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Exporting and Performance of Plants
Evidence from Korean Manufacturing

Chin Hee Hahn

2.1 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 the international trading regime, that is, outward-oriented trade strategy of the former versus import substitution development strategy of the latter. Even in recent years, many developing countries, including Korea, promote exports 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 plant-level panel data on the Korean manufacturing sector dur-

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ing 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 nonexporters 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 markets only.[1] While these studies provided an important stepping stone toward understanding the exporting-performance nexus, they do not by themselves suggest that exporting activities bring medium- to long-run technological and other benefits over and above the static gains from trade. That is, exporters might be better than nonexporters before they start 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 the 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 costs 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 a distribution network. With these costs present, only productive producers can expect to recoup entry costs after entering the foreign market.[2] An alternative explanation 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 referred to as "learning effect." If these mechanisms are at work, then the

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 costs is not an essential feature to explain self-selection. See Clerides, Lach, and Tybout (1998).

3. 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.

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 nonexporters before they start exporting, suggesting that the cross-sectional correlation between exporting and productivity partly reflects a self-selection effect. For example, Clerides, Lach, and Tybout (1998) find some evidence in favor of selection effect using 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 and Bernard and Jensen (1999b) for the United States. However, evidence in favor of learning effect is scarce. 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 gains are very short-lived.

Similar study exists for Korea. Aw, Chung, and Roberts (2000) report that they could not find any strong evidence that supports the learning-by-doing hypothesis or the self-selection hypothesis using plant-level data on the Korean manufacturing sector for three years spread over a five-year interval: 1983, 1988, and 1993. Their evidence on Korea differs 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 to export is eventually guided, plant productivity may not be a good indicator of plant profitability due to heterogeneity across producers on the demand side of the market, particularly in the case of Korea. 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 the 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 nonexporters and that those differences are large and statistically significant. Then, the su-

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 the 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 the theoretically implied direction of change in efficiency critically depends upon model specifics.

perior productivity of exporters to those of nonexporters 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. Using the annual data has an advantage in that dynamic aspects of the exporting-productivity relationship can be more closely examined. In particular, the availability of an export variable at annual frequency allows us to pay more careful attention to the exporting history of a plant in the analysis. We follow two methodologies employed by Bernard and Jensen (1999a) and Bernard and Jensen (1999b). Both studies use a dummy variable regression approach and compare performance measures of plant groups before and after export-market entry. We prefer, however, the methodology used in the latter study, as it better utilizes available information on the exporting history of plants in grouping plants.[5] Nevertheless, we report empirical results by both methodologies.

This study sheds light on several 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 the 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 fully utilize the opportunity that openness provides, then the channels through which openness enhances aggregate productivity and output should be more clearly understood. For example, if openness enhances aggregate productivity not only through intrafirm technological learning but also through cross-firm and cross-industry resource reallocation, then openness per se might not be a 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 some empirical evidence that is necessary to evaluate and guide various measures to promote export. For example, if export-market entry mostly reflects a self-selection process—that is, good firms become exporters—then policies that intervene in the process are likely to bring about less-desirable outcomes than policies that do not in-

5. Details of the methodologies will be described in the following.

tervene. With regard to the learning effect, if there are no postentry rewards from exporting, then policies designed to increase the number of exporters become footloose 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 plant total factor productivity. In section 2.3 and section 2.4, we examine the existence of selection and learning effects using two different methodologies. In section 2.3, we report empirical results based on methodologies by Bernard and Jensen (1999a). In section 2.4, we follow methodologies by Bernard and Jensen (1999b), which allows us to utilize the advantages provided by the annual data set and to pay particular attention to the exporting history of plants. Section 2.5 summarizes the results and concludes.

2.2 Basic Statistics and Exporter Performance

2.2.1 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 the KSIC (Korean Standard Industrial Classification) five-digit level. It is unbalanced panel data with about 69,000 to 97,000 plants for each year during the 1990–1998 period.[6] For each year, plant-level exports as well as other variables on production structures are available. Exports in this data set include direct exports and shipments to other exporters and wholesalers but do not include shipments for further processing. Following the convention in the literature, we define exporters in a given year as plants that reported a positive amount of exports. Accordingly, nonexporters in a given year are those plants with zero exports.[7]

6. Unfortunately, the plant-level data is not publicly available. The 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 the Korea Statistical Office for allowing us to use the data set. Although the surveys exist after 1998, these could not be used due to incomplete information on the plant identity variable.

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

2.2.2 Exporters and Export Intensity

Table 2.1 shows the number of exporting plants and average exports as a 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 has since declined steadily 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 nonexporting plants, rather than an increase in the number of exporting plants. The increase in the number of exporters since 1997 was only modest. These changes are broadly consistent with the huge depreciation of the Korean won and the severe contraction in domestic demand associated with the crisis.

Consistent with the high export dependency of the economy, the share of exports in shipments at the plant level is quite high in Korea. During the sample period, the unweighted average export ratio (exports-shipments) is between 43.6 and 54.8. The average export ratio steadily declines from 1990 to 1996 but rises with the onset of the crisis. The average export ratio

Table 2.1 Number of exporters and export intensity

Year	Total number of plants	Nonexporters	Exporters	Exports/shipments ratio (%)		Export growth (%)
				Unweighted	Weighted	
1990	69,690	58,392	10,298	54.8	37.3	9.4
	(100)	(85.0)	(15.0)			
1991	72,213	61,189	11,024	54.3	37.3	13.9
	(100)	(84.7)	(15.3)			
1992	74,679	63,241	11,438	51.7	36.3	14.7
	(100)	(84.7)	(15.3)			
1993	88,864	77,514	11,350	49.9	36.0	12.5
	(100)	(87.2)	(12.8)			
1994	91,372	80,319	11,053	47.2	35.9	17.7
	(100)	(87.9)	(12.1)			
1995	96,202	85,138	11,064	44.8	37.2	26.7
	(100)	(88.5)	(11.5)			
1996	97,141	86,502	10,639	43.6	35.3	8.3
	(100)	(89.0)	(11.0)			
1997	92,138	80,963	11,175	44.2	38.0	27.5
	(100)	(87.9)	(12.1)			
1998	79,544	67,767	11,777	44.7	48.7	40.4
	(100)	(85.2)	(14.8)			

Notes: Export data in the final column are in current won from the Bank of Korea. Numbers in parentheses are t-statistics.

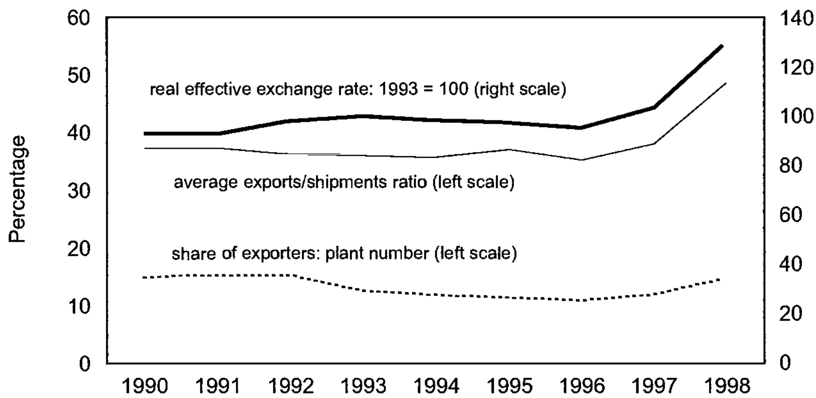

Fig. 2.1 Movements of share of exporters and export intensity

weighted by shipment is generally lower than the unweighted average export ratio, suggesting that smaller exporting plants have a higher export ratio.

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 a large depreciation in the won. Combined with the fact that new entries in the export market since 1997 were only modest, this suggests that the export boom during that period was mainly driven by the increase in export shipments of large firms who had been previously exporting. The fact that a huge favorable exchange rate shock triggered a large increase in exports of previous exporters and an only mild increase of new entries in the export market is consistent with the presence of sunk entry costs in the export market (see figure 2.1).

2.2.3 Performance of Exporters versus Nonexporters

It is a well-established fact that exporters are better than nonexporters by various 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 2.2 compares various plant attributes between exporters and nonexporters for three selected years. In terms of number of workers and shipments, exporters are, on average, much larger in size than nonexporters. The difference in shipments is more substantial than the difference in the number of workers. So the average labor productivity of exporters, measured by production and value added per worker, are higher than that of nonexporters. Compared with the value added per worker differential, the difference in production per worker between exporters and nonexporters is more pronounced. This might reflect the more intermediate-intensive production structure of exporters relative to nonexporters.[8]

8. I am indebted to James Harrigan for pointing out this feature of the data.

Table 2.2 Performance characteristics of exporters vs. nonexporters

	1990		1994		1998	
	Exporters	Nonexporters	Exporters	Nonexporters	Exporters	Nonexporters
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
Nonproduction worker/total employment (%)	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 nonproduction wage (million won)	6.8	5.3	11.6	9.4	15.6	12.4
R&D/shipments (%)			1.2	0.6	1.4	0.6

Although exporters have a higher capital-labor ratio and higher share of nonproduction workers in employment than nonexporters, these differences in inputs do not fully account for the differences in labor productivity. As a consequence, levels of total factor productivity (TFP) of exporting plants are, on average, higher than those plants producing for domestic markets only.[9] Some of the differences in the TFP levels may be attributed to the differences in research and development (R&D) intensity. Controlling for the size of shipments, exporters spent about twice as much on R&D as nonexporters. From the worker's point of view, exporters had more desirable attributes than nonexporters. The average wage of exporters is higher than that of nonexporters. Although the wage of both production and nonproduction workers are higher for exporters compared to nonexporters, the differential in the wage of nonproduction workers is more pronounced.

Table 2.3 shows the average percentage difference in various performance measures between exporters and nonexporters for three years, which is estimated from the following regressions:

$$\ln Y_i = \alpha + \beta \text{EXPORT}_i + \gamma \text{INDUSTRY}_i + \delta \text{REGION}_i + \lambda \ln \text{SIZE}_i + \varepsilon_i,$$

where EXPORT_i is a dummy variable for exporters, INDUSTRY_i and REGION_i are dummy variables for the five-digit KSIC industry and plant location, and SIZE_i denotes plant size measured by number of employees. The three columns in table 2.3 show the estimated coefficients of exporter dummy variable without any control variables, with controls of industry and region, and with additional control of plant size.

The regression confirms that exporters outperform nonexporters in terms of various performance characteristics for all years, even after controlling for industry, region, and plant size. Also, all coefficients on the export dummy variable are highly significant. Controlling industry and region has little effect on the magnitude of the export premium. However, controlling for 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 a higher capital-labor ratio and a higher share of nonproduction workers, they also have a higher TFP level. The TFP levels of exporters are, on average, 2.5 to 7.5 percent higher than nonexporters, with industry, region, and size controlled. Average wage is between 8 and

9. The TFP index is based on the multilateral chained index number approach. For details, see appendix.

Table 2.3 Exporter premia (%)

	Estimated exporter premia		
	No control	Industry and region controlled	Industry, region, and size controlled
1990			
Employment (person)	123.4	117.2	n.a.
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
Nonproduction worker/total employment (%)	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 nonproduction wage (million won)	25.7	27.0	8.4
1994			
Employment (person)	112.9	108.6	n.a.
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
Nonproduction worker/total employment (%)	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 nonproduction wage (million won)	22.6	23.0	8.8
R&D/shipments (%)	–54.7	–54.9	–6.4
1998			
Employment (person)	102.2	93.6	n.a.
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
Nonproduction worker/total employment (%)	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 nonproduction wage (million won)	25.5	23.6	12.0
R&D/shipments (%)	–48.2	–45.6	–7.4

Notes: n.a. = not applicable. All coefficients are significant at the 1 percent level.

13 percent higher for exporting plants compared to plants producing for domestic markets only.

The findings in the preceding cross-sectional analysis suggest that a significant TFP and other performance gaps do exist between exporters and nonexporters. 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.

2.3 Selection and Learning: Methodology by Bernard and Jensen (1999a)

In this section, we follow Bernard and Jensen (1999a) and examine whether good plants export and/or whether exporting improves performance. In order to examine the existence of self-selection effect, we compare various plant characteristics between exporters and nonexporters before exporting. As in Bernard and Jensen (1999a), we divide our sample into two distinct subperiods—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 nonexporters in the final year. For example, we compare various performance measures in 1990 for exporters and nonexporters in 1994.

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

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

$$(1) \qquad \ln Y_{i0} = \alpha + \beta \text{EXPORT}_{iT} + \gamma \text{INDUSTRY}_i + \delta \text{REGION}_i + \lambda \ln \text{SIZE}_{i0} + \varepsilon_i,$$

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 2.4 shows the estimated export premia expressed in percentages for 1990 and 1995.

Table 2.4 shows that exporters have on average more workers and larger shipments than nonexporters before exporting, regardless of the period examined. This result holds whether we control for industry, region, and plant size. Although inclusion of the plant-size variable reduces the size of the estimated exporter premia, they are still statistically significant. A 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 nonproduction workers. However, average wages of exporters are not significantly higher than those of nonexporters. Although wage

Table 2.4 **Ex ante export premia for future exporters: 1990–1994, 1995–1998 (%)**

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

Notes: n.a. = not applicable. Numbers in parentheses are *t*-statistics.

level measures of exporters are estimated to be higher than those of nonexporters without controlling for plant size, the coefficient on export dummy variable loses significance or becomes substantially smaller when the plant-size variable is included.

In table 2.4, ex ante TFP levels of exporters are estimated to be no higher than nonexporters, on average. The coefficient on the export dummy variable is not significantly different from zero in any of the regressions at the conventional significance level. In the regression with all control variables included for 1995–1998 period, the exporters' TFP premium is even negative although insignificant.[10]

In order to see whether future exporters experienced faster growth in various performance measures, we ran the following regressions:

$$(2)\qquad \Delta \ln Y_{iT-1} = \alpha + \beta \text{EXPORT}_{iT} + \gamma \text{INDUSTRY}_i + \delta \text{REGION}_i + \lambda \ln \text{SIZE}_{i0} + \varepsilon_i$$

where $\Delta \ln Y_{iT-1}$ is the annual average growth rate of performance measures, such as TFP, shipments, and employment, between year 0 and $T-1$. The estimated growth rate premia of exporters, which are the coefficients on the export dummy variable, are reported in table 2.5.

For both subperiods, the growth rates of employment and shipments were estimated to be higher for 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. We could not find any strong evidence suggesting that TFP growth rates are higher in plants that will export in the future. Although TFP growth rate premia were positive in the later period, it became insignificant when controlling for plant size.

Let us summarize the preceding results, which are based on methodologies by Bernard and Jensen (1999a). Overall, exporters already have many of the desirable characteristics before they start exporting. Compared with nonexporters, exporters are larger, more capital intensive, have higher labor productivity, and hire proportionately more nonproduction workers several years before they start exporting. Also, future exporters experience higher growth rates of employment and shipments than nonexporters before they start exporting. However, we could not find significant ex ante differences in levels and growth rates of TFP between future exporters and nonexporters.

Now we examine whether exporting improves performance over various

10. One interesting point to note here is that the TFP 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 nonexporters from the sample and entries of previously unproductive producers into the export market during the crisis period.

Table 2.5 **Ex ante growth rate premia of future exporters: 1990–1994, 1995–1998 (%)**

	Estimated ex ante growth rate premia		
	No control	Industry and region controlled	Industry, region, and size controlled
1990–1993 growth rates			
Employment (person)	2.8	2.6	5.1
	(4.8)	(4.5)	(8.9)
Shipments (million won)	3.6	3.8	6.0
	(3.6)	(3.8)	(6.1)
Production per worker (million won)	1.0	1.3	1.1
	(1.1)	(1.5)	(1.3)
Value added per worker (million won)	–1.0	–0.6	–0.5
	(–1.1)	(–0.7)	(–0.6)
TFP	0.2	–0.0	0.3
	(0.3)	(–0.1)	(0.5)
Capital per worker (million won)	1.5	0.5	–1.8
	(1.0)	(0.3)	(–1.2)
Nonproduction worker/total employment (%)	–0.1	0.1	–0.5
	(–0.1)	(0.2)	(–0.5)
Average wage (million won)	0.3	0.4	0.5
	(0.6)	(0.7)	(0.9)
Average production wage (million won)	–0.1	–0.1	–0.0
	(–0.1)	(–0.1)	(–0.0)
Average nonproduction wage (million won)	1.1	1.2	1.6
	(1.4)	(1.6)	(2.1)
1995–1997 growth rates			
Employment (person)	3.6	3.2	6.2
	(6.6)	(5.9)	(11.7)
Shipments (million won)	5.9	5.7	8.3
	(6.4)	(6.0)	(8.8)
Production per worker (million won)	2.1	2.2	1.8
	(2.5)	(2.6)	(2.2)
Value added per worker (million won)	1.6	1.7	1.2
	(1.9)	(2.0)	(1.3)
TFP	1.5	0.9	0.8
	(2.9)	(1.9)	(1.5)
Capital per worker (million won)	–0.2	–0.1	–2.1
	(–0.2)	(–0.1)	(–1.7)
Nonproduction worker/total employment (%)	0.2	0.2	–0.1
	(0.3)	(0.3)	(–0.1)
Average wage (million won)	1.5	1.3	1.1
	(2.6)	(2.2)	(1.8)
Average nonproduction wage (million won)	1.4	1.1	0.9
	(2.2)	(1.8)	(1.5)
Average production wage (million won)	0.9	0.8	1.0
	(1.2)	(1.0)	(1.3)
R&D/shipments (%)	–3.6	–3.3	–8.8
	(–0.4)	(–0.3)	(–0.8)

Note: See table 2.4 note.

Table 2.6 **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	–0.9
	(7.2)	(–1.3)
Medium-run		
1990–1994	1.9	–0.6
	(2.3)	(–0.6)
1994–1998	5.0	2.1
	(8.2)	(2.9)
Long-run		
1990–1998	3.2	0.9
	(5.8)	(1.3)

Notes: Short-run premium is estimated from the pooled time series cross-sectional data. Medium- and long-run premia are estimated from cross-sectional data. Numbers in parentheses are *t*-statistics.

time horizons, following the methodologies by Bernard and Jensen (1999a). The performance measure we are most interested in is the TFP, because, if knowledge or technology spillovers do exist associated with exporting activity, they will show up primarily in TFP. Also, the question of 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 changes in these two variables.[11]

To see whether current exporters perform better subsequently than nonexporters, we ran the following regressions:

$$\Delta \ln Y_{iT} = \alpha + \beta \text{EXPORT}_{i0} + \gamma \text{INDUSTRY}_i + \delta \text{REGION}_i + \lambda \ln \text{SIZE}_{i0} + \varepsilon_{iT} \quad (3)$$

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 the time interval to examine short-run, medium-run, and long-run performances of current exporters relative to nonexporters. 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 2.6 reports TFP growth rates of exporters relative to nonexporters, which are the coefficients on the export dummy variable in regression (3),

11. From here on, we confine our discussion to these three performance measures—TFP, shipments, and employment.

over various time horizons. In the short run, without any control variables, the TFP growth rates of exporters are significantly higher than nonexporters during the 1990–1998 period. However, when industry, region, and size of plants are controlled for, the coefficient on the export dummy variable becomes negative although insignificant. In the medium run, the results are mixed. In the earlier period, the coefficient on the export dummy went from positive to negative, although insignificant, with the inclusion of control variables. Meanwhile, in the later period, it was significantly positive regardless of the inclusion of control variables. However, 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 the inclusion of control variables.

In table 2.7, we report growth rates of shipments of exporters relative to nonexporters. When controlling variables are not included in the regressions, the shipment growth rates of exporters are estimated to be significantly lower than nonexporters 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 nonexporters, which is reported in table 2.8, 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.

Overall, we could not find any clear evidence of TFP improvement from exporting following the methodologies by Bernard and Jensen (1999a). Benefits of exporting are confined to faster employment growth. Subse-

Table 2.7 **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	–3.5
	(–30.7)	(–12.7)
Medium-run		
1990–1994	–5.7	–2.2
	(–20.0)	(–6.4)
1994–1998	–2.0	0.3
	(–6.6)	(0.9)
Long-run		
1990–1998	–2.7	–0.1
	(–11.7)	(–0.5)

Note: See table 2.6 note.

Table 2.8 **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	5.1
	(–22.6)	(33.9)
Medium-run		
1990–1994	–2.7	1.7
	(–15.5)	(8.5)
1994–1998	–2.4	2.2
	(–12.7)	(10.7)
Long-run		
1990–1998	–2.2	1.3
	(–15.0)	(7.5)

Note: See table 2.6 note.

quent growth rates of shipments of current exporters are no faster than that of nonexporters. These results are very similar to what Bernard and Jensen (1999a) found for the United States.

2.4 Selection and Learning: Methodology by Bernard and Jensen (1999b)

In the preceding analysis, which is based on methodologies by Bernard and Jensen (1999a), we could not find any strong evidence supporting the learning-by-exporting or self-selection hypothesis. Then is it justifiable to conclude that the decision to export, for example, is not based on TFP in Korea? The answer seems to be negative because the methodology previously employed does not follow the exporting history of plants closely enough. For example, in table 2.4, we selected plants that did not export during the 1990–1993 period and compared the TFP levels between exporters and nonexporters in 1994. However, the exporting history of those selected plants might vary after 1994. For example, among the plants classified as nonexporters in 1994, there might be productive plants that have entered the export market after 1994. Also, there might exist unproductive plants classified as exporters in 1994 that exited the export market after 1994.[12] With this phenomenon present, it will be hard to find TFP-based self-selection even if it exists in reality.

Now, with the exporting history of plants available at an annual fre-

12. 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.

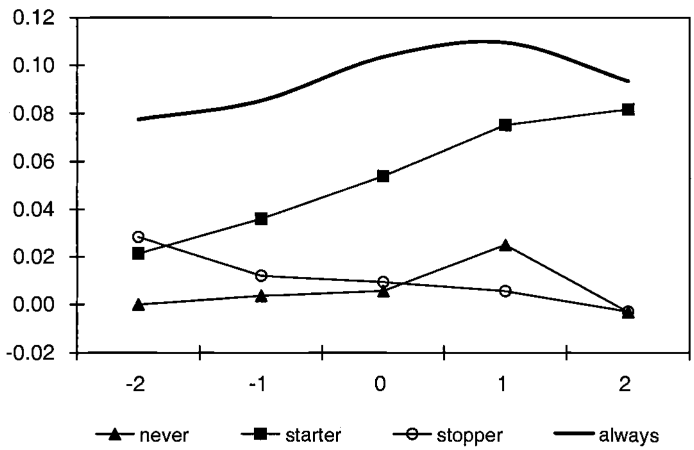

Fig. 2.2 Relative levels of TFP by plant group: Before and after

quency during our sample period, we can perform a more focused analysis. Following Bernard and Jensen (1999b), we take the entire exporting history of plants into account and classify them into the following five categories. There are plants that exported during the entire sample period, which are grouped as "always." Similarly, the "never" group consists of plants that never exported. The "starter" group represents plants that become exporters during the sample period and remain in the export market. Those that drop out of the export market and do not reenter are grouped as "stopper." The "other" plants are those that switched exporting status more than twice during the sample period.[13]

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

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

where $\ln Y_{it}$ logs of various performance measures, G is the set of five plant groups defined as in the preceding, 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 mean values of each plant group g at each location k, controlling for industry, region, and year effects. Figure 2.2

13. Before grouping plants, we selected only those plants that operated either in export markets or domestic markets during the sample period. Thus, plants that ceased operating entirely or began operating during our sample period, for example, are excluded from the following analysis. This procedure, however, enables us to focus on the transition between domestic and export markets.

Table 2.9 **Relative TFP levels before and after exporting (or stopping exporting)**

	Plant group				
Plant location	Never	Stopper	Starter	Always	Other
–2	0.0	2.8	2.1	7.8***	3.0***
	(0.0)	(1.5)	(1.2)	(8.4)	(5.2)
–1	0.4	1.2	3.6**	8.5***	3.2
	(0.2)	(0.8)	(2.2)	(4.1)	(1.7)
0	0.6	0.9	5.4***	10.4***	4.1**
	(0.3)	(0.5)	(2.9)	(5.1)	(2.1)
1	2.5	0.6	7.5***	11.0***	5.8***
	(1.4)	(0.3)	(3.9)	(5.5)	(3.1)
2	–0.3	–0.3	8.2***	9.3***	4.1**
	(–0.2)	(–0.1)	(4.0)	(4.6)	(2.2)

***Coefficient is significantly different from Never (–2) at the 1 percent level.
**Coefficient is significantly different from Never (–2) at the 5 percent level.

shows movements of the total factor productivity level of the five plant groups, expressed as the difference from the never (–2), and table 2.9 shows corresponding coefficients and standard errors.

Figure 2.2 shows that there exists some learning effect associated with exporting. Plants that start exporting widen the TFP gap with those that never exported and close the gap with those that always exported after entering the 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, because the "always" group will enjoy first-mover advantage over the starter in improving the TFP level. However, neither of these phenomenon is observed in the figure.[14] 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 evidence in favor of the learning-by-exporting hypothesis in the Korean manufacturing sector although the learning effect is rather short lived.

Figure 2.2 also confirms the existence of self-selection in the 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 2.9 shows that the TFP gap between those two groups are statistically significant one year before starting to ex-

14. 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 compelling way.

port. 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 2.3 and figure 2.4. Again, the estimated coefficients and their

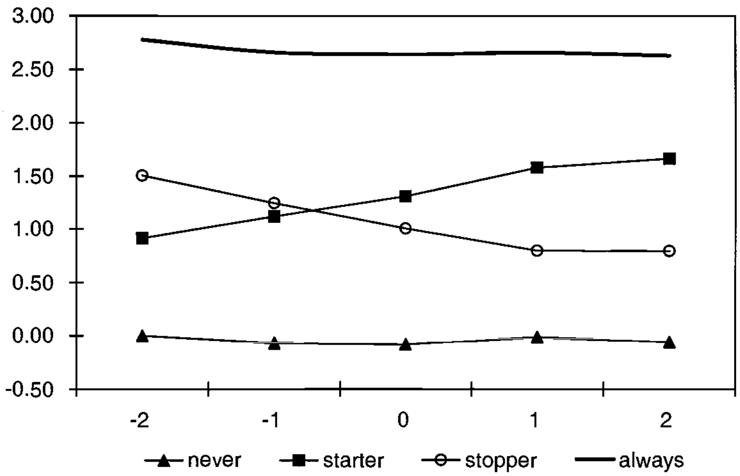

Fig. 2.3 Relative levels of shipments by plant group: Before and after

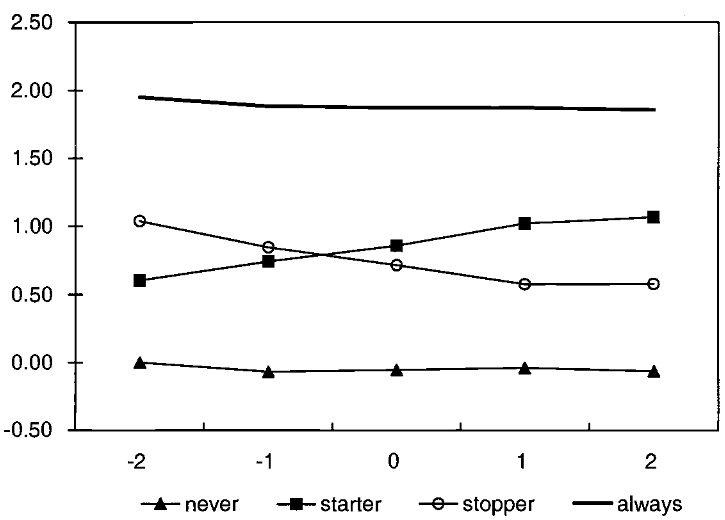

Fig. 2.4 Relative levels of employment by plant group: Before and after

standard errors are shown in table 2.10 and table 2.11. Similar to the case of TFP, plants that start exporting increase both shipments and employment at around the time of entry into the export market, relative to those plants that always export or never export. Also, the gaps in the levels of shipments and employment between always and never are fairly stable over time in terms of percentages, suggesting that the increase in shipments and employment by exporting does not last forever. When compared with relative TFP movements in figure 2.2, one noticeable feature in figure 2.3 and figure 2.4 is that the magnitudes of change in shipments and employment of starters relative to always and never are not very large within the five-year window. That is, exporting-related adjustments in shipments and employ-

Table 2.10 Relative shipments levels before and after exporting (or stopping exporting)

	Plant group				
Plant location	Never	Stopper	Starter	Always	Other
–2	0.0	150.6***	91.4***	277.6***	123.6***
	(0.0)	(20.9)	(13.5)	(77.7)	(54.7)
–1	–7.0	124.5***	112.0***	265.8***	116.9***
	(–0.9)	(20.1)	(17.7)	(32.7)	(15.3)
0	–8.1	100.6***	130.8***	264.1***	116.3***
	(–1.1)	(13.5)	(18.3)	(33.0)	(15.5)
1	–1.0	79.8***	158.0***	265.5***	122.7***
	(–0.1)	(10.3)	(20.9)	(33.9)	(16.7)
2	–5.8	79.3***	166.4***	262.9***	119.5***
	(–0.8)	(10.0)	(21.0)	(33.1)	(16.1)

***Coefficient is significantly different from Never (–2) at the 1 percent level.

Table 2.11 Relative employment levels before and after exporting (or stopping exporting)

	Plant group				
Plant location	Never	Stopper	Starter	Always	Other
–2	0.0	103.7***	60.4***	195.2***	82.5***
	(0.0)	(19.7)	(12.2)	(74.8)	(50.0)
–1	–6.9	84.4***	74.3***	188.3***	76.0***
	(–1.3)	(18.7)	(16.1)	(31.8)	(13.6)
0	–5.6	71.6***	85.7***	187.4***	78.1***
	(–1.0)	(13.2)	(16.4)	(32.1)	(14.3)
1	–4.0	57.6***	101.9***	187.3***	80.0***
	(–0.8)	(10.2)	(18.5)	(32.7)	(14.9)
2	–6.4	57.9***	106.7***	185.8***	78.1***
	(–1.2)	(10.0)	(18.4)	(32.1)	(14.4)

***Coefficient is significantly different from Never (–2) at the 1 percent level.

ment may take a much longer time, compared with TFP levels. While the reasons for the slower adjustment of shipments and employment are not clearly understood, this may suggest that it takes a long time for the gains in allocation efficiency from exporting to materialize. The TFP-based selection and learning effects and similar effects based on shipments and employment, as shown in figures 2.2 to figure 2.4 and tables 2.9 to table 2.11, was robust with the exclusion of the crisis period of 1997 to 1998, when export growth increased significantly with the depreciation in the exchange rate.[15]

2.5 Summary and Concluding Remarks

This study examines the relationship between exporting and various performance measures including TFP, using 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). Following the methodologies from Bernard and Jensen (1999b), this study provides some evidence modestly supporting both self-selection and learning-by-exporting effects. Also, the selection and learning effects are 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 TFP is accounted for by both selection and learning effects. Although the results are somewhat sensitive to the methodologies employed, they 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 are considered as performance measures. Overall, this study suggests that the benefits from exporting have been realized not only through resource reallocation channel but also through the TFP channel in Korea.

Although the different conclusions derived in this study from Aw, Chung, and Roberts (2000) might well be due to the different time periods covered in the analysis, it may also arise from the differences in the data set and methodologies employed. The annual panel data set and methodologies employed in this study allow 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.

If foreign markets provide opportunities to improve aggregate TFP both through the intraplant TFP channel and also through the resource reallocation channel, as suggested by this study, then openness by itself may not be sufficient to fully exploit the potential benefits that openness provides. That is, greater openness accompanied by policies improving resource reallocation will be more effective than policies enhancing openness alone.

15. It is possible that the export boom during the crisis period biased the results toward finding learning effects if it caused disproportionate output expansion of new exporters.

Finally, it might be too hasty to jump to the conclusion, based on the short-lived nature of learning effect, that the export market does not play a significant role in a sustained increase in aggregate productivity. Suppose there is a continual entry and exit of producers in and out of the export market, which is documented in many other studies, and that each new cohort of entrants starts from higher TFP levels than its preceding cohorts. Under these circumstances, exporting may provide an opportunity for the continuous improvement of aggregate TFP, although the learning-by-exporting opportunity may be short lived from the viewpoint of individual producers.

Appendix

Measurement of Plant Total Factor Productivity

Plant TFP is estimated using the chained-multilateral index number approach as developed in Good (1985) and Good, Nadiri, and Sickles (1999). 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-sectional 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.[16]

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

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

where Y, X, S, and TFP denote output, input, input share, TFP level, respectively, and symbols with an upper bar are corresponding measures for

16. Good, Nadiri, and Sickles (1999) summarize the usefulness of chaining multilateral productivity indices succinctly. While the chaining approach of the 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-sectional data, while it has an undesirable property of sample dependency. The desirable properties of both the chaining approach and hypothetical firm approach can be incorporated into a single index by the chained-multilateral index number approach.

hypothetical firms. The subscripts τ and n are indices for time and inputs, respectively. In our study, 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 the disaggregated level.[17] 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 nonproduction 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 average nonproduction workers' and production workers' wages 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 the "other production cost" in the survey. Major production cost covers costs arising from materials and parts, fuel, electricity, water, manufactured goods outsourced and maintenance. The 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 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, the factor elasticity of plants is 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.

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17. Using the price index normalized to 1 at base period implies that we measure real outputs of plants at base year as the current values of production. We use industry-level price indexes rather than aggregate-level price indexes to control for price changes over time, which might differ across industries, in measuring real outputs of plants. Alternatively, if the aggregate price index, such as the gross domestic product (GDP) deflator, were used for all industries, this procedure will attribute any changes over time in relative prices among industries to changes in real outputs.

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Comment Kyoji Fukao

Using plant-level data, the author examines links between productivity and exporting and found evidence for the existence of both a self-selection mechanism (relatively productive firms tend to become exporters later) and learning-by-exporting effects. Compared with a preceding study on this issue by Aw, Chung, and Roberts (2000), which used data for 1983, 1988, and 1993 and, incidentally, did not find any significant evidence for self-selection or learning by exporting, this paper takes greater account of the dynamic aspects of the export-productivity nexus by using annual data for 1990–1998. The empirical analysis is carefully conducted, and I found the paper very instructive.

I have four comments.

My first comment relates to the drawbacks of using plant-level data for this type of analysis. It is true that, generally, total factor productivity (TFP) calculations at the plant level are more reliable than those at the firm level. For example, because firms usually produce a broad range of products, it is difficult to find an appropriate price index to deflate their nominal output. However, in the case of productivity comparisons between exporters and nonexporters, plant-level data is problematic. The reason is that exporting firms may have to incur fixed costs to penetrate foreign markets—a major part of which is probably incurred at the firm level rather than at the plant level. For instance, a firm's sales activities abroad are likely to be paid for by the head office.

Suppose that, because of this fixed cost, the domestic price of a certain product is lower than the export price. Then the TFP level of exporting plants will be estimated to be higher than that of nonexporting plants even when their actual productivity is identical. Probably one solution to this problem is to add firm dummies to the explanatory variables in the regression.

My second comment is on the effects of trade protection. Some of Korea's manufacturing industries are protected by tariff barriers. We will observe relatively high tariff rates and domestic prices for industries that are not competitive and do not export. Therefore, the estimated TFP of nonexporting plants might be biased upward. If we use industry dummies at

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the disaggregated industry level, this bias will be small. So I would like to know more about the industry dummies used in the econometric analysis.

My third comment is on sample size. At the end of section 2.3, the author compares TFP of two groups of plants. The first group consists of plants that started exporting in 1994 and continuously exported thereafter, while the second group consists of plants that never exported during the sample period. Using this comparison, the author finds a significant ex ante TFP premium in 1990 for future exporters. This result is very interesting. But I am afraid that by defining new exporters and nonexporters in a very rigorous way like this, the sample size might become very small. I would like to know how many observations the author has in the first group (new exporters).

My final comment is that a brief overview of Korean trade and TFP growth would have been helpful. In the paper, the descriptive analysis is relatively limited, leaving questions such as in what industries are import tariffs high? What industries show a revealed comparative advantage? How does the Korean government subsidize private investments that are related to exporting activities? In what industries has TFP growth been high? If the author provided overviews of these issues, non-Korean readers would be better able to understand the results of the paper.

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Comment James Harrigan

The paper by Chin Hee Hahn is part of a growing literature on plant-level characteristics and participation in the international economy. As many other researchers have found in other countries and time periods, Hahn finds that exporting plants in Korea during the 1990s were better in many dimensions. In particular, in tables 2.2 and 2.3 Hahn finds that for three years (1990, 1994, and 1998), exporters are larger and more skill-, capital-, and intermediates-intensive. He also finds that labor productivity and total factor productivity (TFP) are higher for exporting plants; for example, in 1994, TFP was about 4 percent higher for exporting rather than non-exporting plants.

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It is worth pausing to think about what it means for one plant to be better than another. Economists should usually focus on aggregate welfare, which depends inter alia on optimal resource allocation. Good resource allocation will generally require a mix of skill- and capital-intensive activities, as well as a mix of production for domestic consumption and for export, so correlations between these attributes have no obvious welfare implications. Productivity is a different story: greater TFP is always and everywhere a good thing, so it is reasonable to regard high-TFP plants as better than low TFP plants. This is not the case for labor productivity (variations that might reflect just variations in usage of other inputs), so I will focus for the rest of this comment on Hahn's results on TFP alone.

Because of the centrality of TFP, it is also worth pausing to consider measurement issues. In principle, TFP is a purely physical concept: for two plants producing *identical* output, we say that plant A has TFP 10 percent higher than plant B if, given identical inputs, plant A can produce 10 percent more output than plant B. In practice, two plants almost never produce exactly the same thing, and even if they did, economists rarely have data on physical outputs. As a consequence, calculations such as those done by Hahn use value data as a proxy for output. The problem is that values can vary due to variations in prices, conflating profitability, and productivity. At a minimum this implies random measurement error, but it might be worse: for example, an inefficient monopoly plant might have higher measured TFP than an efficient plant selling in a competitive market. The conclusion is that cross-plant TFP comparisons should be regarded with some skepticism.

Hahn is interested in explaining the cross-sectional correlations between TFP and exporting observed in tables 2.2 and 2.3. He considers two possibilities: high-TFP plants become exporters, or exporters have faster TFP growth. These are important hypotheses to distinguish, as any reasonable case for export promotion policies hinges on the relevance of the exporting-causes-productivity hypothesis. Quite surprisingly, tables 2.4–2.9 offer no support for *either* hypothesis: future exporters have TFP levels or growth rates no higher than future nonexporters (tables 2.4, 2.5, and 2.6), nor do exporters have faster TFP growth than nonexporters (table 2.7). As Hahn observes in his remarks about an earlier paper on Korean plant-level data that found the same thing, this result is very hard to explain: if exporters have higher TFP (as shown in tables 2.2 and 2.3), that advantage must have appeared at some point.

The obvious solution to the puzzle, though Hahn does not mention it explicitly, is that plants that started exporting before 1990 drive the positive cross-sectional correlation between TFP and exporting. This is indirectly confirmed by the results of table 2.10, which are illustrated in figure 2.2: plants that export throughout the period have substantially higher productivity than everyone else does.