Taiwan's trade and FDI policies and their effect on productivity growth

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TAIWAN'S TRADE AND FDI POLICIES AND THEIR EFFECT ON PRODUCTIVITY GROWTH

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INTRODUCTION

DURING the past two decades Taiwan has achieved an average annual growth rate of 8.1 per cent. This performance is comparable to the 8.7 per cent annual growth rate of the Republic of Korea, and outpaces the world average of 2.8 per cent growth during the same period. As the World Bank in its 1993 report shows, a high growth in total factor productivity (TFP), along with the conventional factors of labor and capital input, has played an important part in this excellent growth performance.[1] TFP growth reflects the impacts of miscellaneous factors affecting productivity, such as institutional changes, improvement in production technology, or management efficiency. TFP also reflects productivity changes due to an industry's exposure to foreign economies through exports or FDI inflow.

This study focuses on Taiwan's manufacturing sector and evaluates the effects of trade and FDI policies enforced after the mid-1970s. In the first section, a survey of Taiwan's trade and FDI policies is presented. The second section provides TFP calculations and comparisons by subsector. The third section evaluates the productivity effects of Taiwan's trade and FDI policies after discussing the relationship between the TFP growth of the country's manufacturing industry and the government's policies. Concluding remarks are presented in the last section.

I. A SURVEY OF TAIWAN'S TRADE AND FDI POLICIES

A great deal of research has been done to confirm the relationship between TFP change and trade and FDI policies.[2] One example is the World Bank's 1993 report which points out that manufacturing exports have a positive effect on productivity through the introduction of new equipment and/or FDI inflow, technology licensing, transfer of nonproprietary technology, acquisition of information from overseas customers, and enhancement of domestic research and

[1] Figure 1.11 in World Bank [15] clearly depicted that in Taiwan, along with other East Asian economies, that portion of economic growth brought on by growth in TFP exceeded 33 per cent for the 1960–89 period, which was a higher figure than for other LDCs.

[2] The chronology of trade and FDI policies presented here relied greatly on Siew [14] and Inoue, Urata, and Kohama [3].

development activities. It also points out that relaxation or abolishment of tariff and nontariff barriers contribute to productivity growth through the reduced cost of capital goods and raw materials. FDI inflow contributes to productivity growth through the domestic dissemination of accompanied know-how, along with the direct effects of the technology embodied in brought-in equipment.

As early as the late 1950s, the Taiwan government started to move away, though gradually, from its import substitution policy. In 1957 the government started to supply low-cost export credit and in 1958 the Foreign Exchange and Trade Reform Plan was made public. In 1960 three major reforms were announced. The first was the promulgation of the Statute for the Encouragement of Investment to introduce foreign direct investment as well as encourage domestic investment. The second was the unification of the multiple exchange rate and fixing it at 40.00 NT dollars per U.S. dollar. This rate was fairly close to the market value at the time. The third reform was amending the tariff rebate system initiated in 1955 in order to further promote exports. By this time it had become apparent that the main focus of Taiwan's trade policy had shifted from import substitution to export promotion. During the mid-1960s export promotion was further extended with the implementation of additional export promotion tools. These included bonded factories and export processing zones, both initiated in 1965. Supported by this series of promotion policies, light industry exports, such as textiles, plastics, plywood, and electronics, greatly increased in the 1960s, leaving behind the agro-related commodities such as sugar and pineapple products which had been the exports of the 1950s. Two major reasons can be pointed out why Taiwan had to promote exports in the 1960s. First, the import substitution program was reaching a dead end in Taiwan where the domestic market was too small to sustain the program. Second, aid from the United States dwindled throughout the 1960s, and in 1965 the United States discontinued new commitments of assistance to Taiwan.

In the 1970s Taiwan's export promotion efforts entered a new phase. Major economic goals during this period were expansion of infrastructure, self-sufficiency of industrial inputs, and heavy industrialization. The Taiwan's withdrawal from the United Nations in 1971 might have played a part in the adoption of such national goals.

As a result of extended export promotion in the 1960s, the increased size of industrial production generated an expanding demand for infrastructure, such as highways, harbors, electricity, and water. However, the government reacted slowly to the increased demand, and the insufficiency of infrastructure gradually became an obstacle to export growth.

Also during this period it was gradually recognized that exports were requiring rather substantial imported inputs, and that net export revenue needed to be improved. In order to increase net export revenue over imported input, the government initiated a "secondary import substitution program." This substituted imported material goods with domestic ones. The establishment of public enterprises during this period in the fields of iron and steel, shipbuilding, and petrochemicals was consistent with this secondary import substitution strategy.

In 1970 the Statute for the Encouragement of Investment was amended, and the government presented a modified investment policy that curtailed support for labor-intensive investment and instead promoted investment in export-oriented firms. In 1973 the government announced the Ten Major Public Sector Projects, which was directed at constructing infrastructure and some key industries. However, in the 1970s, trade friction with a number of advanced economies was no longer negligible, and increasing competition with other developing economies grew more severe. In 1971 the United States and Taiwan agreed to restrict the latter's exports of cotton, synthetic fiber, and wool products to the United States. In 1974 the MFA (Multilateral Fiber Agreement) came into effect, and in 1975 Taiwan enacted its Fiber Export Quota Control Act.

During the 1980s, Taiwan faced a harsh international trade environment symbolized particularly by its exclusion from the GSP (general system of preference) list of the United States in 1988. This severe trade environment hindered rapid growth based on exports of labor-intensive goods. Under such circumstances, the Taiwan government had to worry about and struggle with trade friction. To lessen foreign pressure, the government announced the phase-out of various export promotion schemes along with import, trade, and financial liberalization. In the area of domestic industrial policy, the government turned to the promotion of capital- and technology-intensive industries in reaction to the poor achievements of the public enterprises established in the 1970s, and to cope with Taiwan's changing comparative advantage.

Export promotion continued during the 1980s, but the extent of government support was gradually curtailed. In 1979 the foreign exchange market was established, and the NT dollar rate started to appreciate against the U.S. dollar in the mid-1980s. Export credit continued to be offered at a lower rate compared to general loan contracts; however the difference shrank to 1–2 points in the 1980s from 3–5 points in the 1970s. Support through tariff rebates and preferential investments also decreased. In 1980 tariff rebates and corporate tax exemptions to encourage investment amounted to 22.6 per cent of total tariff and corporate tax collection. However, in 1989 that figure dropped to a mere 6.9 per cent.

As for liberalization, tariff reduction and the relaxation/abolishment of nontariff barriers proceeded apace in the 1980s. Tariff reductions were announced almost every year in an effort to cope with escalating trade friction with a number of advanced economies. The actual tariff rate (tariff collection / total imports) fell to 4.7 per cent in 1991 from the 10 per cent mark in 1979. As of January 1992, out of a total of 9,130 items, 5,976 items, or 65.45 per cent, could be imported without import licenses. Also worth noting is that the tariff reform in 1980 covered a wide range of consumer goods whose tariff rate before the 1980s used to be high. Regarding foreign direct investment, the government maintained a generous attitude. In June 1987, the export requirement for foreign automobile firms was abolished. In February 1988, the negative list for foreign direct investment was reduced further and confined largely to pollution-causing industries, banking and insurance, and public administration. Other liberalization measures were also announced. In July 1987, possession of foreign exchange by the general

public was basically permitted. Starting in April 1989, the pricing of foreign exchange was left completely to the market mechanism. In July of the same year, the abolition of interest rate controls and permission allowing new entries into the banking business were announced.

The government's promotion of capital- and technology-intensive industries during this period was symbolized by the establishment of the Hsinchu Scientific Industrial Park in 1980. The Eighth Four-Year Development Plan of 1982–86 classified some capital- and technology-intensive industries as "strategic industries." Strategic industries included electronics, machinery, and automobile parts. This selection of promoted industries was consistent with the list in the 1977 amendment of the Statute for the Encouragement of Investment, which specified some capital- and technology-intensive industries that the government welcomed to come in from abroad. In addition to those industries, spinning and plastics were listed as industries to be given preferential treatment for automated production. In 1985 the government started to support outward FDI by those industries that met certain conditions (such as industries facing trade barriers in export markets). The main purpose for the promotion of outward FDI was to avoid possible trade friction with trade partners, as well as to enhance domestic industrial adjustment.

The above policy chronology will be combined with regression analysis in Section III to evaluate Taiwan's trade and FDI policies. Since the sample period for evaluating the policy is 1979–91, Taiwan's trade and FDI policies for that period can be summarized as follows: (1) export promotion continued throughout the 1980s but was gradually being phased out; (2) efforts at liberalization and expansion of imports proceeded in the 1980s and accelerated especially after the mid-1980s; (3) continued generosity toward FDI inflow; and (4) promotion of capital- and technology-intensive industries, especially around the beginning of the 1980s.

II. TFP GROWTH OF TAIWAN'S MANUFACTURING SECTOR

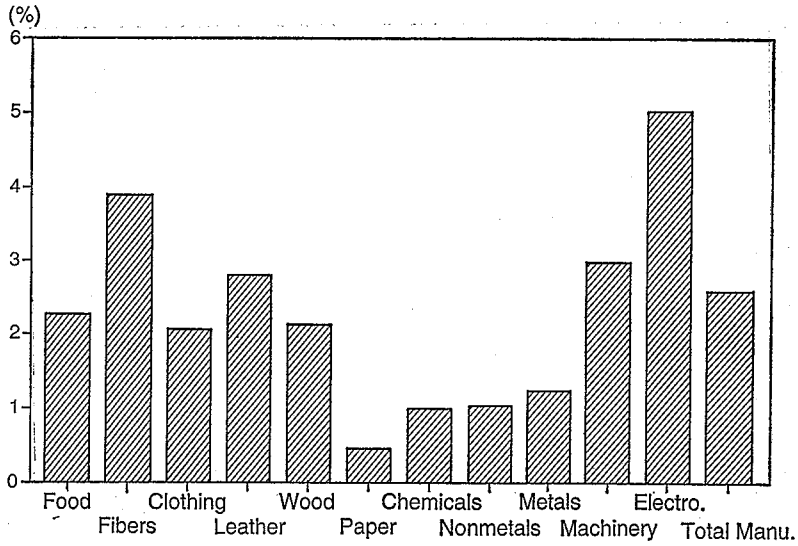
In this section, the TFP growth of Taiwan's manufacturing sector will be shown on a subsector basis. There have been many efforts to measure the TFP growth of Taiwan's manufacturing. Those studies include: DGBAS [11], Li [6] [7], Choi and Hyeong [2], Chen and Tang [1], and Kim, Yu, and Hwang [5]. These studies in principle have adopted the Tornqvist index as an indicator of TFP growth, as shown below:

$$\ln(TFP_t/TFP_{t-1}) = \ln(Y_t/Y_{t-1}) - \sum_i S_{i,t} \ln(X_{i,t}/X_{i,t-1}), \qquad (1)$$

where t denotes time and Y denotes real output. S_i represents the share for factor i, and X_i represents the input of factor i. The above formula shows that real output growth is divided into two portions: a portion due to the TFP growth and a portion due to the input growths (share weighted).

Considering the figures stated in the above-mentioned studies, TFP growth figures used in this study are based on DGBAS [11]. The figures contained in DGBAS [11] were the most recent ones available to the author, and the input

Fig. 1. TFP Growth Rate by Subsector, 1978–91



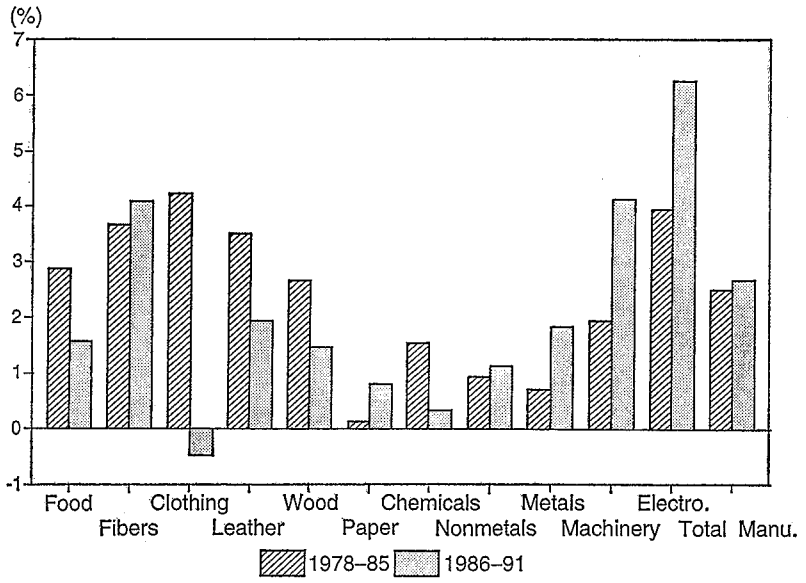
Note: 1986 prices.

factors were defined as capital and labor. When calculating the percentage share for labor, labor compensation was defined as the compensation to employees as shown in the national accounts plus the compensation to executive officers and the self-employed. In this way a possible underestimation of the percentage share of labor and a consequent overestimation of the TFP was avoided. The sample period was 1978 through 1991. DGBAS [11] disaggregated the whole manufacturing sector into eighteen subsectors. In this study, however, these subsectors were aggregated, because the FDI statistics adopted a rather rough disaggregation for the manufacturing sector.[3] Figure 1 displays by subsector the average annual TFP growth for the period 1978–91. Figure 2 displays average annual TFP growth for the sub-periods of 1978–85 and 1986–91.

For the entire period 1978–91, the TFP growth for manufacturing as a whole was 2.6 per cent per annum. At the subsector level, electronics showed a conspicuous growth of 5.0 per cent per annum, followed by fibers, machinery, and leather with 3.9 per cent, 3.0 per cent, and 2.8 per cent growth respectively. For the sub-period 1978–85, TFP growth for manufacturing as a whole registered 2.5 per cent per annum. Food, fibers, clothing, leather, wood products, and

[3] The aggregation process proceeded as follows: TFP index, Tornqvist input index, percentage share of labor, and total capital stock (eighteen subsectors) → GDP growth rate, labor compensation, and growth rate for labor input (eighteen subsectors) → percentage share of labor, growth rate of labor compensation, Tornqvist input index, and finally TFP growth (eleven subsectors). For a comparison of sector classifications between FDI statistics used in DGBAS [11] and this study, see Appendix Table VI.

Fig. 2. TFP Growth Rate by Subsector and Sub-period



Note: 1986 prices.

electronics registered higher-than-average TFP growth. Clothing and electronics in particular reached the 4 per cent growth mark. For the sub-period 1986–91, the good growth performance of high-growth sectors contrasted greatly with the rest of manufacturing. TFP for manufacturing as a whole grew 2.7 per cent per annum, and only fibers, machinery, and electronics showed higher-than-average growth. Growth in electronics was impressive with an annual rate of 6.3 per cent, followed by machinery and fibers with 4 per cent growth rates. For the other subsectors, annual TFP growth was less than 2 per cent. Looking at TFP growth performance by subsector for both sub-periods, we can see that fibers and electronics maintained good growth performance.

Regarding the change of TFP growth performance within each subsector, fibers, paper, nonmetals, metals and, notably, machinery and electronics exhibited accelerated growth during the 1986–91 sub-period. On the other hand, TFP growth during the same period for the subsectors of food, clothing, leather, wood products, and chemicals slowed down. TFP growth for clothing even turned negative during the 1986–91 sub-period.

III. TRADE AND INVESTMENT LIBERALIZATION POLICY AND TFP CHANGE

The studies mentioned at the start of Section II all attempted to explain what brings about TFP changes. Although equation (1) says that every factor affecting productivity leads to a TFP change, in practice we have to choose some factors

that better explain TFP changes. In the above mentioned studies, along with the computation of TFP itself, various factors were picked out for testing.

Li [7] chose the following subsector variable to explain TFP change: operation rate of facilities, hours worked in a week per worker, male/female ratio of workers, white-collar/blue-collar ratio of workers, entry/retirement ratio of the labor force, transition rate of the labor force within a sector, and public/private ratio of a sector's GDP. A regression analysis was performed using a pooled data set that consisted of four sector-level time series. He found that (1) the operation rate of facilities and the white-collar / blue-collar ratio of workers had a statistically significant and positive effect on TFP, and (2) hours worked in a week had a statistically significant and negative effect on TFP. Also, he inferred that a sector's TFP correlated negatively with its market concentration ratio and positively with its level of R&D activities.

Choi and Hyeong [2] attempted to explain subsector TFP change using the accumulated FDI balance of each sector. In the subsectors of food, rubber and plastics, chemicals, machinery, and electronics, the coefficient estimates for the FDI stock were positive and statistically significant. Also they concluded that the FDI inflow in export industries had a positive and statistically significant effect on TFP.

Chen and Tang [1] tried to explain subsector TFP changes using the growth of output and exports for each sector. He showed that growth of output better explained TFP changes than did growth in exports.

World Bank [15] pointed out, through a cross-country analysis of East and Southeast Asian economies, that the ratio of manufactured goods in total exports, as well as the ratio of a country's GDP to that of the United States and the enrollment ratio at the primary education level had a positive and statistically significant effect on TFP.

Considering these existing studies, and recalling that this study is to analyze the effect of trade and FDI liberalization on productivity with special emphasis on the evaluation of recent policy trends, the author would like to explain TFP changes in Taiwan's manufacturing using the following formula:

$$TFP_{t,j} = F(t, FDIK_{t-1,j}, EXPROD_{t,j}, KL_{t,j}, PENE_{t-1,j}, D), \qquad (2)$$

where subscript t stands for the time trend (from 1979 to 1991), and j for industry (eleven subsectors: food, fibers, clothing, wood products, leather, paper, chemicals, nonmetals, metals, machinery, and electronics). *TFP* denotes the TFP indices (1978 = 100). *FDIK* denotes the ratio of FDI stock to total capital stock, which is added to measure the productivity effect of FDI inflow (based on 1986 prices). *EXPROD* is the ratio of exports to total production (based on 1986 prices), which is introduced to measure the productivity effect of export promotion. *KL* stands for capital equipment per worker (at 1986 prices) and is introduced in order to control for subsector factor intensity. *KL* facilitates in measuring the effect of a promotion policy for capital- and technology-intensive industries. *PENE* is the import penetration ratio, which is defined as imports / (production + imports − exports). This variable is introduced in order to measure the produc-

tivity effect of domestic pressure brought about by import liberalization. D is a subsector dummy matrix with eleven columns. The jth column of this matrix is 1 for subsector j and 0 otherwise. For the data used in this study, see the appendix tables: Appendix Table II for the FDI stock/total capital stock ratio by subsector, Appendix Table III for the export ratio by subsector, Appendix Table IV for the capital equipment per worker by subsector, and Appendix Table V for the import penetration ratio by subsector.

Before undertaking regression analyses, some remarks on the specification of the model and the choice of data need to be presented. In existing literature, the growth of TFP, rather than the TFP indices themselves, is commonly used as the dependent variable. The author regressed annual TFP growth on the above-mentioned independent variables, but the result was totally disappointing.[4] The author therefore chose a specification with the TFP indices themselves on the left-hand side as in equation (2).

Regarding the choice of data, using rather "direct" policy variables, in which the effect of an economic policy is clearly figured, would bring about a clearer conclusion. A few examples for such variables include industry data on government expenditures for export promotion, financial losses due to FDI promotion policies, tariff rates, and the effective rate of protection. A complete set of time series for such variables, however, was not readily available, therefore the author adopted rather indirect variables stated in equation (2) in which the consequences of those direct policy variables are expressed.

It also needs to be noted that the FDI stock/total capital stock ratio and the import penetration ratio are both lagged variables. It is not plausible that fresh FDI will quickly contribute to production. Similarly, it is not plausible that the opening of the domestic market will immediately enhance the productivity of competing domestic sectors. Rather, the productivity effect of FDI or import competition becomes visible only gradually, therefore the author considered it relevant to adopt a lag for these variables. There is another reason for a lag in the import penetration ratio. By introducing a lag, one might avoid multicollinearity with the export ratio; if the import penetration ratio and the export ratio are contemporaneous, a multicollinearity problem might occur, since both variables include common factors: exports and production.

In the following regression analysis of TFP changes, the method of analysis is not by sector, but is a cross-sector analysis in which regressions were done using a pool of observations for various industries and years.[5] This implies that the parameters are estimated uniformly across the subsectors. Since the TFP figures

[4] In a trial estimation of a model with TFP growth as the dependent variable, the F-ratio that measured the overall efficiency of the model was a mere 0.733. The adjusted R-square for the trial model was -0.0076.

[5] The reason for not adopting regression analysis by subsector was because the sample period was not long enough, and adopting a subsector-based regression model resulted in an insufficient degree of freedom for each subsector model which in turn caused insignificant estimates of the coefficients. Therefore the author adopted regression on a data pool which was made by merging the observations for all the subsectors. By doing so, a sufficient degree of freedom was guaranteed.

TABLE I

RESULTS OF REGRESSION ANALYSIS

Independent Variable	Coefficients			
	Model 1	Model 2	Model 3	Model 4
t	0.041	0.042	0.045	0.042
	(9.21)****	(9.46)****	(10.91)****	(9.64)****
ln $FDIK_{t-1,j}$	0.034	−0.076	0.086	0.032
	(1.48)*	(−1.17)	(3.68)****	(1.43)*
ln $EXPROD_{t,j}$	−0.043	0.058	−1.141	−0.210
	(−1.13)	(0.86)	(−5.29)****	(−2.77)****
ln $KL_{t,j}$	−0.206	−0.208	−0.786	−0.212
	(−4.51)****	(−4.60)****	(−6.56)****	(−4.72)****
ln $PENE_{t-1,j}$	−0.068	−0.073	−0.086	−0.337
	(−3.55)****	(−3.81)****	(−4.84)****	(−3.12)****
ln $EXPROD_{t,j}$·ln $FDIK_{t-1,j}$		0.034		
		(1.80)**		
ln $EXPROD_{t,j}$·ln $KL_{t,j}$			0.162	
			(5.16)****	
ln $EXPROD_{t,j}$·ln $PENE_{t-1,j}$				0.065
				(2.53)***
R-square (adjusted)	0.6473	0.654	0.707	0.662
Degree of freedom	127	126	126	126

Notes: 1. Dependent variable=ln $TFP_{t,j}$. Sample period=1979–91.
2. Intercepts and coefficients for sector dummies were estimated, but these are not shown in this table.
3. Values in parentheses are t-values.

**** 1 per cent significant, *** 5 per cent significant, ** 10 per cent significant, * 20 per cent significant.

used here are indices, a naive application of equation (2) results in outlying fits for earlier observations of some subsectors, and consequently biased coefficient estimates. Therefore it is necessary to introduce subsector dummy variables so that outlying fits in some earlier observations are successfully controlled.

First, the result for model 1 will be examined. This model is a simple specification of equation (2). The coefficient estimates along with the specification of model 1 are shown in Table I. The coefficient for t evaluates per annum TFP growth that originates from all the factors other than explicitly revealed variables of FDI stock / total capital stock ratio, export ratio, capital equipment per worker, and import penetration ratio. The coefficient for t is statistically very significant as shown in Table I. This strongly suggests that various unstated factors, such as the expansion of economies of scale,[6] the expansion of infrastructure, and the improvement in overall education level, combined to improve Taiwan's productivity during the sample period.

[6] In a cross-economy analysis, World Bank [15] used the ratio of a country's own GDP to the American GDP as an indicator for economies of scale.

Next, let us examine the four major variables. The coefficient estimate for the FDI stock / total capital stock ratio was positive, though only at the 20 per cent level of significance. This result was anticipated by the author and supports the view that the introduction and diffusion of better production and management skills that accompanied FDI inflow contributed to the improvement of Taiwan's productivity. Furthermore, this result would also imply that the government's generous attitude toward FDI inflow throughout the sample period was relevant.

The coefficient for the export ratio was expected to be positive, since externality might be brought about for manufacturing exporters through the acquisition of commodity knowledge, production techniques, and other benefits from foreign customers.[7] If so, an export shock would be positively reflected on the TFP. However, the result from model 1 shows that the coefficient was not significant even at the 20 per cent level, and the direction of the productivity effect was estimated to be negative. Various interpretation can be derived from this result. One possible interpretation for the negative coefficient estimate is that of an "export drive" by which a declining industry tried to find a viable way out by exporting its products. In this case, the causality direction would be from the TFP to exports. However, considering the dwindling government support for exports throughout the 1980s as well as the government's curtailment of support for exports whose productivity impact became ambiguous, the government's declining support to export industries throughout the 1980s would be a reasonable policy shift.

As for the coefficient for capital equipment per worker, the author anticipated a negative estimate, since Taiwan's economy was becoming labor scarce throughout the 1980s, and the estimation was as expected, being negative with the 1 per cent level of statistical significance. This implies that an increase in capital equipment in an industry resulted in lower productivity. When discussing the relationship between this negative coefficient and the government's promotion of capital- and technology-intensive industries, one should note that the favored sectors listed by the Taiwan government around the beginning of the 1980s were, in fact, not really capital-intensive. The government's list did not include capital-intensive sectors such as chemicals and metals. Thus, the Taiwan government's industrial policies announced around 1980 targeted technology-intensive sectors, rather than capital-intensive ones. Machinery and electronics, a core part of the promotion policy, belonged to less capital-intensive sectors as far as the data used in this study show. Promotion of such less capital-intensive sectors would be relevant, considering the sign of the coefficient estimate.

Another interpretation of the negative estimate is possible if the generally less capital-intensive nature of small and medium-sized firms is taken into consideration. Small and medium-sized firms can be more flexible in changing labor input.[8] This characteristic is an advantage, in the sense that they can achieve improved productivity under circumstances of an ever-changing factor price ratio.

[7] The World Bank shared a similar view using the industrialization ratio of exports (see [15, pp. 337–38]). Similar studies are introduced on [15, p. 324].

[8] See Pack [8, p. 105] regarding flexible labor input changes in Taiwan's small and medium-sized firms.

The coefficient for the import penetration ratio was anticipated to be positive since penetration of imported goods would cause competition in the domestic market, and consequently, rationalization of the competing sector as a whole or closing down of unprofitable enterprises would lead to improved sector productivity. However, the estimation result was contrary to expectation. The estimated coefficient was negative and statistically significant at the 1 per cent level. This implies that the increasing presence of imported goods in the Taiwan market lowered the productivity of competing sectors.[9] Again this result can be interpreted in various ways. One interpretation is that for some sectors import liberalization proceeded so rapidly that sector earnings deteriorated. An example for this is the clothing and wood products sectors where the import penetration ratio soared after 1986. Appendix Tables I and V show that both sectors experienced an almost simultaneous drop in TFP and rise in the import penetration ratio.

In the above analysis of model 1, the productivity impact of the export ratio was found to be statistically unclear. However, the impact might be affected by the levels of other independent variables. In order to infer this possibly differing effect, it was appropriate to expand model 1 by adding interaction terms for the export ratio and the other independent variables. Three models were derived from model 1, each including an interaction term for the export ratio and the FDI stock / total capital stock ratio (model 2), the capital equipment per worker (model 3), and the import penetration ratio (model 4).[10] For the estimated results and the specifications of these models, see Table I.

When a model contains an interaction term that includes the export ratio, one should note that the overall productivity impact of the export ratio is obtained by partial differentiation of the model with respect to the export ratio, and it is expressed as follows: own coefficient of the export ratio plus the product of the interaction coefficient and the value of a partner variable. At a fixed level of the export ratio, a positive sign for a coefficient estimate of an interaction term implies that the overall productivity impact of the export ratio rises with the value of the partner variable.

This is the case for models 2 through 4 in which the interaction coefficients are all estimated to be statistically significant, at least at the 10 per cent level. In other words, the overall impact of the export ratio tends to be higher in such sectors with higher FDI, higher capital intensity, or higher import penetration. As seen above, higher capital intensity and import penetration are estimated to interfere with productivity. However, the results from models 2 through 4 show a possibility that such productivity-deteriorating factors could be overcome by increasing the sector's export ratio. This plausibly occurs in the case where a sector is forced to substitute capital for labor due to wage hikes. In the case of

[9] On the other hand, if one wanted to examine a hypothesis that import penetration occurs in a less productive sector, the import penetration ratio would be included in a regression model without a lag.

[10] In order to simplify the calculations, the author omitted the cases where more than two interactions were participating in a model, or where one interaction consisted of more than three variables.

higher import penetration, a moderate increase in exports does not look very helpful. But still there is room for exports to improve sector productivity if exports increase greatly. This brings about a great deal of progress in horizontal international specialization as well as a jump in the export ratio.[11]

Considering all these results, improvement in Taiwan's productivity was achieved in sectors that (1) introduced more foreign direct investment, (2) were less capital-intensive, and (3) were exposed to less import penetration.

However, some qualifications should be made. Regarding the FDI stock / total capital stock ratio, it should be noted that the coefficient estimate in model 1 was not highly significant, only at the 20 per cent level. Regarding the export ratio, a weak negative correlation was observed between it and the TFP. However, one should note the insignificant coefficient estimate in model 1 and the positive interaction coefficients estimated in models 2 through 4 when interacting with the other independent variables. Therefore, it would be risky to admit a uniform and definite statistical relationship between the export ratio and the TFP. If a sector becomes very capital-intensive or import competitive, it was suggested in models 3 and 4 that an increase in the export ratio tends to improve sector productivity. Results from model 4 also imply a possibility that progress in horizontal international specialization improves sector productivity.

[11] If an interaction partner variable satisfies the following condition, then the overall productivity impact of the export ratio is estimated to be statistically significant:

$$t_\alpha \, SE(\text{overall impact}) \,/\, b_I < [\ln(\text{partner}) - \ln(\text{critical value of the partner})],$$

where t_α is the critical t-value at the significance of α; $SE(\cdot)$ stands for the standard deviation; b_I is the regression coefficient of the interaction term; and the critical value of the partner is the level of the partner variable, which is shown by $-b_{EXPROD}/b_I$, which sets the overall impact to zero. The confidence intervals of each partner variable (left-hand side of the above formula) are shown below.

Overall Impact of the Export Ratio	Condition (at the 20% Significance Level)	Critical Value
Model 2:		
+	*FDIK*>96.9%	*FDIK*=17.7%
−	*FDIK*< 3.2%	
?	Otherwise	
Cov (*EXPROD*, Interaction term)=0.0003459297		
Model 3:		
+	*KL*>NT$1.54 mil.	*KL*=NT$1.16 mil.
−	*KL*<NT$0.87 mil.	
?	Otherwise	
Cov (*EXPROD*, Interaction term)=0.0009823576		
Model 4:		
+	*PENE*>5,680%	*PENE*=2,535%
−	*PENE*<1,130%	
?	Otherwise	
Cov (*EXPROD*, Interaction term)=0.0006584873		

CONCLUDING REMARKS

Section I reviewed the course of Taiwan's trade and FDI policies. The country started to shift its policy direction toward export promotion as early as the late 1950s, far more quickly than other developing economies. Taiwan maintained this policy direction throughout the 1960s and 1970s. The main policy tools for export promotion during this period were tariff rebates and preferential loans for export industries. The government maintained a generous attitude toward FDI inflow, and especially welcomed it when the investor was export-oriented. However, tariff and nontariff barriers for consumer goods remained high throughout this period. In the 1980s Taiwan's external surplus steadily increased, and the government had to come to grips with trade friction, especially with the United States. Policies to cope with this problem included the phasing out of export promotion, the expansion of imports, the promotion of capital- and technology-intensive sectors, and an open-door policy toward FDI inflow.

The purpose of this study has been to examine how these policies affected productivity of Taiwan's manufacturing sector. In Section II, as an indicator of productivity, TFP indices of the Taiwan manufacturing were calculated at the subsector level. According to these calculations, the TFP growth for manufacturing as a whole was 2.6 per cent per annum for the period 1978–91, and the subsectors of electronics, fibers, and machinery showed the best performance. Among these sectors, electronics and machinery maintained high productivity performance even after 1986 when the domestic market was opened widely. It should be noted that these sectors were the main targets of the government's promotion policy of capital- and technology-intensive industries announced around 1980. On the other hand, the clothing sector recorded negative TFP growth after 1986.

In Section III, the relationship between TFP and trade and FDI liberalization policies was examined. It was concluded that the policies of the Taiwan government have generally been relevant. In this section a regression of TFP indices was carried out on the following variables: FDI stock / total capital stock ratio, export ratio, capital equipment per worker, and import penetration ratio. The coefficient estimate for the export ratio was not significant. In order to check for its significance taking into account the reciprocal effect between it and other independent variables, the author estimated models which included interaction terms for the export ratio and the other independent variables. According to the estimation results, the FDI stock / total capital stock ratio had a positive, though rather weak, impact on productivity. This provides supporting evidence that the Taiwan government had an open-door policy toward FDI inflow. Regarding the export ratio, a clear-cut relationship with TFP was not observed. However, the government's policy was justifiable in the sense that it is reasonable to decrease support to those areas whose contribution to productivity is becoming unclear. One important suggestion regarding the export ratio is that its increase might help when a sector is highly capital-intensive or competing fiercely with imports.

In the latter case, the consequence of increased exports is progressive horizontal international specialization. The estimation results showed that capital equipment per worker had a negative relationship with TFP. This would reflect the fact that Taiwan's economy was already becoming capital abundant in the 1980s. Considering that the sectors selected for promotion around 1980 were not really capital-intensive ones, the government's choice of sectors was generally relevant. Regarding import penetration, however, the result was contrary to expectation, and the productivity impact was estimated to be negative. For some sectors such as wood products and clothing, import liberalization might have proceeded too quickly.

In this study, direct policy variables and other important variables affecting TFP (such as financial losses due to promotion of preferential industries, sector tariffs, the level of R & D activities, and the market concentration ratio) were not adopted, due to the insufficient availability of data. Also when reviewing the Taiwan government's promotion policy, sector reviews were not presented. The expansion of this study, along with the collection of a better database and the addition of reviews of sector policy are tasks that remain for the future.

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APPENDIX TABLE I

TFP INDEX OF TAIWAN'S MANUFACTURING BY SUBSECTOR

	Food	Fibers	Clothing	Leather	Wood	Paper	Chemicals	Nonmetals	Metals	Machin.	Electronics	Total
1978	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1979	104.4	96.0	103.1	116.8	92.8	112.4	103.8	93.4	101.9	100.0	91.0	100.0
1980	104.0	117.0	121.5	113.0	81.1	118.3	103.5	100.4	101.7	105.8	96.0	104.5
1981	113.8	129.5	136.3	108.1	96.2	125.1	106.6	102.8	95.7	115.6	103.2	111.5
1982	110.9	123.0	141.6	114.5	89.8	106.7	105.6	99.9	89.2	114.7	106.8	109.7
1983	118.3	120.4	138.3	113.2	93.4	100.0	110.6	108.1	97.2	117.7	116.7	113.6
1984	121.3	126.3	146.6	120.5	105.4	102.2	112.5	106.2	102.8	118.1	130.0	118.2
1985	122.4	129.5	134.7	128.1	120.7	101.1	111.6	106.9	105.2	114.7	132.1	119.3
1986	120.4	148.2	139.2	136.1	153.8	110.8	108.4	108.2	114.8	123.4	155.5	127.4
1987	121.8	150.7	139.3	128.6	155.2	105.7	115.7	108.4	112.5	133.5	168.7	130.9
1988	120.7	134.7	127.5	121.3	146.3	99.8	110.0	109.4	112.7	135.5	178.1	129.2
1989	120.5	143.5	128.9	126.9	142.3	100.6	108.1	109.9	111.4	139.9	179.8	130.2
1990	128.1	150.6	129.0	134.9	121.0	107.2	107.6	113.7	111.0	141.6	179.6	132.9
1991	134.6	165.8	131.0	144.2	132.0	106.3	114.1	114.6	117.6	147.2	192.6	140.2
Annual growth rate (%):												
1978–85	2.9	3.0	4.3	3.5	2.7	0.2	1.6	1.0	0.7	2.0	4.0	2.5
1986–91	1.6	4.1	−0.5	2.0	1.5	0.8	0.4	1.2	1.9	4.2	6.3	2.7
1978–91	2.3	3.9	2.1	2.8	2.1	0.5	1.0	1.0	1.2	3.0	5.0	2.6

Source: Calculated from DGBAS [11].

APPENDIX TABLE II

FDI Stock / Total Capital Stock Ratio by Subsector

(%; 1986 prices)

	Food	Fibers	Clothing	Leather	Wood	Paper	Chemicals	Nonmetals	Metals	Machin.	Electronics	Total
1978	0.40	0.71	1.51	4.32	0.38	0.24	3.29	2.71	4.71	7.35	35.26	4.94
1979	0.40	0.66	1.49	3.50	0.42	0.21	3.14	2.26	3.89	6.54	33.58	4.76
1980	0.52	0.61	1.36	2.84	0.40	0.18	3.35	2.22	3.56	5.80	30.76	4.63
1981	0.90	0.53	1.34	2.31	0.36	0.16	3.35	1.93	3.37	6.06	27.85	4.44
1982	1.13	0.47	1.39	1.88	0.96	0.13	3.28	1.90	3.35	5.45	26.24	4.21
1983	1.04	0.39	1.23	1.83	1.22	0.10	3.24	1.97	2.93	8.63	26.56	4.29
1984	0.98	0.32	1.14	1.31	1.12	0.13	3.86	1.61	2.63	8.05	31.36	4.53
1985	1.14	0.29	1.13	1.35	1.02	0.22	4.84	1.50	2.81	8.68	30.77	4.74
1986	1.02	0.28	1.02	1.11	0.94	0.19	4.88	1.53	2.53	9.56	31.75	4.79
1987	1.73	0.28	1.09	1.81	0.92	0.21	4.92	2.24	2.89	19.76	32.87	5.88
1988	1.94	0.35	1.13	1.84	1.19	0.18	4.30	2.41	2.67	17.57	29.71	5.38
1989	3.37	0.57	1.20	2.66	2.05	0.15	5.21	2.45	3.09	15.44	28.98	5.76
1990	3.81	0.62	1.22	3.59	2.13	0.16	5.82	2.57	3.57	14.45	28.07	6.06
1991	3.64	0.81	1.64	4.42	1.91	0.14	5.45	2.63	3.50	14.11	28.95	6.12
Average by period:												
1978–85	0.8	0.5	1.3	2.4	0.7	0.2	3.5	2.0	3.4	7.1	30.3	4.6
1986–91	2.6	0.5	1.2	2.6	1.5	0.2	5.1	2.3	3.0	15.1	30.1	5.7
1978–91	1.6	0.5	1.3	2.5	1.1	0.2	4.2	2.1	3.2	10.5	30.2	5.0

Sources: For FDI, Investment Commission [13]. For exchange rate, DGBAS [10]. For investment deflator, DGBAS [9]. For total capital stock, DGBAS [11].

Notes: Procedures for obtaining FDI stock are as follows: (1) Obtain NT dollar-term FDI by dividing U.S. dollar-term FDI as shown in Investment Commission [13] by the exchange rate for each year (2) Deflate the NT dollar-term FDI by the 1986 investment deflator. (3) Sum up results of (2) for each year, starting from 1965, allowing for 10 per cent depreciation. For the depreciation rate, see Choi and Hyeong [2].

APPENDIX TABLE III

EXPORT RATIO BY SUBSECTOR

(%)

	Food	Fibers	Clothing	Leather	Wood	Paper	Chemicals	Nonmetals	Metals	Machin.	Electronics	Total
1978	9.00	44.41	57.27	43.75	48.43	6.33	10.90	13.36	15.48	33.16	44.57	28.54
1979	8.10	46.78	59.66	37.11	52.00	6.43	9.77	13.59	19.15	30.53	45.08	28.68
1980	10.89	46.90	62.33	35.11	53.04	7.34	9.17	14.95	15.81	33.12	46.94	29.64
1981	8.58	45.97	62.21	41.69	52.30	7.66	9.42	17.18	20.08	38.09	49.21	31.33
1982	8.39	49.03	64.89	27.11	54.04	8.14	9.74	19.39	22.23	44.79	49.10	32.72
1983	6.87	49.74	69.31	21.82	62.88	7.17	10.29	23.18	23.46	46.04	48.86	34.05
1984	6.48	51.05	74.24	23.93	61.86	5.48	10.86	25.89	25.04	55.52	45.49	35.63
1985	6.21	55.14	72.08	21.74	61.01	6.89	11.42	23.90	25.75	63.87	44.29	36.36
1986	7.05	56.84	75.82	22.40	66.54	8.30	13.43	26.53	25.76	71.50	43.57	40.55
1987	5.92	57.67	70.31	24.93	68.04	7.73	14.14	30.13	26.08	76.73	43.31	41.99
1988	6.43	60.75	66.46	27.78	63.68	9.64	14.83	27.29	25.84	81.71	40.63	41.15
1989	4.10	60.26	57.93	17.85	63.48	9.06	16.62	21.52	24.39	80.52	42.68	39.88
1990	4.80	65.64	55.56	15.62	73.07	11.02	18.04	19.59	24.84	88.37	42.23	41.39
1991	5.59	69.97	59.67	14.21	77.15	12.86	19.18	19.92	25.82	94.64	42.85	43.78
Average by period:												
1978–85	8.07	48.63	65.25	31.53	55.69	6.93	10.20	18.93	20.88	43.14	46.69	32.12
1986–91	5.65	61.86	64.29	20.46	68.66	9.77	16.04	24.16	25.45	82.25	42.54	41.46
1978–91	7.03	54.30	64.84	26.79	61.25	8.14	12.70	21.17	22.84	59.90	44.91	36.12

Sources: For exports, Institute of Developing Economies [4]. For GDP, DGBAS [9].
Note: Ratio of exports to GDP.

APPENDIX TABLE IV

Capital Equipment per Worker by Subsector

(NT$ thousand; 1986 prices)

	Food	Fibers	Clothing	Leather	Wood	Paper	Chemicals	Nonmetals	Metals	Machin.	Electronics	Total
1978	843	621	312	111	285	632	1,235	749	579	454	371	583
1979	880	621	316	101	258	620	1,155	741	552	427	356	561
1980	940	700	302	102	261	619	1,179	798	630	448	376	593
1981	961	799	286	97	284	599	1,277	956	787	470	402	647
1982	1,121	898	260	107	307	662	1,261	992	945	537	408	692
1983	1,331	1,003	243	121	266	708	1,302	1,079	947	590	382	706
1984	1,489	1,085	237	145	262	770	1,301	1,124	924	621	343	724
1985	1,624	1,169	236	220	290	871	1,387	1,294	1,019	696	373	802
1986	1,673	1,274	241	238	289	919	1,455	1,641	1,107	726	363	844
1987	1,835	1,459	240	264	283	922	1,581	1,706	1,155	758	337	883
1988	2,010	1,535	260	318	325	1,054	1,851	1,900	1,302	792	375	1,001
1989	2,046	1,794	260	420	334	1,187	2,125	1,860	1,362	819	389	1,081
1990	2,095	2,005	274	534	387	1,273	2,505	2,105	1,414	883	432	1,189
1991	2,046	2,055	282	513	432	1,286	2,779	2,102	1,395	925	486	1,253
Average by period:												
1978–85	1,149	862	274	126	277	685	1,262	967	798	530	376	664
1986–91	1,951	1,687	259	381	342	1,107	2,049	1,886	1,289	817	397	1,042
1978–91	1,492	1,216	268	235	304	866	1,600	1,361	1,008	653	385	826

Source: Calculated from DGBAS [11].

APPENDIX TABLE V

IMPORT PENETRATION RATIO BY SUBSECTOR

(%)

	Food	Fibers	Clothing	Leather	Wood	Paper	Chemicals	Nonmetals	Metals	Machin.	Electronics	Total
1978	3.88	8.13	0.56	21.30	2.40	11.76	15.59	4.48	20.80	46.87	35.22	19.30
1979	4.36	9.90	0.65	16.39	2.46	11.40	15.06	5.37	22.05	45.56	35.41	19.90
1980	4.02	9.01	0.52	12.98	2.89	10.83	14.72	4.87	22.16	48.37	37.67	20.68
1981	4.30	8.97	0.28	15.14	4.10	10.69	13.60	5.66	22.39	49.88	38.04	20.53
1982	4.68	10.04	0.25	8.63	4.45	12.18	12.42	5.33	20.09	52.79	36.45	19.75
1983	4.53	10.93	0.29	7.94	6.44	13.94	14.18	6.79	19.75	50.46	34.85	20.27
1984	4.49	11.42	0.27	8.16	9.92	14.35	13.50	7.33	20.25	54.93	31.58	20.23
1985	4.63	11.66	0.37	5.93	8.58	14.99	12.62	6.82	18.45	59.91	28.90	19.22
1986	4.87	13.76	0.53	7.17	13.01	15.56	16.84	8.41	21.76	65.76	31.32	23.52
1987	5.50	14.73	2.41	9.08	15.82	16.62	17.42	9.25	24.72	71.77	32.38	26.17
1988	6.28	17.62	7.11	11.66	15.61	19.95	19.72	10.30	28.05	78.82	32.68	29.23
1989	6.19	17.38	6.85	9.86	22.34	18.08	21.88	11.04	27.84	78.26	32.91	29.50
1990	6.30	21.43	9.22	10.05	33.13	19.82	25.46	11.83	26.41	85.82	35.50	31.86
1991	7.18	26.94	10.32	10.31	40.97	22.12	26.01	12.90	31.29	92.95	37.51	34.52
Average by period:												
1978–85	4.36	10.01	0.40	12.06	5.16	12.52	13.96	5.83	20.74	51.10	34.76	19.99
1986–91	6.06	18.64	6.07	9.69	23.48	18.69	21.22	10.62	26.68	78.90	33.72	29.13
1978–91	5.09	13.71	2.83	11.04	13.01	15.16	17.07	7.88	23.29	63.01	34.32	23.91

Sources: For production, Department of Statistics [12]. For trade Institute of Developing Economies [4].
Note: Import penetration ratio=imports/(domestic production+imports−exports).

APPENDIX TABLE VI
SECTOR CLASSIFICATION OF MANUFACTURING

FDI Statistics	TFP Statistics	Harmonized Classification*
Food	Food	Food
	Tabacco & beverages	
Fibers	Fibers	Fibers
Clothing	Clothing	Clothing
Leather	Leather	Leather
Wood products	Wood products	Wood products
Paper	Paper	Paper
Chemicals	Chemicals	Chemicals
Rubber & plastics	Coal & petroleum	
	Rubber	
Nonmetals	Nonmetals	Nonmetals
Metals	Basic metals	Metals
	Metal products	
Machinery	Machinery	Machinery
	Transport equipment	
	Precision equipment	
Electronics	Electronics	Electronics
	Miscellaneous	

* Adopted in this study.