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EXPORTING AND PERFORMANCE OF PLANTS: EVIDENCE FROM KOREAN MANUFACTURING

Chin Hee Hahn

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ABSTRACT

This study examines the relationship between exporting and various performance measures including total factor productivity, using the annual plant-level panel data on Korean manufacturing sector during the period of 1990 to 1998. The two key questions examined are whether exporting improves productivity (learning) and/or whether more productive plants export (self-selection). This study provides evidence supporting both self-selection and learning-by-exporting effects, with both effects being more pronounced at around the time of entry into and exit from the export market. Thus, positive and robust cross-sectional correlation between exporting and total factor productivity is accounted for by both selection and learning effects. These results are in contrast with Aw, Chung, and Roberts (2000) who do not find any strong evidence of self-selection or learning in Korea. Similar effects are observed when shipments or employment is considered as a performance measure. Overall, this study suggests that the benefits from exporting have been realized not only through resource reallocation channel but also TFP channel in Korea.

Chin Hee Hahn
Research Fellow
Korea Development Institute
P.O. Box 113 Cheongryangri Dong
Seoul 130-012 Korea
chhahn@kdi.re.kr

1. Introduction

It has been a widely accepted view that international trade and international openness play a key role in enhancing the growth rates of output and income. As a prime example, the past economic successes of Korea and several other East Asian countries have often been attributed, to a large extent, to the export-oriented development strategy. The World Bank (1993) points to the export-promotion development strategy as the hallmark of the East Asian miracle countries. Also, Krueger (1995) argues that the most salient distinguishing characteristic between the success of East Asian countries and the stalled growth of Latin American countries is the openness of international trading regime; i.e., outer-oriented trade strategy of the former versus import substitution development strategy of the latter. Even in recent years, many developing countries, including Korea, promote export based on the belief that exporting activity per se is valuable, bringing additional economic benefits. There is little disagreement on the static gains from trade in the form of improved resource allocation and economic well-being. However, the dynamic relationship between increased trade and long-run output and productivity growth is less well understood.

This study examines the relationship between exporting and productivity using the plant level panel data on the Korean manufacturing sector during the period of 1990 to 1998. The two key questions to be addressed are whether exporting improves productivity and whether more productive plants export. To consider the possibility that the benefits of exporting accrue through channels other than productivity, other measures of plant performance, such as shipment and employment, are also considered in the analysis.

There are numerous studies supporting that exporters are better than non-exporters in terms of various performance measures. That is, exporting plants are more productive, larger, more capital intensive, more technologically sophisticated, and pay higher wages compared with those plants producing for domestic market only.[1] While these studies provided an important stepping stone toward understanding the export-performance nexus, they do not by themselves suggest that exporting activity brings medium- to long-run technological and other benefits over and above the static gains from trade. That is, exporters might be better than non-exporters before they started exporting due to factors other than exporting activity itself. Thus, in order to understand the role of international openness or, more narrowly, the role of exporting in growth of productivity and output, it is necessary to understand the causal relationship between exporting and performance measures including productivity.

There are broadly two strands of theoretical explanations for the positive cross-sectional correlation between exporting and productivity. One explanation is that more productive plants self-select into the export market. In this case, causality runs from productivity to exporting. The usual argument is based on the existence of sunk entry cost associated with export market participation (Bernard and Jensen 1999a). In order to sell goods abroad, producers might have to incur additional costs, such as transport costs, modification costs to meet foreign tastes and regulations, and setup costs to establish distribution network. With these costs present, only productive producers will be able to expect to recoup the entry cost after entering the foreign market.[2] Alternative explanation

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[1] These studies include Aw and Hwang (1995), Aw and Batra (1998), Chen and Tang(1987), Haddad (1993), Handoussa, Nishimizu and Page (1986), Tybout and Westbrook (1995), Aw, Chen and Roberts (2001), Aw, Chung, and Roberts (2000), Bernard and Jensen (1995), and Bernard and Wagner (1997).

[2] The existence of sunk cost is not essential feature to explain self-selection. See Clerides, Lach, and Tybout (1998).

of the positive cross-sectional correlation between exporting and productivity is that exporting activity serves as a vehicle for diffusion of disembodied technology or knowledge across countries and, hence, improves productivity. By exporting, exporters learn from knowledgeable buyers who provide them with blueprints and give them technical assistance.[3] This explanation is often called as learning effect. If these mechanisms are at work then the positive correlation between exporting and productivity might reflect causation running from exporting to productivity.[4]

Several empirical studies provide evidence on the causal relationship between exporting and productivity. Most studies report that exporters are more productive than non-exporters before they start exporting, suggesting that cross-sectional correlation between exporting and productivity partly reflects a self-selection effect. For example, Clerides, Lach and Tybout (1998) find very little evidence that past exporting improves performance, using the plant-level panel data from Colombia, Mexico, and Morocco. Similar results are reported by Aw, Chung, and Roberts (2000) and Aw, Chen, and Roberts (2001) for Taiwan, Bernard and Jensen (1999b) for U.S. To the contrary, evidence in favor of learning effect is scarce. The above studies find little evidence that continuous exporters increase their productivity advantage over non-exporters over time on a sustained basis. Although Bernard and Jensen (1999b) report that new entrants into the export market experience some productivity improvement at around the time of entry, these productivity

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[3] Although this explanation has long been provided by many trade economists, see Grossman and Helpman (1991), Ben-David and Loewy (1998), and Feeny (1999) for recent exposition.

[4] Of course, as Tybout (2001) summarizes, there are other mechanisms whereby exporting may improve productivity. One is exploitation of economies of scale by exporting. However, after surveying empirical evidence, Tybout (2001) concludes that productivity growth due to scale efficiency effects is likely to be very small. Another mechanism is enhanced incentive to innovate and eliminate waste by exporting. However, Tybout (2001) points out that theoretically implied direction of change in efficiency critically depend upon model specifics.

gains are very short-lived.

Similar study exists for Korea. Aw, Chung, and Roberts (2000) report that they could not find strong evidence which supports the learning-by-doing hypothesis or the self-selection hypothesis using plant-level data on the Korean manufacturing sector for the three years: 1983, 1988, and 1993. Their evidence on Korea differs markedly from other countries in that even the self-selection hypothesis is not supported, although the lack of strong evidence of learning-by-doing may be consistent with findings in other countries. Aw, Chung, and Roberts provide two explanations for the absence of productivity-based self-selection in Korea. The first one is that while long-run expected profitability is an indicator by which the decision of export market participation is eventually guided, plant productivity may not be a good indicator of plant profitability in Korea due to heterogeneity across producers on the demand side of the market. The second explanation is that the Korean government's investment subsidies tied to exporting activity rendered plant productivity a less useful guide on the decision to export.

These explanations might or might not be close to reality in Korea. However, their rejection of self-selection hypothesis as well as learning-by-doing in Korea seems somewhat problematic. As Aw, Chung, and Roberts (2000) show, there exists a strong and robust cross-sectional correlation between exporting and productivity even in Korea's case. That is, they show that exporters have higher productivity than non-exporters and that those differences are large and statistically significant. Then, the superior productivity of exporters to those of non-exporters must have developed before or after export market participation. In other words, the strong and robust cross-sectional correlation between exporting and productivity is at odds with the rejection of both self-selection and learning.

Thus, there is a need to reexamine the relationship between exporting and productivity. In this study, we use annual plant-level panel data from 1990 to 1998, while Aw, Chung, and Roberts (2000) used five-year interval panel data for three years—1983, 1988, and 1993. Using the annual data has advantage in that dynamic aspects of the exporting-productivity relationship can be more closely examined. In addition, the availability of export variable at annual frequency allows us to pay more careful attention to the exporting history of a plant in the analysis.

This study can also shed light on policy issues. There are many studies documenting that international trade openness is one of the key factors explaining cross-country variations in long-run economic growth. For example, Sachs and Warner (1995) provide empirical evidence that openness and growth are positively related. Hall and Jones (1999) show that openness and institutional quality are the most important factors determining the long-run total factor productivity level, which accounts for most of the cross-country variations in long-run output level. If we take these empirical findings seriously, then we need to understand exactly how openness improves a country's long-run output level and growth rate. In order to utilize fully the opportunity that openness provides, then the channels through which openness enhances aggregate productivity and output should be more clearly understood. For example, if the openness enhances aggregate productivity not only through intra-firm technological learning but also through cross-firm and cross-industry resource reallocation, then openness per se might not be cure-all. That is, greater openness accompanied by policies improving resource reallocation will be more effective than policies enhancing openness alone in order to exploit the potential benefits that openness provides.

Also, this study provides empirical evidence which is necessary to evaluate and guide various measures to promote export. For example, if export market entry mostly reflects self-selection process—i.e., good firms become exporters—then policies that intervene this process are likely to bring about outcome less desirable than that without such intervention. With regard to the learning effect, if there are no post-entry rewards from exporting, then policies designed to increase the numbers of exporters become foot-loose and waste resources, as those firms and their workers will not receive any extra benefits. On the other hand, if exporting activity per se involves technological learning then appropriate policy intervention might be to reduce barriers to export market participation, such as export assistance, information programs, joint marketing efforts, and trade credits (Bernard and Jensen 1999a).

This paper is organized as follows. In the following section, some basic statistics on exporting plants are provided. Also, we examine cross-sectional correlation between exporting and various performance measures, including productivity. In section 3, we compare performance measures of exporters with those of non-exporters before export market participation. Utilizing the advantages provided by annual data, we pay particular attention to the exporting history of plants in the analysis. In section 4, we examine whether exporting improves performance over various time horizons. Section 5 summarizes the results and concludes.

2. Basic Statistics and Exporter Performance

Data

We briefly describe the data and provide some basic statistics on exporting plants. The data used in this study is the unpublished plant-level data underlying the Annual

Report on Mining and Manufacturing Survey. The data 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 during the 1990-1998 period.[5] For each year, the exports amount of a plant as well as other general plant characteristics are available as a continuous variable. The exports in this data set include direct exports and shipments to other exporters and wholesalers, but do not include shipments for further manufacture. Following the convention in the literature, we define exporters in a given year as plants which reported positive amount of exports. Accordingly, non-exporters in a given year are those plants with zero exports.[6]

Exporters and Export Intensity

<Table 1> shows the number of exporting plants and average exports as percentage of shipments (export intensity) during the 1990-1998 period. During the sample period, the exporting plants accounted for between 11.0 and 15.3 percent of all manufacturing plants. The share of exporting plants rose slightly between 1990 and 1992, but since then it steadily declined until 1996. However, with the outbreak of the financial crisis in 1997, the share of exporting plants rose somewhat noticeably to reach 14.8 percent in 1998. The rise in the share of exporting plants since 1997 can be attributed mostly to the closing of non-exporting plants, rather than increase in the number of exporting plants. The increase in the number of exporters since 1997 was only modest.

[5] Unfortunately, the plant-level data is not publicly available. Korea Development Institute has been allowed access to the data set under the condition that no information on individual plants or firms are revealed in the analysis. We appreciate Korea Statistical Office for allowing to use the data set. Although the Surveys exist after 1998, these could not be used due to incomplete information on plant identity variable.

[6] All the values of export variable are either zero or positive. There are no missing or negative

These changes are broadly consistent with the severe contraction of domestic demand and the huge depreciation of Korean won associated with the crisis.

// Table 1 here//

Consistent with the high export dependency of the economy, the share of exports in shipments at plant level is quite high in Korea. During the sample period, the unweighted mean export share is between 43.6 and 54.8. The mean export share steadily declines from 1990 to 1996, but rises with the onset of the crisis. The mean export share weighted by shipment is generally lower than unweighted mean export share, suggesting that smaller exporting plants have higher export share.

One interesting point to note is that the rise in weighted export share is much more dramatic than in unweighted export share during the 1997-1998 period when there was large depreciation of won. Recalling that the new entry into the export market since 1997 was only modest, this suggests that the export boom during that period, as shown in the final column of Table 1, was mainly driven by the increase in export shipments of large firms who had been previously exporting. The fact that huge favorable exchange rate shock triggered large increase in exports of previous exporters and only mild increase of new entry into export market is consistent with the presence of sunk entry cost in export market (Figure 1).

// Figure 1 here//

Performance of Exporters versus Non-Exporters

It is a well-established fact that exporters are better than non-exporters by various

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values.

performance standards. As a point of departure, we examine whether the same pattern holds in our data set for the period covered in this study. <Table 2> compares various plant attributes between exporters and non-exporters for three selected years. In terms of number of workers and shipments, exporters are on average much larger in size than non-exporters. The differential in shipment is more substantial than the differential in number of workers. So, the average labor productivity of exporters, measured by production and value added per worker, are higher than that of non-exporters. Compared with the value added per worker differential, the differential in production per worker between exporters and non-exporters are more pronounced. This might reflect more intermediate-intensive production structure of exporters relative to non-exporters.[7] Although exporters have higher capital-labor ratio and higher share of non-production workers in employment than non-exporters, these differences in inputs do not fully account for the differences in labor productivity. As a consequence, total factor productivity levels of exporting plants are, on average, higher than those plants producing for domestic market only.[8] Some of the differences in the total factor productivity levels may be attributed to the differences in R&D intensity. Controlling for the size of shipments, exporters spent about twice as much on R&D as non-exporters. From the worker's point of view, exporters had more desirable attributes than non-exporters. Average wage of exporters is higher than that of non-exporters. Although both production worker's wage and non-production worker's wage are higher in exporters than in non-exporters, the differential in non-production worker's wage is more pronounced.

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[7] I am indebted to James Harrigan for pointing out this feature of the data.
[8] The total factor productivity index is based on multilateral chained index number approach. For details, see Appendix.

// Table 2 here//

<Table 3> shows the average percentage difference in various performance measures between exporters and non-exporters for three years, which is estimated from the following regressions.

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

where $EXPORT_i$ is a dummy variable for exporters, $INDUSTRY_i$ and $REGION_i$ are dummy variables for five digit KSIC industry and plant location, and $SIZE_i$ denotes plant size measured by employment. The three columns in Table 3 shows the estimated coefficients of exporter dummy variable without any control variables, with controls of industry and region, and with additional control of plant size.

// Table 3 here//

The regression confirms that exporters are better than non-exporters in terms of various performance characteristics for all years, even after controlling for industry, region, and size of the plants. Also, all coefficients on export dummy variable are highly significant. Controlling industry and region has little effect on the magnitude of the export premium. However, controlling plant size greatly reduced the coefficients of the export dummy variable, which suggests that to a large extent the desirable characteristics of the exporters are attributable to their larger size. Nevertheless, the estimated export premium remained highly significant.

Controlling for industry and region, exporters employed more workers by about 100 percent. Controlling for industry, region, and size, the shipments of exporters were larger by about 50 percent, production per worker by about 50 percent, and value added per worker by about 20 to 30 percent. Although exporters have higher capital-labor ratio and higher share of non-production workers, they also have higher total factor productivity level. The total factor productivity levels of exporters are, on average, 2.5 to 7.5 percent more productive than non-exporters, with industry, region, and size controlled. Average wage is between 8 and 13 percent higher in exporting plants than in plants producing for domestic market only.

The findings in the above cross-sectional analysis suggest that there does exist significant total factor productivity and other performance gaps between exporters and non-exporters. As discussed earlier, however, these findings should not be interpreted as suggesting that exporting per se makes plants or firms better. We now turn to the issue of whether these performance gaps developed before or after exporting.

3. Do Good Plants Export?: Self-selection

In this section, we examine whether good plants export. We compare various plant characteristics between exporters and non-exporters before exporting. We follow Bernard and Jensen (1999a) and divide our sample into two distinct sub-periods—1990-1994 and 1995-1998. We select all plants that did not export in any of the first years and compare initial levels and growth rates of performance measures for exporters and non-exporters in the final year. For example, we compare various performance measures in 1990 of exporters and non-exporters in 1994.

In 1997 and 1998, export growth increased significantly with the huge depreciation of won. If the huge depreciation of Korean currency induced previously unproductive plants to enter the export market, then it will work against finding self-selection effect even if it really existed. Also, if the non-exporting plants that stopped operation in 1998 with the severe contraction of domestic demand were located at the lower end of productivity distribution, this factor will also work against finding self-selection effect. Thus, the self-selection effect is more likely to be observable in the first sub-period if it exists.

The ex-ante levels of performance measures of exporters compared with non-exporters are obtained as the coefficient on export dummy variable from the following regressions.

$$\ln Y_{i0} = \alpha + \beta EXPORT_{iT} + \gamma\, INDUSTRY_i + \delta\, REGION_i + \lambda \ln SIZE_{i0} + \varepsilon_i \qquad (1)$$

where $\ln Y_{i0}$ is logarithm of plant performance measures at the initial year of the period and $EXPORT_{iT}$ is an export dummy variable at the final year of the period. <Table 4> shows estimated export premia expressed in percentage terms for 1990 and 1995.

Table 4 shows that exporters have, on average, more workers and larger shipments than non-exporters before exporting, regardless of the period examined. This result holds whether or not we control for industry, region, and plant size. Although inclusion of plant size variable reduces the size of the estimated exported premia, they are still statistically significant. Similar conclusion holds for labor productivity measures, such as production per worker and value added per worker, as well as for capital-labor ratio and share of non-production workers. However, average wages of exporters are not significantly higher than those of non-exporters. Although wage level measures of exporters are estimated to be higher than those of non-exporters without the control of plant size, the coefficient on export dummy variable loses significance or becomes substantially smaller when plant size variable is included.

In Table 4, ex-ante total factor productivity level of exporters is estimated to be no higher than non-exporters, on average. The coefficient on the export dummy variable is not significantly different from zero at conventional significance level in any of the regressions. In the regression with all control variables included for 1995-1998 period, the exporters' total factor productivity premium is even insignificantly negative. One interesting point to note here is that the total factor productivity premia of exporters are generally lower in the 1995-1998 period compared with those in the 1990-1994 period, although they are all insignificant. As discussed earlier, this may be due to the disappearance of low-productivity non-exporters from the sample and entries of previously unproductive producers into the export market during the crisis period.

// Table 4 here//

Overall, exporters are already larger, more capital intensive and hire proportionately more non-production workers. In terms of labor productivity, exporters were already more productive than non-exporters before they started to export, but we caution against interpreting this result as a strong evidence of self-selection. The differences in labor productivity between future exporters and non-exporters may just reflect differences in production technology, i.e., capital intensity, not the differences in expected profitability, which may be better captured by total factor productivity. However, the above analysis, which is based on a methodology by Bernard and Jensen (1999a), does not reveal any significant ex-ante differences in total factor productivity between future exporters and non-exporters.

The ex-ante growth rate premia of exporters are estimated as the coefficient on the export dummy variable from the following regressions.

$$\Delta \ln Y_{iT-1} = \alpha + \beta EXPORT_{iT} + \gamma\, INDUSTRY_i + \delta\, REGION_i + \lambda \ln SIZE_{i0} + \varepsilon_i \qquad (2)$$

where $\Delta \ln Y_{iT-1}$ is the annual average growth rate of performance measures between year 0 and T-1. The estimated growth rate premia of exporters are reported in <Table 5>.

For both sub-periods, measures of plant size such as employment and shipments grow significantly faster in future exporters. With industry, region, and initial plant size controlled, the growth rate premia of exporters are 5.1 to 6.2 percent per year for employment and 6.0 to 8.3 percent per year for shipments, depending on the period. The regressions of labor productivity growth show somewhat mixed results. Growth rates of production per worker in future exporters are generally higher but significant only in the later period. With all control variables included, growth rates of value-added per worker are lower in the earlier period but higher in the later period, although they are not significant. We could not find any strong evidence suggesting that total factor productivity growth rates are higher in plants that will export in the future. Although total factor productivity growth rate premia were positive in the later period, it became insignificant with the control of plant size. In terms of capital-labor ratio, the share of non-production workers, and average wage levels, we could not find strong evidence of growth rate premia of future exporters, either.[9]

// Table 5 here//

To summarize the above results, exporters already have many of the desirable characteristics before they start exporting. Compared with non-exporters, exporters are larger, more capital-intensive, have higher labor productivity, and hire proportionately more non-production workers several years before they start exporting. To the contrary, we could not find significant ex-ante difference in levels and growth rates of total factor productivity between future exporters and non-exporters.

Then, is it justifiable to conclude that the decision of export market entry is not based on total factor productivity in Korea? The answer seems to be negative. If we follow more closely the exporting history of plants and repeat similar analysis, we can observe differences in the ex-ante levels of total factor productivity between future exporters and non-exporters. In <Table 4>, we selected plants who did not export during the 1990-1993 period and compared the total factor productivity levels between exporters and non-exporters in 1994. However, the exporting history of those selected plants might be varied after 1994. For example, among the plants classified as non-exporters in 1994, there are plants that have entered the export market after 1994. If these plants had high total factor productivity in the past, then it will be hard to find TFP-based self-selection even if it exists in reality.[10]

Thus, we compared the total factor productivity levels in 1990 between two groups of plants, using regressions as in (1). The first group consists of plants that first began exporting in 1994 and continuously exported thereafter. The second group consists of plants that never exported throughout the 1990-1998 period. <Table 6> shows that future exporters had a TFP advantage over those plants that never exported, regardless to the inclusion of industry, region, and size control variables. However, the ex-ante TFP advantage of future exporters was not a very robust result. The statistical significance and, in some cases, even the sign of TFP premium were sensitive to the year of export market

[9] The exception is growth rate of non-production worker wage in the earlier period.
[10] At the same time, there are plants that switch exporting status more than twice since 1994. Without further analysis, it is hard to predict the effect of the presence of these plants in the sample.

entry and to the length of time before entry into export market. Nevertheless, there was a tendency for the estimated ex-ante exporter TFP premium to become significantly positive as the length of pre-export time period becomes shorter.[11] This suggests that ex-ante exporter TFP premium develops close to the time of export market entry.[12]

// Table 6 here//

4. Does Exporting improve performance?: Learning

The empirical evidence presented in the previous section suggests that strong cross-sectional correlations between exporting and various performance measures are at least partly results of better performance of exporters even before they start to export. In this section, we examine whether exporting improves performance over various time horizons. The performance measure we are most interested in is the total factor productivity, since, if there exist knowledge or technology spillovers associated with exporting activity, they will show up primarily in total factor productivity. Also, whether there are extra TFP gains from exporting has been at the center of the debate on the benefits of exporting. As additional performance measures, we consider shipments and employment. The reason is that if there are benefits of exporting in the form of improved resource allocation, then they are likely to be captured, to a large extent, by analyzing these two variables.

As a preliminary check, we examine the relationship between exporting status of plants at a point in time and subsequent performance, which is a frequently employed

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[11] However, non of the estimated ex-ante exporter premium was significant when industry, region, and plant size are all controlled. The detailed results of the robustness test are available from the author upon request.

[12] In the pooled regression to be discussed in the next section, we show additional evidence supporting this claim.

methodology in the literature. Next, we will perform an additional analysis which takes advantage of annual data set to follow the exporting history of the plants more closely.[13] Then, with the results from both methodologies at hand, we will attempt to answer whether there are "learning" effects associated with exporting.

To see whether current exporters perform better subsequently than non-exporters, we ran following regressions.

$$\Delta \ln Y_{iT} = \alpha + \beta EXPORT_{i0} + \gamma\, INDUSTRY_i + \delta\, REGION_i + \lambda \ln SIZE_{i0} + \varepsilon_{iT} \qquad (3)$$

where $\Delta \ln Y_{iT}$ is the average annual growth rate of various performance measures of plants for a time interval of length T. We vary the length of time interval to examine short-run, medium-run, and long-run performance of current exporters relative to non-exporters. The short-run performance is estimated from the pooled time-series and cross-sectional data with T equal to one. Medium- or long-run performance of exporters are estimated from the cross-sectional data.

<Table 7> reports total factor productivity growth rates of exporters relative to non-exporters, which are the coefficients on export dummy variable in regression (3), over various time horizons. In the short-run, without any control variables, the total factor productivity growth rates of exporters are significantly higher than non-exporters during the 1990-1998 period. However, when industry, region, and size of plants are controlled for, the coefficient on export dummy variable becomes negative although insignificant. In the medium-run, the results are mixed. In the earlier period, the coefficient on export dummy turned from positive to negative, although insignificant, with inclusion of control

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13 The methodologies employed in the subsequent analysis follow closely Bernard and Jensen (1999a, 1999b).

variables. Meanwhile, in the later period, it was significantly positive regardless to the inclusion of control variables. However, the bottom panel of Table 7 suggests that the significantly positive export dummy variable in the later period might have been heavily influenced by the export boom during the 1997-1998 period. In the long-run, the export dummy variable lost significance with inclusion of control variables.

// Table 7 here//

In <Table 8>, we report growth rates of shipments of exporters relative to non-exporters. When controlling variables are not included in the regressions, the shipment growth rates of exporters are estimated to be significantly lower than non-exporters over various time horizons. When industry, region, and size of plants are controlled, however, the coefficients were reduced substantially in absolute magnitude or became insignificant. In the case of employment growth rates of exporters relative to non-exporters, which is reported in <Table 9>, the coefficients on past export dummy variables are negative over various time horizons. However, when industry, region, and size of plants are controlled,they all became significantly positive.

// Table 8 here//

// Table 9 here//

Overall, we could not find any clear evidence of TFP improvement from exporting. Benefits of exporting are confined to the faster employment growth. Subsequent growth rates of shipments of current exporters are no faster than non-exporters. These results are very similar to what Bernard and Jensen (1999a) found for the U.S. As mentioned before, however, we postpone drawing out any strong conclusion on the benefits of exporting from the above results until further analysis are carried out below with more careful attention to the exporting history of plants.

Now, with exporting history of plants available at annual frequency during our sample period, we can perform more focused analysis. In the analysis above, we classified plants in a certain year into exporters and non-exporters. However, the exporting history of plants may be diverse. For example, the plants that are classified as exporters in a given year may or may not have been exporters before or after that year. The same is true for those plants classified as non-exporters in a given year. Also, there might be plants which switch exporting status more than twice during our sample period.

Thus, we classify plants into the following five categories taking entire exporting history during our sample period into account, as in Bernard and Jensen (1999b). There are plants that exported during the entire sample period, which is grouped as “always”. Similarly, the “never” group consists of plants that never exported. The “starter” is a group of plants that become exporters during the sample period and stay in the export market. Those that drop out of the export market and do not re-enter are grouped as “stopper”. The “other” plants are those that switched exporting status more than twice during the sample period.[14]

Then, we examined five-year window centered around the switching years for starter and stopper, in comparison with always, never, and other. The regressions are of the following form.

[14] Before grouping plants, we selected only those plants, which operated either in export market or in domestic market during the sample period. Thus, plants that ceased operation entirely or began operation during our sample period, for example, are excluded from the analysis below. This procedure, however, enables us to focus on the transition between domestic and export market.

$$\ln Y_{it} = \Sigma_{g\in G}\, \Sigma_{k\in K}\, \beta_{gk}\, D_{gi}\, D_{ki} + \gamma\, \text{INDUSTRY}_i + \delta\, \text{REGION}_i + \theta\, \text{YEAR}_t + \varepsilon_{it} \qquad (4)$$

where $\ln Y_{it}$ logs of various performance measures, G is the set of five plant groups defined as above, and K is the set of locations in the five-year window so that K = {-2, -1, 0, 1, 2}. D_g and D_k are dummy variables denoting plant group and location in the five-year window, respectively. Thus, the coefficient β_{gk} denotes the mean values of each plant group g at each location k, controlling for industry, region, and year effects. <Figure 2> shows movements of the total factor productivity level of five plant groups, expressed as the difference from the never(-2) and <Table 10> shows corresponding coefficients and standard errors.

// Figure 2 here//

// Table 10 here//

Figure 2 shows that there exists some learning effect associated with exporting. Plants that start exporting widen TFP gap with those that never exported and close the gap with those that always exported, after entering exporting market. However, the learning effect is very short-lived and pronounced immediately after entry into the export market. If the learning effect from exporting is long-lived, then we can expect the following. First, the productivity gap between never and always will widen over time. Second, starter will not close the TFP gap with always, since the "always" group will enjoy first-mover advantage over the starter in improving TFP level. However, neither of these phenomenon is observed in the figure.[15] Also, a large part of the TFP gap between starter group and always group disappears two years after they start exporting. In short, we find some

[15] Starters begin to improve relative TFP level even before they start exporting. However, as Bernard and Jensen (1999a) discuss, it is not easy to explain this phenomenon in a theoretically

evidence in favor of learning-by-exporting hypothesis in the Korean manufacturing sector although the learning effect is rather short-lived.

Figure 2 also confirms the existence of self-selection in entry into and exit from the export market. Plants that start exporting have somewhat higher TFP levels compared to those that never export several years before they enter the export market. Table 10 shows that the TFP gap between those two groups are statistically significant one year before starting to export. Also, those plants that drop out of the export market exhibit persistently lower and deteriorating TFP compared with "always" during the pre-exit period.

In order to see whether the benefits of exporting are realized in channels other than TFP improvement, we ran regression (4) with logs of shipments and employment as dependent variables, respectively. The results are reported in <Figure 3> and <Figure4>. Again, the estimated coefficients and their standard errors are shown in <Table 11> and <Table 12>. Similar to the case of TFP, plants that start exporting increase both shipments and employment at around the time of entering the export market, relative to those plants that always export or never export. Also, the gaps in levels of shipments and employment between "always" and "never" are fairly stable over time in percentage terms, suggesting that the increase in shipments and employment by exporting does not last forever. When compared with relative TFP movements in Figure 2, one noticeable feature in Figure 3 and Figure 4 is that the magnitudes of changes in shipments and employment of starters relative to always and never are not very large during the five-year window. That is, exporting-related adjustments in shipments and employment may take much longer time,

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compelling way.

compared with TFP levels. While the reasons for slower adjustment of shipments and employment are not clearly understood, this may suggest that it takes long time for the gains in allocation efficiency from exporting to be materialized. The TFP-based selection and learning effects and similar effects based on shipments and employment, as shown in Figure 2 to Figure 3 and Table 10 to Table 12, was robust to the exclusion of the crisis period of 1997 to 1998 when exports growth increased significantly with exchange rate depreciation.[16]

// Figure 3 and 4 here//

// Table 11 and 12 here//

5. Summary and Concluding Remarks

This study examines the relationship between exporting and various performance measures including total factor productivity, using the annual plant-level panel data on the Korean manufacturing sector during the period of 1990 to 1998. The two key questions examined are whether exporting improves productivity (learning) and/or whether more productive plants export (self-selection). This study provides evidence supporting both self-selection and learning-by-exporting effects, with both effects being more pronounced at around the time of entry into and exit from the export market. Thus, positive and robust cross-sectional correlation between exporting and total factor productivity is accounted for by both selection and learning effects. These results are in contrast with Aw, Chung, and Roberts (2000) who do not find any strong evidence of self-selection or learning in Korea.

[16] It is possible that the export boom during the crisis period baised the results towards finding learning effects, if it caused disproportionate output expansion of new exporters.

Similar effects are observed when shipments or employment is considered as a performance measure. Overall, this study suggests that the benefits from exporting have been realized not only through resource reallocation channel but also TFP channel in Korea.

Although the different conclusion between this study and Aw, Chung, and Roberts (2000) might well be due to the different time period covered in the analysis, it may also arise from the different data set employed. Annual panel data employed in this study allows us to follow more closely the exporting history of plants and to observe important changes that occur at around the time of entry into and exit from the export market. However, further study is required to shed more light on this issue.

If foreign market provides opportunities to improve aggregate total factor productivity both through intra-plant TFP channel but also through resource reallocation channel, as suggested by this study, then openness by itself may not be sufficient to exploit full potential benefits that openness provides. That is, greater openness accompanied by policies improving resource reallocation will be more effective than policies enhancing openness alone in order to exploit the potential benefits of openness.

Finally, it might be too hasty to jump to the conclusion, based on the short-lived nature of learning effect, that export market does not play a significant role in "sustained" increase in aggregate productivity. Suppose there are continual entry and exit of producers in and out of the export market, which is documented in many other studies, and that each new generation of successful entrants experience learning. Then, although the learning-by-exporting opportunity may be short-lived from the viewpoint of individual producers, from the viewpoint of the economy as a whole, exporting may provide an opportunity for continuous improvement of aggregate TFP.

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Appendix: Measurement of Plant Total Factor Productivity

Plant total factor productivity is estimated using the chained-multilateral index number approach as developed in Good (1985) and Good, Nadiri, and Sickles (1997). It uses a separate reference point for each cross-section of observations and then chain-links the reference points together over time. The reference point for a given time period is constructed as a hypothetical firm with input shares that equal the arithmetic mean input shares and input levels that equal the geometric mean of the inputs over all cross-section observations. Thus, the output, inputs, and productivity level of each firm in each year is measured relative to the hypothetical firm at the base time period. This approach allows us to make transitive comparisons of productivity levels among observations in a panel data set.[17]

Specifically, the productivity index for firm i at time t in our study is measured in the following way.

$$\ln TFP_{it} = (\ln Y_{it} - \overline{\ln Y_t}) + \sum_{\tau=2}^{t}(\overline{\ln Y_\tau} - \overline{\ln Y_{\tau-1}}) - \left\{ \sum_{n=1}^{N}\frac{1}{2}(S_{nit} + \overline{S_{nt}})(\ln X_{nit} - \overline{\ln X_{nt}}) + \sum_{\tau=2}^{t}\sum_{n=1}^{N}\frac{1}{2}(\overline{S_{n\tau}} + \overline{S_{n\tau-1}})(\overline{\ln X_{n\tau}} - \overline{\ln X_{n\tau-1}}) \right\},$$

where Y, X, S, and TFP denote output, input, input share, TFP level, respectively, and symbols with upper bar are corresponding measures for hypothetical firms. The subscripts τ and n are indices for time and inputs, respectively. In our study,

[17] Good, Nadiri, and Sickles (1996) summarize the usefulness of chaining multilateral productivity indices succinctly. While the chaining approach of Tornqvist-Theil index, the discrete Divisia, is useful in time series applications, where input shares might change over time, it has severe limitations in cross-section or panel data where there is no obvious way of sequencing the observations. To the contrary, the hypothetical firm approach allows us to make transitive comparisons among cross-section data, while it has an undesirable property of sample dependency. The desirable properties of both chaining approach and the hypothetical firm approach can be incorporated into a single index by chained-multilateral index number approach.

the year 1990 is the base time period.

As a measure of output, we used the gross output (production) of each plant in the Survey deflated by the producer price index at disaggregated level. As a measure of capital stock, we used the average of the beginning and end of the year book value capital stock in the Survey deflated by the capital goods deflator. As a measure of labor input, we used the number of workers, which includes paid employees (production and non-production workers), working proprietors and unpaid family workers. Here, we allowed for the quality differential between production workers and all the other types of workers. The labor quality index of the latter was calculated as the ratio of non-production workers' and production workers' average wage of each plant, averaged again over the entire plants in a year. As a measure of intermediate input, we used the "major production cost" plus "other production cost" in the Survey. Major production cost covers costs arising from materials and parts, fuel, electricity, water, manufactured goods outsourced and maintenance. Other production cost covers outsourced services, such as advertising, transportation, communication and insurance. The estimated intermediate input was deflated by the intermediate input price index.

We assumed constant returns to scale so that the sum of factor elasticity equals to one. Labor and intermediate input elasticity for each plant are measured as average cost shares within the same plant-size class in the five-digit industry in a given year. Thus, factor elasticity of plants are allowed to vary across industries and size classes and over time. Here, plants are grouped into three size classes according to the number of employees: 5-50, 51-300, and over 300.

Table 1. Number of Exporters and Export Intensity

year	total number of plants	non-exporters	exporters	exports/shipments ratio (percent)		export growth* (percent)
				unweighted	weighted	
1990	68,690 (100)	58,392 (85.0)	10,298 (15.0)	54.8	37.3	9.4
1991	72,213 (100)	61,189 (84.7)	11,024 (15.3)	54.3	37.3	13.9
1992	74,679 (100)	63,241 (84.7)	11,438 (15.3)	51.7	36.3	14.7
1993	88,864 (100)	77,514 (87.2)	11,350 (12.8)	49.9	36.0	12.5
1994	91,372 (100)	80,319 (87.9)	11,053 (12.1)	47.2	35.9	17.7
1995	96,202 (100)	85,138 (88.5)	11,064 (11.5)	44.8	37.2	26.7
1996	97,141 (100)	86,502 (89.0)	10,639 (11.0)	43.6	35.3	8.3
1997	92,138 (100)	80,963 (87.9)	11,175 (12.1)	44.2	38.0	27.5
1998	79,544 (100)	67,767 (85.2)	11,777 (14.8)	44.7	48.7	40.4

Note: Exports data in the final column are values in current won from Bank of Korea.

Numbers in the parentheses are t-statistics.

Table 2. Performance Characteristics of Exporters vs Non-exporters

	1990		1994		1998	
	exporters	non-exporters	exporters	non-exporters	exporters	non-exporters
employment (person)	153.6	24.5	119.4	20.0	95.1	17.8
shipments (million won)	11,505.5	957.0	17,637.1	1,260.3	25,896.8	1,773.8
production per worker (million won)	50.5	26.8	92.4	47.0	155.0	74.2
value-added per worker (million won)	16.5	11.3	31.0	20.4	51.3	29.6
TFP	0.005	-0.046	0.183	0.138	0.329	0.209
capital per worker (million won)	16.8	11.9	36.0	21.9	64.6	36.7
non-production worker/ total employment (percent)	24.9	17.1	27.5	17.5	29.6	19.2
average wage (million won)	5.7	5.1	10.3	9.2	13.7	11.5
average production wage (million won)	5.5	5.1	10.0	9.2	13.1	11.4
average non-production wage (million won)	6.8	5.3	11.6	9.4	15.6	12.4
R&D/shipments (percent)	-	-	1.2	0.6	1.4	0.6

Table 3. Exporter Premia

(unit : %)

	estimated exporter premia		
	no control	industry and region controlled	industry, region, and size controlled
1990			
employment (person)	123.4	117.2	
shipments (million won)	186.4	186.6	47.9
production per worker (million won)	64.0	70.2	48.3
value-added per worker (million won)	30.2	35.1	21.7
TFP	5.1	5.9	2.5
capital per worker (million won)	32.0	39.3	31.3
non-production worker/ total employment (percent)	15.6	26.6	24.8
average wage (million won)	11.8	16.3	8.1
average production wage (million won)	7.1	12.3	6.7
average non-production wage (million won)	25.7	27.0	8.4
1994			
employment (person)	112.9	108.6	
shipments (million won)	179.3	175.4	47.4
production per worker (million won)	67.0	67.3	47.6
value-added per worker (million won)	33.9	34.3	23.5
TFP	4.5	4.5	3.8
capital per worker (million won)	55.1	51.4	34.5
non-production worker/ total employment (percent)	17.8	24.2	22.5
average wage (million won)	12.5	15.0	9.7
average production wage (million won)	8.6	11.7	8.4
average non-production wage (million won)	22.6	23.0	8.8
R&D/shipments (percent)	-54.7	-54.9	-6.4
1998			
employment (person)	102.2	93.6	
shipments (million won)	181.3	166.3	54.4
production per worker (million won)	79.3	72.9	54.7
value-added per worker (million won)	48.4	43.9	32.5
TFP	12.0	10.2	7.5
capital per worker (million won)	57.3	46.6	32.9
non-production worker/ total employment (percent)	15.6	22.1	24.4
average wage (million won)	19.1	17.9	12.5
average production wage (million won)	14.8	14.1	10.5
average non-production wage (million won)	25.5	23.6	12.0
R&D/shipments (percent)	-48.2	-45.6	-7.4

Note : * All coefficients are significant at 1 percent level.

Table 4. Ex-ante Export Premia for Future Exporters : 1990-1994, 1995-1998

(unit : %)

	ex-ante export premia		
	no control	industry and region controlled	industry, region, and size controlled
1990			
employment (person)	52.9 (16.2)	47.9 (16.2)	
shipments (million won)	78.0 (15.4)	71.5 (16.2)	15.8 (5.7)
production per worker (million won)	25.7 (7.6)	24.1 (8.7)	16.4 (6.0)
value-added per worker (million won)	17.3 (6.6)	15.8 (6.6)	11.1 (4.6)
TFP	1.6 (1.1)	2.4 (1.8)	0.6 (0.5)
capital per worker (million won)	16.5 (3.2)	15.2 (3.4)	14.6 (3.2)
non-production worker/ total employment (percent)	14.6 (5.1)	15.6 (6.2)	13.5 (5.3)
average wage (million won)	5.4 (3.1)	4.1 (2.6)	1.3 (0.8)
average production wage (million won)	3.2 (1.8)	2.5 (1.5)	1.0 (0.6)
average non-production wage (million won)	11.1 (5.5)	9.5 (4.8)	0.5 (0.3)
1995			
employment (person)	43.3 (19.9)	43.0 (21.4)	
shipments (million won)	72.2 (20.9)	69.2 (22.7)	18.4 (9.6)
production per worker (million won)	30.0 (13.0)	27.2 (14.2)	19.5 (10.3)
value-added per worker (million won)	16.4 (9.2)	13.9 (8.6)	9.8 (6.1)
TFP	0.9 (0.9)	-0.0 (-0.0)	-0.9 (-0.9)
capital per worker (million won)	33.8 (9.1)	29.9 (9.5)	25.3 (8.0)
non-production worker/ total employment (percent)	13.7 (7.0)	16.9 (9.8)	15.9 (9.1)
average wage (million won)	3.7 (3.1)	3.3 (3.1)	1.0 (0.9)
average non-production wage (million won)	2.2 (1.7)	2.1 (1.9)	0.8 (0.7)
average production wage (million won)	7.5 (5.5)	6.5 (4.8)	0.0 (0.0)
R&D/shipments (percent)	-25.5 (-2.1)	-25.0 (-1.9)	0.8 (0.1)

Note : * Numbers in the parentheses are t-statistics.

Table 5. Ex-ante Growth Rate Premia of Future Exporters : 1990-1994, 1995-1998

(unit : %)

	estimated ex-anti growth rate premia		
	no control	industry and region controlled	industry, region, and size controlled
1990 – 1993 growth rates			
employment (person)	2.8 (4.8)	2.6 (4.5)	5.1 (8.9)
shipments (million won)	3.6 (3.6)	3.8 (3.8)	6.0 (6.1)
production per worker (million won)	1.0 (1.1)	1.3 (1.5)	1.1 (1.3)
value-added per worker (million won)	-1.0 (-1.1)	-0.6 (-0.7)	-0.5 (-0.6)
TFP	0.2 (0.3)	-0.0 (-0.1)	0.3 (0.5)
capital per worker (million won)	1.5 (1.0)	0.5 (0.3)	-1.8 (-1.2)
non-production worker/ total employment (percent)	-0.1 (-0.1)	0.1 (0.2)	-0.5 (-0.5)
average wage (million won)	0.3 (0.6)	0.4 (0.7)	0.5 (0.9)
average production wage (million won)	-0.1 (-0.1)	-0.1 (-0.1)	-0.0 (-0.0)
average non-production wage (million won)	1.1 (1.4)	1.2 (1.6)	1.6 (2.1)
1995-1997 growth rates			
employment (person)	3.6 (6.6)	3.2 (5.9)	6.2 (11.7)
shipments (million won)	5.9 (6.4)	5.7 (6.0)	8.3 (8.8)
production per worker (million won)	2.1 (2.5)	2.2 (2.6)	1.8 (2.2)
value-added per worker (million won)	1.6 (1.9)	1.7 (2.0)	1.2 (1.3)
TFP	1.5 (2.9)	0.9 (1.9)	0.8 (1.5)
capital per worker (million won)	-0.2 (-0.2)	-0.1 (-0.1)	-2.1 (-1.7)
non-production worker/ total employment (percent)	0.2 (0.3)	0.2 (0.3)	-0.1 (-0.1)
average wage (million won)	1.5 (2.6)	1.3 (2.2)	1.1 (1.8)
average non-production wage (million won)	1.4 (2.2)	1.1 (1.8)	0.9 (1.5)
average production wage (million won)	0.9 (1.2)	0.8 (1.0)	1.0 (1.3)
R&D/shipments (percent)	-3.6 (-0.4)	-3.3 (-0.3)	-8.8 (-0.8)

Note : * Numbers in the parentheses are t-statistics.

Table 6. Ex-ante TFP Advantage of Future Exporters:

(unit : %)

	ex-ante TFP premium		
	no control	industry and region controlled	industry, region, and size controlled
TFP in 1990 (log)	12.7	14.0	10.2
	(2.95)	(3.39)	(2.47)

Note : TFP premium in 1990 of those plants that started exporting in 1994 and continuously exported there after, over those who never exported during the sample period. Numbers in parentheses are t- statistics. All coefficients are significant at 1% level.

Table 7. TFP Growth Rate Premium of Current Exporters over Various Time Horizons

	subsequent annual TFP growth rate premium	
	no control	industry, region, and size controlled
short-run		
1990-1998	4.4 (7.2)	-0.9 (-1.3)
medium-run		
1990-1994	1.9 (2.3)	-0.6 (-0.6)
1994-1998	5.0 (8.2)	2.1 (2.9)
long-run		
1990-1998	3.2 (5.8)	0.9 (1.3)

Note : Short-Run premium is estimated from the pooled time-series cross-section data. Medium and Long-run Premia are estimated from cross-section data. Numbers in parentheses are t-statistics.

Table 8. Shipments Growth Rate Premium of Current Exporters over Various Time Horizons

	subsequent annual shipments growth rate premium	
	no control	industry, region, and size controlled
short-run		
1990-1998	-7.4 (-30.7)	-3.5 (-12.7)
medium-run		
1990-1994	-5.7 (-20.0)	-2.2 (-6.4)
1994-1998	-2.0 (-6.6)	0.3 (0.9)
long-run		
1990-1998	-2.7 (-11.7)	-0.1 (-0.5)

Note : Short-Run premium is estimated from the pooled time-series cross-section data. Medium and Long-run Premia are estimated from cross-section data. Numbers in parentheses are t-statistics.

Table 9. Employment Growth Rate Premium of Current Exporters over Various Time Horizons

	subsequent annual employment growth rate premium	
	no control	industry, region, and size controlled
short-run		
1990-1998	-3.0 (-22.6)	5.1 (33.9)
medium-run		
1990-1994	-2.7 (-15.5)	1.7 (8.5)
1994-1998	-2.4 (-12.7)	2.2 (10.7)
long-run		
1990-1998	-2.2 (-15.0)	1.3 (7.5)

Note : Short-Run premium is estimated from the pooled time-series cross-section data. Medium and Long-run Premia are estimated from cross-section data. Numbers in parentheses are t-statistics.

Table 10. Relative TFP Levels Before and After Exporting (or Stopping Exporting)

plant location	plant group				
	never	stopper	starter	always	other
-2	0.0 (0.0)	2.8 (1.5)	2.1 (1.2)	7.8** (8.4)	3.0** (5.2)
-1	0.4 (0.2)	1.2 (0.8)	3.6* (2.2)	8.5** (4.1)	3.2 (1.7)
0	0.6 (0.3)	0.9 (0.5)	5.4** (2.9)	10.4** (5.1)	4.1* (2.1)
1	2.5 (1.4)	0.6 (0.3)	7.5** (3.9)	11.0** (5.5)	5.8** (3.1)
2	-0.3 (-0.2)	-0.3 (-0.1)	8.2** (4.0)	9.3** (4.6)	4.1* (2.2)

Note : * (**)indicates that the coefficient is significantly different from Never(-2) at 5%(1%) level.

Table 11. Relative Shipments Levels Before and After Exporting (or Stopping Exporting)

plant location	plant group				
	never	stopper	starter	always	other
-2	0.0 (0.0)	150.6** (20.9)	91.4** (13.5)	277.6** (77.7)	123.6** (54.7)
-1	-7.0 (-0.9)	124.5** (20.1)	112.0** (17.7)	265.8** (32.7)	116.9** (15.3)
0	-8.1 (-1.1)	100.6** (13.5)	130.8** (18.3)	264.1** (33.0)	116.3** (15.5)
1	-1.0 (-0.1)	79.8** (10.3)	158.0** (20.9)	265.5** (33.9)	122.7** (16.7)
2	-5.8 (-0.8)	79.3** (10.0)	166.4** (21.0)	262.9** (33.1)	119.5** (16.1)

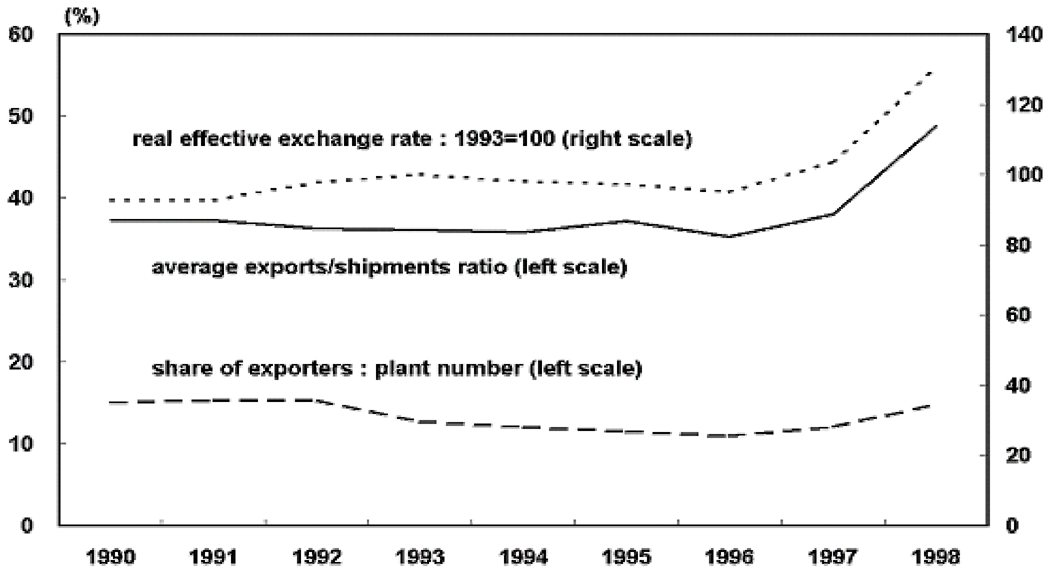
Note : *(**) indicates that the coefficient is significantly different from Never(-2) at 5%(1%) level.

Table 12. Relative Employment Levels Before and After Exporting (or Stopping Exporting)

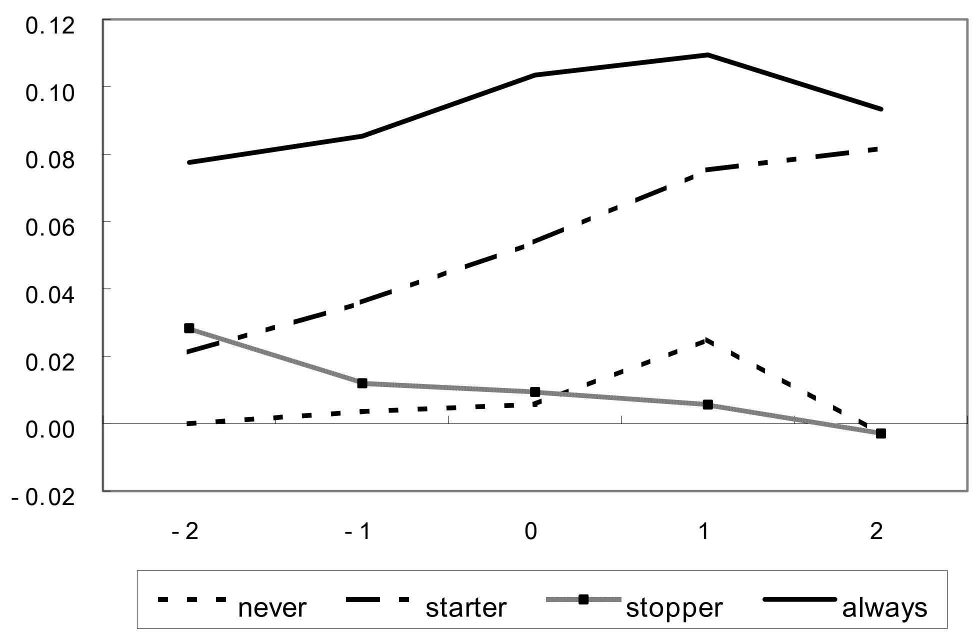
plant location	plant group				
	never	stopper	starter	always	other
-2	0.0 (0.0)	103.7** (19.7)	60.4** (12.2)	195.2** (74.8)	82.5** (50.0)
-1	-6.9 (-1.3)	84.4** (18.7)	74.3** (16.1)	188.3** (31.8)	76.0** (13.6)
0	-5.6 (-1.0)	71.6** (13.2)	85.7** (16.4)	187.4** (32.1)	78.1** (14.3)
1	-4.0 (-0.8)	57.6** (10.2)	101.9** (18.5)	187.3** (32.7)	80.0** (14.9)
2	-6.4 (-1.2)	57.9** (10.0)	106.7** (18.4)	185.8** (32.1)	78.1** (14.4)

Note : *(**) indicates that the coefficient is significantly different from Never(-2) at 5%(1%) level.

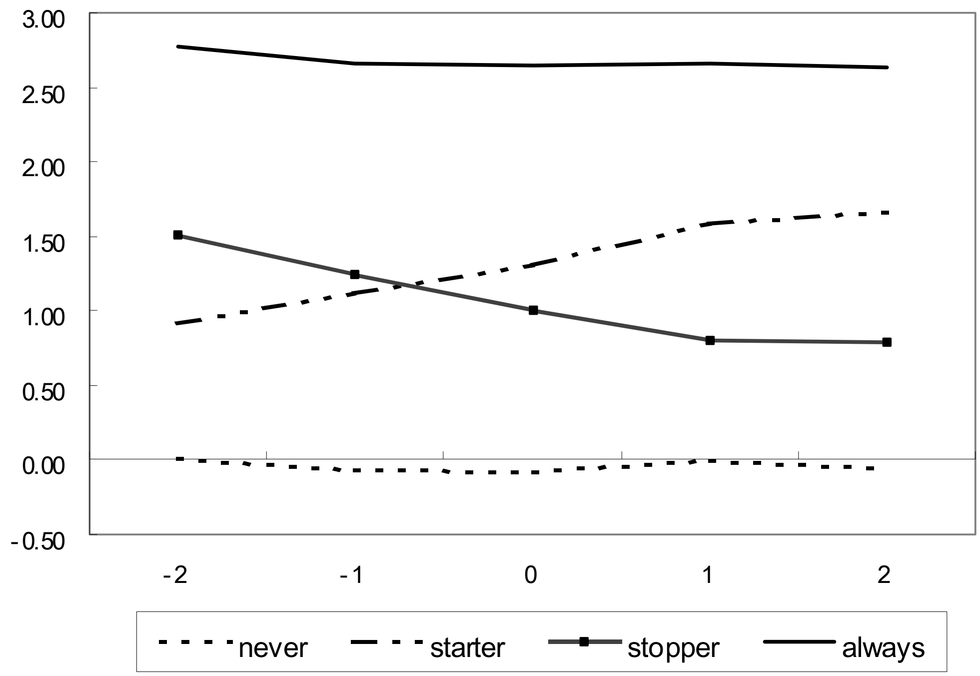
<Figure 1> Movements of Share of Exporters and Export Intensity



<Figure 2> Relative Levels of TFP by Plant Group : Before and After



<Figure 3> Relative Levels of Shipments by Plant Group : Before and After



<Figure 4> Relative Levels of employment by Plant Group : Before and After