994 than during the period 1994-1998. The product destruction also explains a large share of total number of products and manufacturing aggregate shipments. During the same eight-year period, products destroyed accounts for 22.9 percent of total number of products and 14.6 percent of manufacturing shipments in the beginning year, which is 1990. Thus, although product destruction rate is somewhat smaller than product creation rate, leading to the expansion of the range of products produced, the rapid growth of the Korean manufacturing sector was accompanied by large amounts of product creation and product destruction. Although the expansion of the product range is consistent with the implications of variety-based models of growth, such as Grossman and Helpman (1991), the co-existence of product creation and destruction in the growth process of Korean manufacturing sector suggests that models which feature both introduction of new products and dropping of old products, such an Stokey (1988), are a more realistic description of the real world's growth process.

<Table 3> Product Creation and Destruction Rate: Number of Product and Shipments

Period	Destruction Rate* (percent)		Creation Rate* (percent)	
	Number of products	Shipments	Number of products	Shipments
90-98	23.0	14.6	40.9	28.7
90-94	15.3	7.4	31.5	21.0
94-98	12.6	10.7	17.1	14.7

Note: * The creation rate during a period is the share of created products in all products at the end year while the destruction rate during a period is the share of destroyed products in all products at the beginning year. The table shows both unweighted shares and weighted (by shipments) shares.

Then, how much of the aggregate manufacturing shipment growth can be accounted for product creation and product destruction? To answer this question, we perform a simple decomposition exercise as follows. Let Y_t denote aggregate manufacturing shipments at year t. Then, the aggregate change in manufacturing shipment between year t and year $t+\tau$ can be decomposed into the contributions from continuing plants (CP), entering plants (NP), and exiting plants (XP).

$$\Delta Y_t = \sum_{j \in CP} \Delta Y_{jt} + \sum_{j \in NP} \Delta Y_{jt} + \sum_{j \in XP} \Delta Y_{jt},$$

where j is an index for plants. Each plant produces a set of products, such that $Y_{jt} = \sum_i Y_{ijt}$, where i is an index for products. The set of products produced by continuing plants in year t or $t + \tau$ can be broken down into continuing products (C), new products (N), and products destroyed (X). Here, new products and destroyed products are defined from the viewpoint of the aggregate manufacturing sector, not from the viewpoint of individual plants. The products produced by entering plants are either continuing products or new products, and the products produced by exiting plants are either continuing products or destroyed products. That is,

$$\Delta Y_t = \sum_{j \in CP} (\sum_{i \in C} \Delta Y_{ijt} + \sum_{i \in N} \Delta Y_{ijt} + \sum_{i \in X} \Delta Y_{ijt}) + \sum_{j \in NP} (\sum_{i \in C} \Delta Y_{ijt} + \sum_{i \in N} \Delta Y_{ijt}) + \sum_{j \in XP} (\sum_{i \in C} \Delta Y_{ijt} + \sum_{i \in X} \Delta Y_{ijt}).$$

Rearranging,

$$\Delta Y_t = \sum_{i \in C} (\sum_{j \in CP} \Delta Y_{ijt} + \sum_{j \in NP} \Delta Y_{ijt} + \sum_{j \in XP} \Delta Y_{ijt}) + \sum_{i \in N} (\sum_{j \in CP} \Delta Y_{ijt} + \sum_{j \in NP} \Delta Y_{ijt}) + \sum_{i \in X} (\sum_{j \in CP} \Delta Y_{ijt} + \sum_{j \in XP} \Delta Y_{ijt}).$$

The above equation decomposes the change in aggregate manufacturing shipment into three components: contributions from continuing products, new products, and destroyed products. Each component can be further broken down into contributions from each plant type. Thus, the decomposition exercise can tell us, for example, how much of the aggregate change in manufacturing shipments is due to new products and, furthermore, how much of the (contribution from) new products are accounted for by continuing plants and entering plants, respectively.

Table 4 shows the decomposition results. During the period from 1990 to 1998, the aggregate manufacturing shipments increased by 145 percent. Although the growth of continuing products explains much (about 60 percent) of this growth, the role of new products is also very large; new products account for about half of the growth of aggregate manufacturing shipments during the eight-year period. Net product creation effect is also large: it accounts for almost 40 percent of aggregate manufacturing shipments growth. The results for the two four-year sub-periods are more or less similar—new products and net creation of products account for substantial portions of the aggregate shipments growth. Since new products are defined as new from the viewpoint of the aggregate manufacturing sector, not from the viewpoint of plants, these numbers seem very large. This fact provides a strong motivation for exploring the underlying determinants of new product introduction, which is tackled in subsequent sections of this paper.

<Table 4> Decomposition of the Aggregate Manufacturing Growth: by Product Type

Period	Aggregate Shipments Growth A (A=b+c+d)	Continuing Product B	Product Created C	Product Destroyed D	Net Creation E (E=c+d)
90-94 (%)	69.4 (100.0)	41.3 (59.5)	35.5 (51.2)	-7.4 (-10.6)	28.1 (40.6)
94-98 (%)	44.6 (100.0)	34.0 (76.3)	21.2 (47.6)	-10.7 (-23.9)	10.5 (23.7)
90-98 (%)	144.9 (100.0)	89.2 (61.5)	70.3 (48.6)	-14.6 (-10.1)	55.7. (38.5)

Note: Growth rates are not annualized.

Then what are the respective roles of continuing and entering plants in new product creation? Table 5 shows the decomposition results that are same as above but further broken down into each plant types. During the period 1990-1998, continuing plants contributed to 28.4 percent of the aggregate manufacturing shipments growth through new product creation, while entering plants 20.2 percent; the contribution of entering plants is as much as four-fifth of the contribution of continuing plants. Thus, new product creation is not a monopoly of continuing plants; entering and surviving plants are about as equally, although not more, important as continuing plants during the time span of eight years. If the time span becomes longer, then the contribution of entering and surviving plants is likely to become larger. In terms of net product creation, entering and exiting plants play a role that is roughly comparable to that of continuing plants.

<Table 5> Decomposition of the Aggregate Growth: by Product and Plant Type

Period	Aggregate Shipments Growth	Continuing Product			
		Continuing Plant	Entering Plant	Exiting Plant	Sub Total
	a=e+h+k	b	c	c	E=b+c+d
90-94 (%)	69.4 (100)	29.8 (42.9)	27.9 (40.2)	-16.4 (-23.6)	41.3 (59.5)
94-98 (%)	44.6 (100)	30.2 (67.8)	22.4 (50.1)	-18.6 (-41.6)	34.0 (76.3)
90-98 (%)	144.9 (100)	59.5 (41.0)	55.3 (38.2)	-25.6 (-17.7)	89.2 (61.5)

Period	Product Creation			Product Destruction			Net Creation		
	Continuing Plant	Entering Plant	Sub Total	Continuing Plant	Exiting Plant	Sub Total	Continuing Plant	Entering& Exiting Plant	Sub Total
	f	G	h=f+g	i	j	k=i+j	l=f+i	m=g+j	N=h+k
90-94 (%)	25.5 (36.8)	10.0 (14.3)	35.5 (51.2)	-6.2 (-9.0)	-1.2 (-1.6)	-7.4 (-10.6)	19.3 (27.8)	8.8 (12.7)	28.1 (40.6)
94-98 (%)	17.2 (38.5)	4.0 (9.1)	21.2 (47.6)	-8.2 (-18.3)	-2.5 (-5.6)	-10.7 (-23.9)	9.0 (20.2)	1.5 (3.5)	10.5 (23.7)
90-98 (%)	41.1 (28.4)	29.2 (20.2)	70.3 (48.6)	-9.2 (-6.3)	-5.4 (-3.8)	-14.6 (-10.1)	31.9 (22.1)	23.8 (16.4)	55.7. (38.5)

Note: Growth rates are not annualized.

Then, how pervasive is new product introduction? Is it dominated by some small fraction of plants? To see this, we classify continuing plants during a time interval into four mutually exclusive and exhaustive groups: none, destruction only, creation only, creation and destruction.

Creation only is the plants that created at least one product from the viewpoint of the aggregate economy, while destruction only is the plants that destroyed at least one product during a time interval. For comparison, we classify continuing plants alternatively into none, drop only, add only, and add and drop, as in Bernard, Redding, and Schott (2010).[10] Here, add is the plants that added at least one product from the viewpoint of the plant, while drop is the plants that dropped at least one product during a time interval. So, a plant classified as creation also added at least one product, but not vice versa. Table 6 shows the share of each group of plants for the period 1990-1998 and for the two four-year sub-periods.

During the eight-year time span, the fraction of plants did some creation or destruction of products is large: as much as 45 percent of plants were involved in some creation or destruction activity. The fraction of plants that created at least one product is also large, which is about 40 percent of all continuing plants. Creation only accounts for about 26 percent of plants, which is about twice as large as the set of plants that both create and destroy at least one product, which is 12 percent. When weighted by the beginning-year shipments, product creation is even more frequent; about 60 percent of all continuing plants created at least one product during the eight-year time span. This suggests that large plants are more likely to create new products. In particular, plants that both create and destroy products tend to be large plants as suggested by their much larger shipment-weighted share.

[10] It should be noted, however, that Bernard, Redding, and Schott (2010) uses firm-product data while this paper uses plant-product data.

<Table 6> Product Creation and Destruction Activity by Plants

(unit: %)

Plant Activity	90-94	94-98	90-98
Creation and Destruction			
Unweighted			
None	65.1	83.5	54.8
(Number of plants)	(18060)	(23795)	(8307)
Destruction	5.2	3.5	6.7
(Number of plants)	(1441)	(999)	(1012)
Creation	23.7	6.5	26.4
(Number of plants)	(6558)	(1840)	(4003)
Creation & Destruction	6.0	6.5	12.1
(Number of plants)	(1663)	(1843)	(1837)
Total	100	100	100
(Number of plants)	(27722)	(28477)	(15159)
Weighted by Shipment			
None	42.1	67.5	33.7
Destruction	9.5	4.6	6.5
Creation	24.3	9.1	22.0
Creation & Destruction	24.1	18.8	37.8
Total	100	100	100
ADD & Drop			
Unweighted			
None	26.3	36.1	21.1
(Number of plants)	(7285)	(10273)	(3205)
Drop	5.4	5.9	5.2
(Number of plants)	(1499)	(1680)	(783)
Add	5.9	7.1	5.7
(Number of plants)	(1631)	(2018)	(863)
Add & Drop	62.4	50.9	68.0
(Number of plants)	(17307)	(14506)	(10308)
Total	100	100	100
(Number of plants)	(27722)	(28477)	(15159)
Weighted by Shipment			
None	13.0	18.9	10.2
Drop	7.2	8.5	5.6
Add	7.7	8.4	7.3
Add & Drop	72.1	64.2	76.9
Total	100	100	100

The bottom panel of Table 6 shows that plants' product switching—add or drop—is even more frequent, as expected. During the eight-year period, about 80 percent of plants changed their product mix. Consistent with Bernard, Redding, and Schott (2010), plants frequently both add and drop products; they account for 68 percent and 77 percent of the total number and shipments of continuing plants, respectively. This pattern is somewhat in contrast with the product creation and destruction behavior; the share of plants that both create and destroy products is much smaller than the share of plants that both add and drop. This suggests that the underlying factors that determine plants' product creation and destruction behavior might be different from the factors that determine plants' product switching behavior. Based on the frequent behavior of simultaneous adding and dropping of products, Benard, Redding, and Schott (2010) suggest that the class of explanations for the product switching that are consistent with the data should emphasize the interactions of firm and product attributes. For example, the accumulation of R&D knowledge or the substitution of one management team for another, may have uneven effects across products, resulting in an addition of those products whose relative profitability has risen and a dropping of those products whose relative profitability has fallen. The product switching behavior observed in Korean manufacturing plants are very similar to those observed by Bernard, Redding, and Schott (2010), in the sense that both adding and dropping dominate product switching behavior. However, the much less frequent simultaneous creation and destruction suggests that firm (or plant) attributes might be as important in explaining product creation and destruction as firm-product attributes. In as much as plants' exporting status is a plant characteristic, focusing on exporting as a possible determinant of new product introduction as in this paper is not incompatible with the patterns of product creation and destruction documented above.

III.2 Superior Exporter Performance: Cross-sectional Correlations

It is a well-established fact that exporters are better than non-exporters by various performance measures including TFP. [11] We first check whether similar results are found for Korean

[11] Plant TFP is measured using multilateral-chained index number approach. See Hahn (2005) for details.

manufacturing sector. We estimate average difference in various performance measures between exporters and non-exporters using the following regression equation.

$$Y_i = \alpha + \beta \cdot EXPORT_i + \gamma \cdot INDUSTRY_i + \delta \cdot REGION_i + \lambda \cdot SIZE_i + \varepsilon_i,$$

where $EXPORT$ is a dummy variable for exporters, and $INDUSTRY$, $REGION$, and $SIZE$ are dummy variables for five-digit KSIC (Korea Standard Industrial Classification) industry, dummy variables for provincial-level plant location, and log of plant size proxied by employment, respectively. Y is a measure of plant performance of interest. Exporters in a particular year are defined as those plants with positive exports, while non-exporters are those with zero exports. The coefficient on $EXPORT$ is the estimated exporter premium.

Table 7 confirms that exporters have higher TFP than non-exporters. In addition, exporters are "better" than non-exporters in terms of various characteristics considered here.[12] That is, exporters are larger, more capital- and skill-intensive, and pay higher wages than non-exporters. The key issue here is whether the learning-by-exporting can be at least a part of the reasons for the existence of the TFP premium of exporters. This will be one of the subjects of our main empirical analyses below.

Next, we examine whether exporting is positively correlated with product creation (new product introduction) and product destruction. For comparison purposes, we also examine the correlations between plant's exporting status and measures of product adding, dropping, and product scope.

[12] Hahn (2005) documents in more detail that exporters are "better" than non-exporters in most performance characteristics. The results for other years are qualitatively similar to Table 7 and are not reported separately.

<Table 7> Exporter Premia

(unit: %)

	Estimated exporter premia		
	No control	Industry & region controlled	Industry , region & size controlled
1994			
Employment(person)	112.6	108.3	
Shipments(million won)	178.9	174.6	47.0
Production per worker(million won)	66.8	66.8	47.2
Value-added per worker(million won)	34.1	34.2	23.3
TFP	4.4	4.4	3.8
Capital per worker(million won)	56.0	51.4	34.5
Non-production worker/total employment(percent)	17.9	24.3	22.7
Average wage(million won)	12.8	15.2	9.7
Average production wage(million won)	8.9	11.9	8.3
Average non-production wage(million won)	22.6	23.0	8.7

Note: All co-efficient are significant at 1 percent level.

As a measure of new product introduction, we use the cumulative count of creation of new products, CCC henceforth. This is a measure of track record of a plant on new product introduction, which is intended to capture the innovativeness of a plant. Since the dataset covers the period 1990-1998, CCC in 1990 is assumed to be zero for every plant. CCC for year t is the sum of the count number of new products introduced each year between 1990 and year t. Similarly, our measure of product destruction is the cumulative count of destruction of products (CDC) between 1990 and year t.[13] The measures for product adding and dropping are also the cumulative count of product adding (CEC) and dropping (CXC) of a plant. An added product in

[13] Mechanically speaking, CDC of a plant is the cumulative number of products for which the plant was the last one to drop the product. What plant is most likely to be the last one to drop a product does not seem clear *ex ante*. Although the most able plant can profitably hold on to a product while others have to abandon it, it seems also possible that the most able plant can leave a product early that is becoming obsolete. The aim of this paper is not to provide a theory of product creation, but to provide empirical facts that will be the basis of such a theory.

year t is defined as a product that was not produced in year t-1 but that began to be produced in year t, and a dropped product is defined likewise, as in Bernard, Redding, and Schott (2010). Our measure for the plant's produce scope (PRNOPP) is the number of eight-digit products.

Table 8 shows the cross-section regression results using the above equation for selected years during the period 1990-1998. As expected, we find a strong tendency that CCC, as well as CDC, of exporting plants is significantly higher than that of non-exporting plants, whether or not industry and region dummy variables are included. When we include plant size as a control variable, the coefficient on export dummy variable becomes smaller but still remains significant for the year 1994 or after. So, the regression results suggest that exporters not only create new products but also destroy old products more frequently than non-exporters. What is interesting is that exporter premium is generally estimated to be higher for CCC than for CDC, which suggests that exporters are better than non-exporters in terms of net-creation of products.

Table 8 also shows that both cumulative count of product adding and product dropping are also higher for exporters. The coefficient for exporting dummy variable remains positive and significant even after controlling for industry and region dummy variables as well as plant size. Finally, the bottom rows of Table 8 show that exporters produce larger number of products than non-exporters. This finding is consistent with the finding by Bernard, Redding, and Schott (2010) that multi-product firms are more likely to be exporters.[14]

[14] The fact that multi-product firms are more likely to be exporters might reflect two-way causality: self-selection by multi-product firms into exporting and exporting having positive effect on product adding. Bernard, Redding, and Schott (2010) do not explicitly discuss this issue. This paper provides some evidence that shed light on this issue.

<Table 8> Exporter Premia: Product Creation and Destruction, etc..

(unit: product)

	Estimated exporter premia		
	No control	Industry & region controlled	Industry , region & size controlled
1991			
CCC	0.07***	0.05***	0.01
CDC	0.01***	0.00***	-0.00
CEC	0.14***	0.14***	-0.01
CXC	0.12***	0.13***	-0.02
PRNOPP	0.25***	0.33***	-0.02
1993			
CCC	0.11***	0.09***	0.01
CDC	0.04***	0.02***	-0.01
CEC	0.53***	0.54***	0.01
CXC	0.48***	0.47***	-0.01
PRNOPP	0.29***	0.36***	0.00
1995			
CCC	0.16***	0.15***	0.03***
CDC	0.09***	0.08***	0.02***
CEC	0.95***	0.95***	0.14***
CXC	0.97***	0.96***	0.14***
PRNOPP	0.29***	0.33***	0.02*
1997			
CCC	0.22***	0.17***	0.04***
CDC	0.13***	0.10***	0.02***
CEC	1.24***	1.18***	0.15***
CXC	1.24***	1.15***	0.13***
PRNOPP	0.30***	0.33***	0.03***

Note: Coefficients with asterisks are significant at 1%(***), 5%(**), and 10%(*) level.

In sum, we find that plant's exporting status is positively correlated not only with plant total factor productivity but also with the measure of new product introduction. We also find that, compared with non-exporters, exporters are more likely to add or drop products and have larger number of products. These findings provide us with a motivation for our main empirical analysis.

IV. Methodology: Propensity Score Matching

We use propensity score matching procedure as explained in Becker and Ichino (2002) to estimate the effect of exporting on plant TFP and new product introduction. To implement this procedure we first classify all plants in the dataset during the period 1990-1998 into five sub-groups: Always, Never, Starters, Stoppers, and Other.[15] "Always" is a group of plants that were exporters in the year that they first appear in the dataset and never changed their exporting status. Similarly, "Never" is a group of plants that were non-exporters in the first year they appear in the data set and never switched to exporters. "Starters" includes all plants that were non-exporters in the first year that they appear, but switched to exporters in some later year and remained as exporters thereafter. "Stoppers" consists of all plants that were exporters in the first year that they appear, and then switched to non-exporters, never switching back to exporters thereafter. "Other" is a group of plants that changed their exporting status more than twice during the sample period.

To estimate the effect of exporting on plant performance outcome variables, such as TFP and new product introduction, one natural way to proceed might be compare the performance outcome of "Starters" after the export market entry with "Never". However, it is widely acknowledged that the decision to become an exporter is not a random event but a result of deliberate choice. Specifically, the participation decision in the export market is likely to be correlated with the data generating process for plant TFP or the measure of new product introduction. In this situation, the estimate based on traditional simple mean difference test on the outcome variable will be biased. Propensity score matching is a way to reduce this bias by addressing problems associated with endogenous participation decision, by comparing the

[15] We confine our analysis to only those plants that do not have a split in time series observations during the period from 1990 to 1998.

outcomes using treated (starters) and control (never) subjects that are as similar as possible.[16] The outcome variables of main interest in this paper are plant TFP and cumulative count of new products of plant, CCC. In addition to CCC, we also examine whether there is an effect of exporting on product destruction (CDC), as well as product adding (CEC) and dropping (CXC). We also examine whether exporting has any effect on the number of products produced per plant (PRNOPP) which starts to export.

To implement the propensity score matching procedure, we estimate the following probit model.

$$P(X_i) \equiv \Pr(d_i = 1 \mid X_i) = E(d_i \mid X_i) \qquad (1)$$

Where $P(X_i)$ is the probability of becoming an exporter for plant i conditional on the vector of pre-treatment characteristics X_i, and d_i is the dummy indicating export market participation. In our baseline specification, we consider the plant TFP (log of total factor productivity), as well as plant size (log of worker) and capital intensity (log of capital per worker) as pre-exporting plant characteristics, following the convention in the literature. We also include year and ten industry dummy variables. All explanatory variables including plant TFP enter the probit model with a value at one year before export market participation. In addition to the baseline specification, we consider two alternative specifications. In the first alternative specification of the probit model for each outcome variable (alternative I), we include R&D intensity (=R&D/Shipments*100) in addition to the plant characteristics in the baseline specification, in order to control for the pre-exporting differences in R&D input across

[16] In order to assess the effect of exporting on new product introduction, what we would like to ask is the question "what would have happened to the new product introduction of starters, had they not participated in the export market?". However, we don't have such counterfactual observations on the outcome variable available. The basic idea underlying propensity score matching is to reproduce the counterfactual outcome of the treated (starters) had they not been treated (exported), out of the control group (never). See Becker and Ichino (2002) for details of propensity score matching technique.

plants which might affect export participation.[17] In the second alternative specification of the probit model for each outcome variable (alternative II), we include the value of the corresponding outcome variable one year before export market participation as an additional characteristic.[18] We expect that the lagged outcome variable contains some information on the "ability" of plants which might not be adequately captured by plant total factor productivity.

Based on the estimated propensity score, a set of Never plants is matched to each Starter plant. Let T be the set of treated units and C the set of control units, and y_i^T and y_j^C be the observed outcomes of the Starter and Never plants, respectively. Denote the set of Never plants matched to the treated unit i by $C(i)$. Also let us denote the number of Never plants matched with $i \in T$ by N_i^C and the number of plants in the Starter group by N^T. Then, the propensity score matching estimator for the average treatment effect on the treated at s years after the export market entry is given by

$$ATT_s^* = \frac{1}{N^T} \sum_{i \in T} \left(y_{i,s}^T - \sum_{j \in C(i)} w_{ij} y_{j,s}^C \right), \tag{2}$$

where $w_{ij} = 1/N_i^C$ if $j \in C(i)$ and $w_{ij} = 0$ otherwise.[19]

V. Main Results

V.1 Full Sample

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[17] Constantini and Melitz (2008) and Aw, Roberts, and Xu (2009) explain the theoretical mechanism through which R&D affects positively export market participation.
[18] So, when plant TFP is used as the outcome variable, the baseline and the alternative II specifications are the same.
[19] We use nearest neighbor matching which is invoked by using **attnd.ado** procedure in Becker and Ichino (2002). In the case of nearest neighbor matching, one control unit is matched to each treated unit. For convenience, we expressed equation (2) as general formula which covers both nearest neighbor matching and radius matching.

Table 9 and Table 10 show our main estimation results.[20] The upper and middle panel of Table 9 shows our main empirical results. The upper panel shows the results for which plant TFP is used as outcome variable. First and foremost, we find strong learning-by-exporting effect. All estimated coefficients are positive and highly significant in both specifications. Second, productivity gain for Starters begins to materialize immediately after entering the export market and tends to get bigger in the following year, but tends to stabilize after two or three years. Thus, exporting has a permanent and positive effect on productivity level and a temporary effect on productivity growth of plants, especially during the first several years after entry. Third, the estimated learning-by-exporting effect is large; it is 6.8 percent in the baseline specification and 6.4 percent in the alternative II specification. Although the estimated effects tend to become somewhat smaller in alternative II specification where we include plant R&D intensity, they are still quite large. In so far as inclusion of plant R&D intensity one year before export participation controlled for the effect of exporting on forward-looking R&D, the results indicate that the estimated learning-by-exporting effect is likely to capture channels associated with international knowledge spillovers. The above results are quite in contrast with Aw, Chung, and Roberts (2000) who do not find learning-by-exporting effect for Korea.

Now we turn to the estimated effect of exporting on new product introduction, which is shown at the middle panel of Table 9. As discussed at introduction, examining this effect could be considered as an effort to clarify the mechanism whereby exporting affects firm productivity. We find some evidence suggesting that exporting promotes the new product introduction. In the baseline, the estimated effects are positive and significant for the four years since export market participation. When we controlled for plant R&D intensity one year before export market

[20] The estimates were obtained with the common support restriction. While imposing the common support restriction may improve the quality of the matches, the sample may be considerably reduced. See Becker and Ichino (2002) for further discussion on this issue. In our paper, the estimates were hardly sensitive to the common support restriction.

participation in the probit model of exporting, we still observe   Even when $CCC_{s=-1}$ is included as an additional conditioning variable instead of R&D intensity (alternative II), the estimated effects of exporting on new product introduction remain still positive, although they become less significant for some years.

<Table 9> The Effects of Exporting on Plant TFP and Product Creation and Destruction

Outcome variable	Probit model specification	Number of treat units	S=0	S=1	S=2	S=3
lnTFP	Baseline	5797	0.056*** (0.008)	0.068*** (0.009)	0.076*** (0.011)	0.059*** (0.014)
	Alternative I	5797	0.049*** (0.008)	0.064*** (0.010)	0.062*** (0.012)	0.064*** (0.013)
CCC	Baseline	5797	0.067*** (0.011)	0.060*** (0.015)	0.036* (0.021)	0.072*** (0.030)
	Alternative I	5797	0.067*** (0.012)	0.073*** (0.016)	0.051*** (0.021)	0.077*** (0.033)
	Alternative II	3506	0.052*** (0.017)	0.016 (0.024)	-0.002 (0.031)	0.005 (0.044)
CDC	Baseline	5797	0.038*** (0.009)	0.044*** (0.013)	0.012 (0.019)	0.049* (0.028)
	Alternative I	5797	0.036*** (0.009)	0.046*** (0.013)	0.006 (0.017)	0.026 (0.028)
	Alternative II	3232	0.001 (0.014)	0.014 (0.018)	0.001 (0.022)	0.014 (0.034)

Note: Numbers in parenthesis are t-statistics. Coefficients with asterisks are 1%(***), 5%(**), and 10%(*) level.

Then, does exporting also promote destruction of old products as well?[21] Suppose we find that exporting not only makes a plant to introduce new products more easily but also makes that plant more likely to be the last one to drop old products. Then, we might infer that knowledge spillovers related to exporting is a plant-level productivity shock, rather than plant-product specific productivity shock, which makes the plant more productive in producing all range of

[21] Accurately speaking, we are asking whether exporting makes a plant more likely to be the last one to drop a certain product, since our measure of destruction of old products, CXC, is the cumulative number of products for which the plant has been the last one holding on to produce it but dropped it eventually.

products which it currently produces or could produce in the future. The results shown at the bottom rows of Table 9 do not provide a very conclusive answer to this question. Although the effects of exporting on CDC were estimated to be significant and positive for most years in the baseline and alternative I specification, they were not robust to the inclusion of $CDC_{s=-1}$ as an additional pre-exporting plant characteristic. The estimated effects remained still positive but not significant for most years. This suggests that the significant and positive effects estimated from the baseline specification mostly reflect pre-exporting differences in CDC between Starter and Never which is persistent over time.

The results do not allow us to draw out a definitive conclusion on whether exporting has an effect on product adding (CEC) and product dropping (CXC), either. As shown in Table 10, the effects of exporting on CEC and CXC are estimated to be positive and significant in the baseline and alternative I specification. In the alternative II specification, however, the estimated effects are mostly negative and some of them are even significantly negative. Finally, although we find generally positive effects of exporting on the number of products produced per plant (PRNOPP) in all three specifications, they become significant in alternative I specification. So, the positive effect of exporting on PRNOPP estimated in the baseline and alternative II specification might reflect pre-exporting differences in plant R&D intensity.[22]

Taken together, the positive estimated effect of exporting on both plant TFP and new product introduction indicates that exporting raises plant TFP either directly through learning-by-exporting spillovers or indirectly through promoting innovation.[23] The fact that we could obtain some positive effect of exporting on new product introduction controlling for pre-exporting

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[22] When we added R&D intensity to alternative II specification, the estimated effects became insignificant.
[23] As discussed at introduction, we conjectured that product innovation new to the aggregate economy is likely to be related to product cycle phenomenon while product innovation new to the plant is likely to be related to imitation by domestic competitors. More robust effect of exporting on new product introduction is consistent with this conjecture.

R&D activity seems to imply that even this indirect effect is likely to be related to learning-by-exporting spillovers.

<Table 10> The Effects of Exporting on Product Adding, Dropping, and Product Scope

Outcome variable	Probit model specification	Number of treat units	S=0	S=1	S=2	S=3
CEC	Baseline	5797	0.599*** (0.039)	0.539*** (0.056)	0.571*** (0.085)	0.711*** (0.130)
	Alternative I	5797	0.601*** (0.037)	0.579*** (0.056)	0.555*** (0.087)	0.741*** (0.120)
	Alternative II	3506	-0.020 (0.070)	-0.490*** (0.114)	-0.670*** (0.172)	-0.337 (0.229)
CXC	Baseline	5797	0.601*** (0.037)	0.493*** (0.054)	0.499*** (0.081)	0.636*** (0.121)
	Alternative I	5797	0.566*** (0.037)	0.501*** (0.055)	0.451*** (0.088)	0.610*** (0.113)
	Alternative II	3232	-0.037 (0.070)	-0.550*** (0.109)	-1.002*** (0.178)	-1.001*** (0.241)
PRNOPP	Baseline	5797	0.006 (0.021)	0.031 (0.030)	0.081** (0.040)	0.118** (0.056)
	Alternative I	5797	-0.009 (0.022)	0.018 (0.032)	0.008 (0.039)	0.083 (0.052)
	Alternative II	3587	0.064** (0.027)	0.065* (0.039)	0.158*** (0.049)	0.251*** (0.067)

Note: Numbers in parenthesis are t-statistics. Coefficients with asterisks are 1%(***), 5%(**), and 10%(*) level.

V.I Sub-group Estimation Results

So far, the effects of exporting on plant TFP and new product introduction were assumed to be the same across all plants that start to export. However, there might be differential treatment effects depending on the characteristics of plants. In particular, “absorptive capacity” of plants might matter in enhancing productivity and promoting new product introduction with the help of knowledge gained through exporting activity. To consider this possibility, we used skill intensity of plants as a proxy for absorptive capacity. Skill intensity is measured as a share of non-production workers in total workers which is the sum of production and non-production workers. According to skill intensity, the sample was also divided into three sub-groups: low (smaller than 10 percent), medium (between 10 and 40 percent), and high (greater than 40 percent). Table 11 shows the estimated effect of exporting on plant TFP and new product introduction (CCC) for the three specifications: baseline, alternative I, and II.

<Table 11> The Effects of Exporting: Sub-group Estimation Results

Specification	Plant Group by Skill Intensity	Outcome variable	Number of Treated	Average Effect of Exporting on Exporters			
				S=0	S=1	S=2	S=3
Baseline	Low	lnTFP	1115	-0.005 (0.021)	0.051** (0.024)	0.092** (0.028)	0.118*** (0.036)
		CCC	1115	0.007 (0.027)	-0.025 (0.036)	-0.011 (0.056)	0.011 (0.074)
	Medium	lnTFP	3389	0.041*** (0.010)	0.041*** (0.010)	0.047*** (0.013)	0.032*** (0.015)
		CCC	3389	0.057*** (0.014)	0.060*** (0.017)	0.065*** (0.023)	0.107*** (0.032)
	High	lnTFP	1293	0.068*** (0.018)	0.085*** (0.021)	0.105*** (0.027)	0.075*** (0.026)
		CCC	1293	0.049* (0.029)	0.124*** (0.035)	0.075* (0.045)	0.142** (0.073)
Alternative I	Low	lnTFP	1115	-0.006 (0.019)	0.007 (0.024)	0.015 (0.035)	0.100*** (0.032)
		CCC	1115	0.047** (0.023)	0.001 (0.037)	-0.001 (0.056)	-0.064 (0.077)
	Medium	lnTFP	3389	0.051*** (0.009)	0.050*** (0.011)	0.056*** (0.012)	0.069*** (0.014)
		CCC	3389	0.069*** (0.014)	0.065*** (0.017)	0.074*** (0.023)	0.111*** (0.030)
	High	lnTFP	1293	0.066*** (0.018)	0.043** (0.021)	0.065*** (0.024)	0.036 (0.027)
		CCC	1293	0.088*** (0.029)	0.128*** (0.036)	0.088** (0.043)	0.090 (0.080)
Alternative II	Low	CCC	576	0.017 (0.036)	-0.034 (0.048)	-0.048 (0.066)	-0.158 (0.098)
	Medium	CCC	2128	0.019 (0.022)	-0.027 (0.027)	-0.029 (0.038)	-0.071 (0.051)
	High	CCC	802	0.120*** (0.042)	0.181*** (0.052)	0.086 (0.065)	0.080 (0.131)

Note: Numbers in parenthesis are t-statistics. Coefficients with asterisks are 1%(***), 5%(**), and 10%(*) level.

We find that the estimated effects of exporting on both plant TFP and new product introduction are largest and most significant for the sub-group with high skill intensity. In as much as skill intensity measure can be regarded as a proxy for "absorptive capacity" of a plant, this result suggests that the absorptive capacity matters for raising productivity as well as for successfully introducing new products with the help of new knowledge gained through exporting activity.

VI. Summary and Concluding Remarks

This paper provides empirical evidence suggesting that exporting leads to the increase in productivity. In addition, utilizing previously unexplored plant-product matched data on Korean manufacturing sector, this paper also provides some evidence suggesting that exporting promotes new product introduction which is one mechanism through which exporting increases productivity. These results are largely robust to the control of pre-exporting R&D intensity of plant, which indicates that the evidence documented in this paper is likely to be related to international knowledge spillovers. Finally, we find some evidence that absorptive capacity matters in enhancing productivity and new product introduction with the help of knowledge gained through exporting activity.

It is well understood that the continual process of Schumpeterian creative destruction—introduction of new products and dropping of old products—is an integral part of economic growth. In addition, existing theoretical and empirical studies on trade and growth suggest, although there are some controversies remaining, that international trade or trade liberalization not only generates static gains but also promotes economic growth of developing countries. Then, one natural issue that arises is whether trade promotes creative destruction process. We think that the evidence in this paper can shed light on this issue.

If international trade, or exporting in particular, has an effect of increasing productivity and facilitating new product introduction, then the longer-term gains from opening up to trade or lowering trade costs might be much bigger than conventionally accepted.[24] We think that the evidence in this paper help understanding sources of heterogeneity in firm productivity, which is assumed to be exogenously determined in most theoretical models of heterogeneous firms and trade.

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