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4 The Effects of NT Dollar Variations on Taiwan's Trade Flows

San Gee

The vast appreciation of the New Taiwan (NT) dollar after the mid-1980s has not only affected the external trade structure of Taiwan but has also had a tremendous impact on internal industrial structural change in Taiwan. For instance, the NT dollar's dramatic appreciation against the U.S. dollar has certainly imposed great difficulties on Taiwanese exporters attempting to sell their products to the United States. In addition, the rising tide of protectionism in the mid-1980s created tremendous pressure for Taiwanese exporters to diversify their markets away from the United States. It is also important to note that, while the NT dollar appreciated considerably against the U.S. dollar, the German mark and Japanese yen appreciated against the U.S. dollar at an even faster pace. As a result, the NT dollar has actually depreciated against the German mark and Japanese yen, despite the fact that it has appreciated by more than 30 percent over the period 1986–90. Furthermore, many Southeast Asian currencies have actually depreciated against the U.S. dollar, which makes it very difficult for Taiwan's exporters to diversify their markets to this region. Consequently, it is not difficult to see that Europe has become the natural and best alternative for Taiwanese exporters to explore, and from the middle of the 1980s there has been a significant trade structure change in Taiwan.

To examine explicitly how the NT dollar appreciation affects Taiwan's external trade structure we have divided this paper into five sections. In sections 4.1 and 4.2 we establish an empirical model to examine how NT dollar fluctuations affect Taiwan's external trade relations, and we report and discuss the model's empirical results. In section 4.3, instead of using the nominal exchange rate to examine the effect of variations of the NT dollar on Taiwan's external trade, we shall calculate the real effective exchange rate (REER) for NT dollars and shall

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investigate what kind of REERs are more capable of indicating proper exchange rate levels for the NT dollar and how REERs can explain the export and import behavior of Taiwan's economy. Since REERs are less suitable for explaining bilateral trade activities, in section 4.4 we calculate the price-competition index (PCI) for Taiwan's major trading partners and examine the relationship between PCIs and bilateral trade activities between Taiwan and these partners. Finally, a brief summary of the main findings in this paper is made in section 4.5.

4.1 The Empirical Model

Some studies, for instance, Miles (1979), have tried to determine how a devaluation affects the trade balance or balance of payments. In Miles's model the trade balance is affected by real factors such as the relative growth rate and real output as well as by monetary factors such as the money supply and nominal exchange levels. Miles found that devaluations do not improve the trade balance but do improve the balance of payments. However, Miles's study was criticized by Himarios (1985) for two major reasons: first, Miles uses only nominal exchange rates in his model to examine the effect of exchange rate variations on trade flow. However, as Krueger (1978) pointed out, following devaluation it is the price of tradables *relative* to nontradables that matters. Therefore, Himarios argued, it would be more appropriate to use the real exchange rate, rather than nominal rates, to examine the effect of exchange rate variations on the trade balance. Second, Himarios argued that Miles imposes a priori subtractive linear restrictions and that they produce biased estimates of the coefficients. In light of these studies by Miles and Himarios, we shall undertake a more detailed study by separating Taiwan's trade balance into exports and imports and then examining how these two contrasting trade activities are affected by the nominal and real exchange rates. In addition, a linear, rather than a subtractive linear restrictions, form is employed in order to avoid bias in the estimates.

In light of the above discussion, we shall now specify our empirical model of the effect of changes of the nominal exchange rate on Taiwan's total export (TEXT) as

$$\text{TEXT} = f(\text{INCOME, UST, WAGE, Q1} - \text{Q3, T}), \text{ where}$$

TEXT: Taiwan's total quarterly export value (in million U.S. dollars) from the first quarter of 1972 to the fourth quarter of 1990.

INCOME: the weighted average GNP of Taiwan's five major export destination countries/areas (the United States, Japan, Canada, Singapore, and Hong Kong). The weights are based on their share of exports.

UST: Exchange rate between one NT dollar and the U.S. dollar.

WAGE: Relative real wage ratios between Taiwan's real wages and the

weighted average real wages of the above five major exporting countries/regions. The weights are also determined by their share of exports.

Q1 − Q3: Quarterly dummies.

T: Time trend variable.

As for Taiwan's total imports model, it is specified as

$$TIMT = f(TGNP, UST, WAGE, Q_1 - Q_3, T), \text{ where}$$

TIMT: Taiwan's total quarterly import value (in million U.S. dollars) from the first quarter of 1972 to the fourth quarter of 1990.

INCOME: Taiwan's quarterly GNP in billion U.S. dollars.

WAGE: Relative real wage ratios between Taiwan's real wages and the weighted average real wages of Taiwan's five major import-source countries/regions (the United States, Japan, West Germany, Singapore, and Hong Kong).

In the above models we assume that Taiwan's exports (imports) depend on importing countries' (Taiwan's) income levels and terms of trade, which include relative real wages or productivity as well as exchange rates, seasonal factors, and time trends. If we merely wish to examine Taiwan's import and export relationship with the United States, then INCOME will be U.S. GNP, and WAGE will be the relative real wage ratio between Taiwan and the United States.

4.2 Empirical Results for the Nominal Exchange Rate Model

Based on our empirical models of the equations for TEXT and TIMT, we present our empirical results in table 4.1. From this table, we see that when Taiwan's income in terms of GNP value increases, INCOME significantly and positively affects Taiwan's total importing value (TIMT). As for exchange rates, the first two equations of table 4.1 show that an appreciation in the NT dollar (which will lead to an increase in UST by our definition) will lead to an increase in Taiwan's total import value, but this increase will not become significant until after two to three quarters have elapsed. As for the relative real wage ratio between Taiwan and the weighted average of Taiwan's five major import sources, the WAGE variables in equations (1) and (2) confirm that an increase in Taiwan's productivity relative to that of its import sources will lead to a decline in Taiwan's total importing value. Clearly the first two equations of table 4.1 show that an increase in Taiwan's income and/or an appreciation of the NT dollar will lead to an increase in Taiwan's total imports, while an increase in Taiwan's productivity will result in more import substitution and will reduce Taiwan's total imports.

Equations (3) and (4) of table 4.1 report the empirical results for Taiwan's total export value (TEXT). Our empirical results show that an increase in the

Table 4.1 **Determination of Taiwan's Total Exports (TEXT) and Imports (TIMT) (absolute *t*-statistics)**

	TIMT		TEXT	
Variable	(1)	(2)	(3)	(4)
CONSTANT	−6.55 E-3	−9.26 E-3	−1.09 E-4	−1.11 E-4
	(2.68)***	(3.60)***	(9.15)***	(6.55)***
INCOME	171.52	116.49	4.76	4.74
	(2.71)***	(1.70)*	(5.66)***	(5.69)***
UST	1.21 E-5	3.60 E-4	4.86 E-5	5.21 E-5
	(1.47)	(0.41)	(8.19)***	(7.47)***
UST1	7.34 E-4	6.15 E-4	−8.34 E-5	−7.64 E-4
	(1.28)	(1.18)	(1.38)	(1.20)
UST2	9.97 E-4	5.35 E-4	−1.36 E-5	−1.04 E-5
	(1.80)*	(1.01)	(2.36)**	(1.60)
UST3		2.79 E-5		−6.43 E-4
		(3.63)***		(0.70)
WAGE	1225.19	−2103.83	2312.47	−2268.60
	(0.82)	(0.98)	(1.20)	(0.82)
WAGE1	−2450.52	−5841.09	2752.63	3582.72
	(1.32)	(2.53)**	(1.25)	(1.24)
WAGE2	−5420.13	−5151.16	1628.40	924.07
	(3.44)***	(2.13)**	(0.90)	(0.39)
WAGE3		−321.52		−1554.56
		(0.14)		(0.66)
Q1	−157.30	−99.21	−432.68	−464.24
	(1.43)	(0.99)	(3.77)***	(3.84)***
Q2	182.71	246.19	141.89	91.99
	(1.49)	(2.17)**	(1.12)	(0.67)
Q3	56.82	92.98	228.91	195.44
	(0.54)	(0.94)	(2.10)**	(1.65)
T	61.57	86.79	−70.40	−66.68
	(2.76)***	(3.65)***	(1.60)	(1.51)
$\bar{R}^2$	0.93	0.93	0.97	0.98
D-W	1.87	1.94	1.85	1.81
N	78	78	78	78

Notes: Variable INCOME in TIMT equations is Taiwan's GNP level, in TEXT equations, the weighted average GNP of Taiwan's five major export markets. In addition, consult text under eq. (1) and (2) for definitions of WAGE in TIMT and in TEXT equations. UST1, UST2, UST3, WAGE1, WAGE2, and WAGE3 are different time lag variables for variables UST and WAGE, respectively.

*Significant at 10 percent level

**Significant at 5 percent level

***Significant at 1 percent level

weighted average GNP of Taiwan's major export markets (INCOME) will lead to an increase in Taiwan's total exports; the income effect is thus quite clear. As for exchange rates, equations (3) and (4) show that an appreciation in the NT dollar will initially lead to an increase in Taiwan's total exports but will then have an adverse effect on Taiwan's total exports. However, judging from the empirical results in equation (4), this adverse effect may not be very significant. The main reason that an appreciation in the NT dollar will lead to an increase in Taiwan's total exports in the initial period may be that, in light of possible further NT dollar appreciation, Taiwanese exporters are likely to deliver their shipments earlier than they had originally scheduled. Therefore Taiwan's total export value will rise particularly in the initial period of NT appreciation. Although in equation (3) we have confirmed that an appreciation in the NT dollar will adversely affect Taiwan's total exports, this result is not supported by our findings in equation (4). One possible explanation for this may be that an appreciation in the NT dollar against the U.S. dollar may adversely affect Taiwanese exports to the U.S. market. However the NT dollar has actually depreciated against other vastly appreciated currencies such as the German mark and Japanese yen, which will certainly help Taiwan's exporters diversify their markets away from the United States to other major markets, in particular the European market. Consequently, an appreciation in the NT dollar may have no significant impact on Taiwan's total export value.

To support the above argument, we can examine market share statistics in table 4.2. Here, we list Taiwan's export shares for the United States, Japan, and European countries. The statistics show that Taiwan's share of the U.S. market increased dramatically from 34 percent in 1980 to 48 percent in 1985. This is due mainly to the undervaluation of the NT dollar accompanied by the rapid

Table 4.2 **Taiwan Major Export Partners (%)**

Year	United States	Japan	Europe	Great Britain	France	Netherlands	West Germany
1980	34	11	16	2	1	2	5
1981	36	11	13	3	1	2	4
1982	39	11	12	2	1	1	4
1983	45	10	11	2	1	2	3
1984	49	10	10	2	1	1	3
1985	48	11	10	2	1	1	3
1986	48	11	12	2	1	2	3
1987	44	13	15	3	1	2	4
1988	39	14	16	3	2	2	4
1989	36	14	17	3	2	2	4
1990	32	12	18	3	2	3	5
1991	29	12	18	3	2	3	5

Source: Monthly Statistics of Export and Import in Taiwan Area of the ROC (Taipei: Ministry of Finance).

acceleration of the U.S. trade deficit from the early to the mid-1980s. However, as the NT dollar appreciated dramatically after the mid-1980s and as the tide of protectionism in the United States rose, Taiwanese exporters swiftly shifted their markets from the United States to Europe. As a result, Taiwan's U.S. market share declined from 48 percent in 1985 to 32 percent in 1990 and 29 percent in 1991, while Taiwan's European market share increased from 10 percent in 1985 to 18 percent in 1990 and 1991. Clearly, there was a dramatic structural change in Taiwan's trade relationship with the United States and Europe in the 1980s.

In table 4.3, we examine how changes in exchange rates and relative productivities affect Taiwan-U.S. trade. In the first two equations of this table we present the empirical results for Taiwanese imports from the United States (TIMUS). From equation (1) we see that Taiwanese GNP (represented by INCOME) has a significant effect on U.S. exports to Taiwan, while an appreciation in the NT dollar against the U.S. dollar (UST2) and an increase in Taiwan's productivity relative to that of the United States (WAGE2) have significant positive and negative impacts, respectively, on Taiwan's imports from the United States six months later. In equation (2) of table 4.3, we introduce more time lags for exchange rate (UST) and relative productivity (WAGE) variables to examine factors relevant to Taiwanese imports from the United States. The empirical results again confirm the result in equation (1) that an appreciation in the NT dollar will lead to a reduction in import cost and induce more imports from the United States. Conversely, an improvement in Taiwan's productivity relative to that of the United States will promote more import substitution and will reduce Taiwanese imports from the United States.

We also examine relevant factors that affect Taiwanese exports to the United States. The empirical results from equations (3) and (4) show that U.S. GNP levels (INCOME) positively affect Taiwanese exports to the United States. An appreciation in the NT dollar against the U.S. dollar will adversely affect Taiwanese exports to the United States—though it may promote such exports in the first period of NT appreciation. Contrary to our expectations, however, equations (3) and (4) show that an improvement in Taiwan's productivity relative to that of the United States will reduce Taiwanese exports to the United States. This is illustrated by the many negative and highly significant regression coefficients for the WAGE variables. There are several possible explanations for this phenomenon. First, as Taiwan improves its productivity, more and more Taiwanese exporters find it feasible to meet the higher standards demanded by European customers, and therefore an increase in Taiwan's productivity may result in a structural shift in exports away from the U.S. to the European market. Second, the United States introduced more trade protection clauses such as "301" or "super 301" into the U.S. Trade Act in the mid- to late-80s, and this undoubtedly forced Taiwanese exporters to diversify their export market away from the United States. These responses were, in turn, negatively correlated with the faster-rising productivity trend (relative to the

Table 4.3 **Determination of Taiwan's Total Exports (TEXUS) and Imports (TIMUS) with the United States (absolute *t*-statistics)**

	TIMUS		TEXUS	
	(1)	(2)	(3)	(4)
CONSTANT	−2.32 E-3	−4.30 E-3	−3.67 E-3	−5.64 E-3
	(3.90)***	(3.30)***	(2.24)**	(3.62)***
INCOME	35.82	59.09	1.60	2.47
	(2.02)**	(1.39)	(2.26)**	(5.06)***
UST		−7.93 E-4	2.19 E-5	2.98 E-5
		(1.82)*	(6.55)***	(8.47)***
UST1		7.58 E-4	−3.60 E-4	−1.69 E-4
		(2.52)**	(1.15)	(0.51)
UST2	9.67 E-4	5.30 E-4	−9.06 E-4	−6.67 E-4
	(4.18)***	(1.56)	(2.58)***	(1.90)*
UST3		1.51 E-5		−5.73 E-4
		(3.40)***		(1.18)
WAGE		−1471.29	−4493.74	−5514.88
		(0.90)	(3.48)***	(3.48)***
WAGE1		−1459.32	−2422.12	−2869.92
		(0.85)	(1.80)*	(1.54)
WAGE2	−2325.61	−4526.07	1651.16	−914.55
	(1.91)*	(2.29)**	(1.34)	(0.60)
WAGE3		−3777.36		−3644.38
		(2.12)**		(2.60)**
Q1	38.63	14.49	−156.47	−214.71
	(0.75)	(0.27)	(2.95)***	(3.65)***
Q2	132.09	71.29	141.56	93.74
	(2.29)**	(1.17)	(2.32)**	(1.38)
Q3	67.87	53.09	139.93	121.31
	(1.19)	(1.02)	(2.72)***	(2.11)**
T	18.61	30.48	−7.23	−33.52
	(3.00)***	(2.84)***	(0.17)	(1.23)
$\bar{R}^2$	0.87	0.84	0.83	0.95
D-W	1.77	1.72	1.76	1.74
N	78	78	78	78

Notes: Variable WAGE is relative real wages (productivities) between Taiwan and the United States. Variable INCOME in TIMUS equations is Taiwan's GNP level, in TEXUS equations, U.S. GNP level.

*Significant at 10 percent level.

**Significant at 5 percent level.

***Significant at 1 percent level.

United States) in Taiwan. Third, beginning in the mid-1980s Taiwan's outward investment in Southeast Asian countries, as well as in mainland China, increased dramatically. The statistics from the investment authorities of Southeast Asian countries show that in 1989, in Thailand, Malaysia, and the Philippines, Taiwan ranked second only to Japan as the largest foreign direct

investment (FDI) source country. Furthermore, it is estimated that the total amount of Taiwanese investment in mainland China increased from $100 million (U.S.) in 1987 to more than $1 billion (U.S.) in 1989. These huge outward investments may be due to such internal factors as the labor shortage together with rising labor cost, the introduction of the Labor Standards Law in 1984 to protect worker's rights, which in turn boosted the cost of labor considerably, the relaxation of foreign exchange control, and the appreciation of the NT dollar. More and more traditional labor-intensive industries have thus moved their operations out of Taiwan. This, in turn, may actually increase Taiwan's overall competitiveness, but it will reduce Taiwanese exports to the United States. Therefore, the negative relationship between a relative improvement in Taiwan's labor productivity and a decline in its export to the United States, as we found in table 4.3, may not be unreasonable at all. From the discussion above we would like to point to the significant trade-structure shift from the United States to Europe after the mid-1980s, which is, in fact, in accordance with the appreciation of the NT dollar and industrial restructuring in Taiwan. To explore this issue more carefully, we shall now turn to the model of Taiwan's trade with Europe in table 4.4.

In table 4.4 we present our empirical results for international trade between Taiwan and Europe. From equations (1) and (2) of this table, we see that Taiwan's income level is the most important factor in determining Taiwan's total import value from Europe. Furthermore, our empirical results also confirm that an appreciation in the NT dollar will also increase Taiwan's imports from Europe. However some possible negative effects also exist. From equations (1) and (2) we also find that an increase in Taiwan's productivity relative to that of the European countries will lead initially to an increase in Taiwan's imports from Europe, but eventually to a decline in such imports. As for Taiwanese exports to Europe, equation (3) in table 4.4 shows that an appreciation in the NT dollar against the U.S. dollar will induce Taiwanese exports to Europe in the initial period. This is likely due to the depreciation of the NT dollar relative to the German mark. As for the relative productivity factor between Taiwan and the European countries, equation (3) suggests that an increase in Taiwan's productivity might induce more Taiwanese exports to Europe (the t-statistic for WAGE1 is 1.77). However, the Durbin-Watson (D-W) statistic for equation (3) is still too weak for us to make a strong assertion. In equation (4) we present the empirical results for Taiwanese exports to Europe without correcting for serial correlation. Again, we do find empirical evidence that increased Taiwanese productivity has enhanced Taiwan's diversification to the European market. However the poor D-W statistic keeps us from making any further arguments. Perhaps the basic problem in identifying such a trade structure change is that the relevant change may have occurred only in recent years, too recent to undergo rigorous statistical testing.

In this section of the paper we adopted quarterly data from 1972 to 1990 to examine how a fluctuation in the NT dollar/U.S. dollar exchange rate affects

Table 4.4 **Determination of Taiwan's Total Export to (TEXE) and Import from (TIME) Europe (absolute *t*-statistics)**

	TIME		TEXE	
	(1)	(2)	(3)	(4)
CONSTANT	−486.87	−545.08	−1100.48	−1644.43
	(2.59)**	(2.62)**	(2.18)**	(7.63)***
INCOME	30.63	29.72	0.07	0.37
	(6.01)***	(5.35)***	(0.31)	(3.85)***
UST	2.45 E-4	2.42 E-4	2.33 E-4	6.32 E-4
	(2.52)**	(2.10)**	(2.61)***	(4.91)***
UST1	−1.99 E-4	−1.92 E-4	1.02 E-4	−5.09 E-3
	(1.82)*	(1.74)	(1.17)	(0.31)
UST2	1.56 E-4	6.58 E-3	1.32 E-3	2.96 E-3
	(1.69)	(0.59)	(0.15)	(0.17)
UST3		1.15 E-4		−1.71 E-4
		(1.01)		(1.07)
WAGE	741.30	690.26	157.94	210.52
	(3.14)***	(2.41)**	(0.62)	(0.44)
WAGE1	−115.55	−346.89	559.51	825.53
	(0.52)	(1.26)	(1.77)*	(1.72)*
WAGE2	−769.77	−796.82	236.05	814.55
	(3.37)***	(3.09)***	(0.94)	(2.07)**
WAGE3		156.16		802.50
		(0.57)		(1.91)**
Q1	−32.25	−28.11	−26.40	−19.18
	(1.55)	(1.34)	(1.81)*	(0.62)
Q2	20.44	29.33	−16.67	−5.35
	(0.99)	(1.33)	(1.01)	(0.17)
Q3	18.09	27.34	7.32	7.87
	(0.94)	(1.32)	(0.52)	(0.25)
T	−0.77	−0.34	15.84	−10.32
	(0.45)	(0.17)	(1.04)	(2.02)**
$\bar{R}^2$	0.97	0.97	0.49	0.98
D-W	1.99	1.99	1.50	0.88
N	78	78	78	78

Notes: Variable INCOME in TIME equations is Taiwan's GNP level, in TEXE equations, the weighted average GNP of major European countries. Variable WAGE is relative real wages (productivities) between Taiwan and weighted average of major European countries.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

Taiwan's overall international trade, Taiwan's trade with the United States, and Taiwan's trade with European countries. Our empirical results suggest that among various factors affecting international trade, changes in the importing countries' income level is one of the most important in determining Taiwanese exports. Similarly, changes in Taiwan's own income level will also significantly

affect Taiwan's import value. Besides income levels, this study also confirms that an appreciation in the NT dollar will increase Taiwan's imports from the United States and Europe as well as Taiwan's overall import value. However, there is a time lag of roughly four quarters for such a stimulation.

Contrary to popular perceptions, we find that an increase in Taiwan's productivity relative to that of importing countries will not have any significant effect on Taiwan's overall level of exports. In addition, this increase in Taiwan's relative productivity may actually reduce Taiwan's exports to the United States. One possible explanation for such a phenomenon is that as Taiwan's productivity improves relative to that of the United States, Taiwanese exporters are more likely and more able to diversify their markets away from the United States to European countries, either because of rising protectionism starting in the mid- to late 1980s in the United States, or because of the depreciation of the NT dollar relative to the German mark, or because of both. As a result, we observe that the share of the U.S. market held by Taiwan's total exports dropped from 48 percent in 1985 to 29 percent in 1991, whereas that share of the European market increased from 10 percent in 1985 to 18 percent in 1991. In this study we also found some empirical evidence for our argument that an increase in Taiwan's productivity relative to that of the European countries will increase Taiwanese exports to those countries. However, because these structural changes have been observed in more recent years, further empirical testing using a longer series of data is needed in order to identify the cause for such changes.

Generally speaking, the role of the NT dollar/U.S. dollar exchange rate is critical to Taiwan's export performance. We find that an appreciation in the NT dollar will adversely affect Taiwan's exports to the United States but that it may have a less adverse affect on Taiwan's exports to Europe. Furthermore, our empirical results show that as the NT dollar appreciates against the U.S. dollar Taiwan's exports are likely to increase, particularly in the initial period of NT dollar appreciation. This is primarily because Taiwanese exporters are likely to advance their delivery ahead of the original schedule in order to minimize their loss from a continuing stronger NT dollar. In the above study, we also found two contradictory results as to the effect of NT dollar appreciation on Taiwan's total exports: one empirical model shows that the vast appreciation of the NT dollar may not necessarily have any significant effect on Taiwan's overall export performance, and the factors discussed above could explain such phenomena. On the other hand, our empirical study does find that NT dollar appreciation can adversely affect Taiwan's overall export performance. To reconcile these differences, further study through differential approaches to the effect of exchange rates on compositional change in Taiwan's overall trade activity is warranted. We turn to this in the next section.

4.3 The Real Effective Exchange Rate and Taiwan's External Trade

In the sections above, we utilized nominal exchange rates to evaluate Taiwan's external trade. The direct advantages of using nominal rates are twofold: namely, the U.S. dollar is the most commonly used currency for international trade, and the adoption of nominal exchange rates between the NT dollar and the U.S. dollar merely reflects this fact. Second, the NT dollar has appreciated considerably against the U.S. dollar since the mid-1980s, and the adoption of nominal exchange rates will thus be able to capture the impact of this appreciation. However, as we discussed in the previous section, both Krueger (1978) and Himarios (1985) argued that it is more appropriate to use the real exchange rate rather than nominal rates to examine the effect of exchange rate variation on trade balance. Furthermore, it is important to note that other major currencies such as the Japanese yen, French franc, and German mark also appreciated considerably against the U.S. dollar in the mid- to late 1980s. In addition, the relative price changes in major trading countries are important in determining comparative advantage for Taiwan's international trade. To properly take all of these factors into consideration, we must evaluate Taiwan's currency on its real effective exchange rate base rather than its nominal value. For this, we shall now try to calculate Taiwan's real effective exchange rates (REER) and try to examine how they will affect Taiwan's external trade.

4.3.1 The Calculation of the Real Effective Exchange Rates

To properly evaluate the real value of the NT dollar, we calculate its real effective exchange rates (REER) from its nominal effective exchange rates (NEER). The formulas for the relevant calculations are:

$$\text{NEER} = \prod_{j=1}^{n}\left(\frac{RT_{j,t}}{RT_{j,0}}\right)^{W_{j,t}*100}, \text{ where}$$

NEER = nominal effective exchange rate for the NT dollar,
$RT_{j,t}$ = exchange rates between one NT dollar and country j's currency at period t,
$RT_{j,0}$ = exchange rate between one NT dollar and country j's currency at period 0, and
$W_{j,t}$ = weights for country j at period t.

$$\text{REER} = \frac{\text{NEER}}{\prod_{j=1}^{n}\left(\frac{P_{j,t}/P_{j,0}}{P_{\text{T},t}/P_{t,0}}\right)W_{j,t}}, \text{ where}$$

REER = real effective exchange rate of NT dollars,
$P_{j,t}$ = wholesale price index of country j at period t,
$P_{j,0}$ = wholesale price index of country j at period 0,
$P_{\text{T},t}$ = wholesale price index of Taiwan (T) at period t, and
$P_{t,0}$ = wholesale price index of Taiwan (T) at period 0.

One may use either Taiwan's bilateral trade value or Taiwan's average export value with country j as the weight for country j in the calculation of NEER and REER. The formula for bilateral-trade weights is

$$W_{j,t}\ (\text{bilateral trade}) = \frac{X_{Tj} + M_{Tj}}{\sum_{j=1}^{n}(X_{Tj} + M_{Tj})},$$

where X_{Tj} = Taiwan's seasonal export value to country j,
M_{Tij} = Taiwan's seasonal import value from country j.

The formula for average-export-value weights is

$$W_{j,t}\ (\text{average export value}) = 0.5 * \frac{X_{Tj}}{\sum_{j=1}^{n} x_{Tj}} + 0.5 * \frac{X_j - M_{Tj}}{\sum_{j=1}^{n}(X_j - M_{Tj})},$$

where X_j = country j's seasonal total export value.

It is important to note that in calculating the above NT dollar exchange rate indexes, we have adopted the volume quotation method by calculating the value of country j's currency for one NT dollar. Therefore, if the REER is greater (smaller) than unity, it suggests that the NT dollar is overvalued (undervalued) and that the NT dollar should be devalued (appreciated) so that the real value of the NT dollar is comparable to that in the base period.

In this study we have chosen 1979 and 1980–82 as the two base periods for comparison. The underlying reasons for selecting these two periods are: first, beginning in 1979 Taiwan adopted a floating exchange rate system, and the resulting exchange rate levels are therefore closer to market equilibrium levels. Second, Taiwan's trade surplus in 1980 was only $7.7 million (U.S.), the closest to actual balance over the entire period of the 1970s and 1980s. Consequently, the period 1979–82 has already been adopted by the Central Bank, as well as by many other economic and financial institutions in Taiwan, as the base period for calculating effective exchange rates for the NT dollar.

The trading nations to be included in our calculation are the United States, the United Kingdom, France, (West) Germany, Italy, the Netherlands, Canada, Japan, Australia, Korea, Singapore, Malaysia, Indonesia, Thailand, and Hong Kong. The 15 countries/areas above accounted for 86 percent of Taiwan's total exports in 1991 and 84 percent over the period 1976–91. They also accounted for 83 percent of Taiwan's total trade value in 1991 and 81 percent over the period 1976–91.

Now, we first present our calculations of REERs in table 4.5. From this table it is clear that almost all trade balance statistics for TBUS, TBT, and TB15 are positive over the period 1975–90, which suggests that Taiwan enjoyed a consistent trade surplus over this period. Naturally, the relevant question is then, Does the level of the NT dollar have anything to do with the trade balance? From this table, we see that most of the RE802A statistics are smaller than our base period (1980:1–1982:4) level of 100 except in 1985:1 and

Table 4.5 **Real Effective Exchange Rates for the NT Dollar and Taiwan's Trade Balance and Foreign Exchange Reserve (FER) Statistics, 1975–90**

Year and Quarter	Rate[a]	Real Effective Exchange Rate				Trade Balance			
		RE802A	RE802B	RE79A	RE79B	TBUS[b]	TBT[b]	TB15[b]	FER[c]
1975 1	38.00	95.39	99.71	103.23	104.05	—	−185	—	1.073
2	38.00	97.37	101.92	105.36	106.36	—	−93	—	1.061
3	38.00	99.48	102.91	107.64	107.40	—	−179	—	1.164
4	38.00	98.50	101.81	106.59	106.25	—	−186	—	1.074
1976 1	38.00	97.96	101.17	105.87	105.30	239	66	153	1.004
2	38.00	97.94	100.73	105.85	104.84	266	72	163	1.301
3	38.00	96.89	99.33	104.70	103.39	422	239	397	1.536
4	38.00	96.01	98.86	103.76	102.89	314	191	284	1.516
1977 1	38.00	94.47	97.01	102.08	100.63	239	47	126	1.259
2	38.00	93.30	95.66	100.81	99.23	363	87	138	1.320
3	38.00	92.30	94.62	99.74	98.15	473	317	372	1.351
4	38.00	89.40	91.23	96.61	94.63	597	400	525	1.345
1978 1	38.00	86.48	88.70	93.54	92.23	493	178	277	1.329
2	38.00	86.15	87.59	93.18	91.07	685	484	505	1.358
3	36.00	88.96	89.71	96.23	93.27	789	587	663	1.447
4	36.00	89.72	91.37	97.05	95.00	667	411	568	1.406
1979 1	35.95	90.38	92.97	97.89	96.87	500	251	381	1.444
2	36.10	92.11	95.37	99.77	99.38	541	254	335	1.448
3	36.03	92.09	95.85	99.74	99.87	689	548	696	1.455
4	36.03	93.29	98.18	101.04	102.30	539	277	442	1.467
1980 1	36.06	96.41	101.18	104.31	105.42	451	26	414	1.509
2	36.01	98.40	102.11	106.47	106.38	508	−246	254	1.489
3	35.93	97.03	100.39	104.99	104.59	524	−29	303	1.836
4	36.01	99.61	101.66	107.78	105.91	604	327	712	2.205

(*continued*)

Table 4.5 (continued)

Year and Quarter	Rate[a]	Real Effective Exchange Rate				Trade Balance			
		RE802A	RE802B	RE79A	RE79B	TBUS[b]	TBT[b]	TB15[b]	FER[c]
1981 1	36.35	100.81	101.26	108.52	105.22	309	−514	−21	2.665
2	36.36	102.74	102.49	110.60	106.50	683	36	516	3.339
3	37.91	102.01	101.27	109.81	105.23	1,303	1,131	1,248	5.216
4	37.84	98.19	98.41	105.70	102.26	1,104	758	1,217	7.235
1982 1	38.13	97.60	97.78	105.00	101.59	702	472	787	7.711
2	39.39	95.81	96.11	103.08	99.85	1,160	674	914	7.525
3	39.87	95.42	95.58	102.66	99.30	1,150	1,128	1,048	7.897
4	39.91	95.79	95.87	103.06	99.61	1,184	1,042	1,287	8.532
1983 1	40.04	92.94	92.67	99.85	96.00	1,031	490	981	9.585
2	40.20	94.23	93.81	101.24	97.18	1,795	1,839	1,827	10.443
3	40.19	95.93	94.98	103.06	98.40	2,044	1,682	2,048	11.446
4	40.27	94.92	93.50	101.98	96.87	1,818	824	1,484	11.859
1984 1	39.92	94.93	93.42	101.76	96.55	2,001	1,669	2,083	12.910
2	39.63	95.75	94.24	102.64	97.40	2,843	2,552	2,875	13.765
3	39.18	98.31	96.20	105.38	99.43	2,689	2,396	2,637	14.571
4	39.47	98.51	95.92	105.60	99.14	2,293	1,880	2,267	15.664
1985 1	39.54	100.52	97.10	107.92	100.38	2,020	2,123	2,461	17.614
2	40.00	96.17	94.05	103.25	97.23	2,723	2,734	3,006	18.557
3	40.40	92.43	91.30	99.23	94.39	2,790	2,938	3,130	20.001
4	39.83	89.38	88.71	95.97	91.71	2,493	2,829	3,002	22.556
1986 1	38.77	87.87	87.76	94.89	91.07	2,781	3,058	3,208	26.027
2	38.09	88.45	88.53	95.52	91.87	3,380	3,820	3,599	30.851

3	36.72	89.29	89.91	96.42	93.30	3,720	4,209	3,977	38.205
4	36.29	89.84	90.93	97.02	94.36	3,710	4,597	4,215	46.310
1987 1	34.26	90.59	92.31	98.06	96.18	3,625	4,231	4,012	54.505
2	31.08	95.30	96.86	103.15	100.91	4,312	4,889	4,610	60.717
3	30.09	97.61	99.06	105.65	103.21	4,555	5,772	5,602	64.903
4	28.55	97.98	100.03	106.05	104.22	3,539	3,762	4,118	76.748
1988 1	28.64	94.97	96.64	102.71	100.92	1,965	1,341	1,938	74.756
2	28.89	94.18	95.63	101.87	99.86	2,111	3,220	3,079	70.326
3	28.93	97.14	97.60	105.06	101.91	3,306	3,082	3,201	69.005
4	28.17	96.55	97.37	104.43	101.68	3,078	3,351	3,423	73.897
1989 1	27.17	101.32	101.64	109.46	106.24	2,446	2,773	2,785	75.156
2	25.91	105.30	105.48	113.75	110.26	3,104	3,449	3,799	74.348
3	25.60	104.76	105.27	113.17	110.03	3,521	4,288	4,456	73.801
4	27.17	96.11	97.42	103.82	101.82	2,962	3,528	3,705	73.224
1990 1	26.41	96.82	99.86	104.91	104.62	1,870	1,811	2,200	69.761
2	27.20	94.22	98.02	102.10	102.70	2,172	3,130	3,180	63.631
3	27.30	92.29	96.18	100.01	100.76	2,920	4,361	4,524	68.090
4	27.11	85.34	88.56	92.48	92.79	2,173	3,196	3,688	72.441

Notes: In this table, we have reported four different REERs, which are calculated based on four different assumptions, namely, RE802A—base period is 1980–82 and weights are average export values, RE802B—base period is 1980–82 and weights are total bilateral trade values, RE79A—base period is 1979 and weights are average export values, and RE79B—base period is 1979 and weights are total bilateral trade values.

Trade balance columns report TBUS—Taiwan's trade balance with the United States, TBT—Taiwan's total trade balance, and TB15—Taiwan's trade balance with the 15 major trading countries that we included in the REER calculation. These seasonal trade balance statistics are defined as total seasonal exports minus the corresponding seasonal imports. Therefore, a positive balance is a trade surplus for Taiwan.

Taiwan's foreign exchange reserve statistics are reported as FER.

[a]Nominal exchange rate between 1 U.S. dollar and NT dollar.

[b]In million of U.S. dollars.

[c]In billion U.S. dollars.

1983:3–1989:3. This clearly suggests that the NT dollar was undervalued most of the time, compared to the 1980–82 base period level, and should have been appreciated in order to restore the trade balance situation. Contrary to those for RE802A, however, the statistics of RE79A suggest that the NT was overvalued, especially during the period 1979:4–1985:2, because most of the RE79A statistics are greater than the base level of 100 in 1979; therefore the RE79A index suggests, although not conclusively, that the NT dollar should have been depreciated in order to restore the trade balance. As for the remaining two real exchange rate indexes—RE802B and RE79B, which utilize bilateral trade values, not merely export values, as weights to calculate the real value of the NT dollar—the statistics in table 4.5 show that these two indexes are perhaps more reliable and more reasonable than RE802A and RE79A, discussed above. One can see from table 4.5 that both the RE802B and RE79B indexes suggest that NT dollars were undervalued (the indexes are less than 100) over the period 1982 to early 1987, which is consistent with the rapid growth of the trade surplus as well as with the accumulation of foreign exchange reserves from the early to mid-1980s. In particular, both RE802B and RE79B show that around the first quarter of 1986, REERs of the NT dollar reached an all-time low point (87.76 for RE802B and 91.07 for RE79B), which suggests that the nominal exchange rate level of $1 (U.S.) for NT$38.77 in the first quarter of 1986 was very low. This unbalanced situation persisted, and in the third quarter of 1987 the nominal exchange rate was $1 (U.S.) for NTS$30.09, while RE802B and RE79B registered levels of 99.06 and 103.21, respectively. As a result, all the trade balance statistics in table 4.5 reached high points at that time, namely, $4,555, $5,772, and $5,602 million (U.S.) for TBUS, TBT, and TB15, respectively. Furthermore, the foreign exchange reserve (FER) also increased dramatically from $9.585 billion (U.S.) in the first quarter of 1983 to $64.903 billion (U.S.) in the third quarter of 1987. Obviously, as suggested by both the RE802B and RE79B indexes, the huge trade imbalance and vast accumulation of foreign exchange reserves experienced by Taiwan during the critical 1980–87 period were really due to the consistent undervaluation of the NT dollar. To dramatically cut the enormous accumulation of foreign exchange reserves, the NT dollar began to appreciate sharply from 1987:1 with a rate of $1 (U.S.) for NT$34.26 to $1 (U.S.) for NT$25.60 in 1989:3—a 25.27 percent appreciation within two years. As a result, not only did the RE802B and RE79B indexes increase dramatically, but the accumulation of foreign exchange reserves slowed.

In the discussion above, we found that RE802B and RE79B are more appropriate in explaining the trade balance and foreign exchange reserve problem in Taiwan than the other REERs calculated. To examine the performance of the four different REER indexes more carefully, one can actually compare the correlation coefficients between each of them and the trade balance statistics. As we argued before, when an REER index increases above the base period level of 100, it implies that the NT dollar is overvalued relative to the base period;

this will reduce exports, encourage imports, and therefore worsen Taiwan's trade balance. In contrast, however, when an REER index declines below the base period level of 100 the NT dollar is undervalued relative to the base period; this will encourage exports, discourage imports, and subsequently improve Taiwan's trade balance. Clearly, the correlation coefficient between Taiwan's trade balance and the REER indexes, as defined above, should be negative.

In table 4.6 we report correlation coefficients between different trade balance statistics and the four REER statistics. These results show that RE802B generally has a negative relationship with trade balance statistics, which is in accordance with our argument above. Furthermore, RE802B has larger correlation coefficients when we lag it by two (RE802(−2)) to four (RE803B(−4)) quarters. Similarly, we also find sizable correlation coefficients between various trade balance statistics and the RE79B(−2) and RE79B(−4) indexes. In contrast, however, table 4.6 also clearly shows that the correlation coefficients between trade balance statistics and RE802A or RE79A are very low. Consequently we may conclude that REER indexes weighted by bilateral trade values are more capable of illustrating interaction between trade balance statistics and the real value of the NT dollar.

To examine the relationship between REERs of the NT dollar and Taiwan's external trade activities more closely, in table 4.7 we present the regression results of REER under various definitions and different time lags. For instance, in equation (1) of table 4.7, the REER variable is represented by RE802A, and our empirical results show an increase in REER, representing an overvaluation of the NT dollar. This discouraged Taiwan's total exports (TEXT) for RE802A, and REER lagged by two quarters (REER2) is negative and highly significant

Table 4.6 **Correlation Coefficients between Taiwan's Trade Balance Statistics and Real Effective Exchange Rate (REER) Statistics**

	Trade Balance Statistics		
REER Statistics	TBUS	TBT	TB15
RE802B	−0.02	−0.12	−0.02
RE802B(−2)	−0.21	−0.20	−0.13
RE802B(−4)	−0.22	−0.16	−0.14
RE79B	−0.02	−0.11	−0.01
RE79B(−2)	−0.21	−0.19	−0.01
RE79B(−4)	−0.24	−0.17	−0.14
RE802A	0.11	−0.001	0.07
RE802A(−2)	−0.03	−0.03	0.02
RE802A(−4)	0.02	0.07	0.09
RE79A	0.11	−0.001	0.08
RE79A(−2)	−0.04	−0.04	0.01
RE79A(−4)	−0.002	0.05	0.07

Table 4.7 **Real Effective Exchange Rate (REER) and Taiwan's External Trade (absolute *t*-statistics)**

	Equation (REER)					
	(1)	(2)	(3)	(4)	(5)	(6)
Variable	TEXT (RE802A)	TIMT (RE802B)	TEXUS (RE79A)	TIMUS (RE79B)	TEXE (RE79A)	TIME (RE802B)
CONSTANT	−5.69 E-3	−6.29 E-3	−3.11 E-3	−1.69 E-3	297.05	19.04
	(1.29)	(1.30)	(1.30)	(0.77)	(0.45)	(0.07)
INCOME	5.03	329.08	1.71	21.32	0.21	45.41
	(2.53)***	(4.89)***	(1.67)	(0.41)	(0.83)	(13.73)***
REER	100.01	−31.77	47.35	−22.64	−2.46	5.12
	(3.75)***	(1.04)	(3.92)***	(1.50)	(0.78)	(1.33)
REER1	−26.96	53.32	−1.66	13.69	−1.32	−5.16
	(1.02)	(2.11)**	(0.14)	(1.20)	(0.43)	(1.04)
REER2	−72.01	11.33	−34.31	2.12	−5.94	−0.28
	(2.71)***	(0.43)	(2.87)***	(0.17)	(1.90)*	(0.05)
REER3	−7.74	48.37	−0.26	19.83	−1.05	0.76
	(0.26)	(1.73)*	(0.02)	(1.62)	(0.30)	(0.20)
WAGE	2.11 E-3	1.50 E-3	−2.63	2.44 E-3	1.23 E-3	989.19
	(0.77)	(0.58)	(1.47)	(1.66)	(2.76)***	(3.25)***
WAGE1	5.29 E-3	−3.75 E-3	−3.06	3.01	1.62 E-3	−215.85
	(1.70)*	(1.27)	(1.48)	(2.47)***	(3.05)***	(0.72)
WAGE2	5.17 E-3	−7.08 E-3	705.70	71.48	1.53 E-3	−956.42
	(1.64)	(2.04)**	(0.34)	(0.04)	(2.62)***	(3.42)***
WAGE3	5.28 E-3	−514.38	346.35	−967.79	1.26 E-3	207.93
	(1.81)*	(0.16)	(0.18)	(0.48)	(2.38)***	(0.68)
Q1	−488.00	−170.84	−181.81	−43.06	−35.64	−36.77
	(3.11)***	(1.22)	(2.29)**	(0.62)	(1.84)*	(1.27)
Q2	160.39	222.49	191.75	32.00	−18.93	17.05
	(0.09)	(1.38)	(2.14)**	(0.39)	(0.87)	(0.57)
Q3	212.83	99.27	175.06	27.80	2.45	19.67
	(1.43)	(0.72)	(2.36)**	(0.41)	(0.13)	(0.69)
T	−89.16	24.58	5.33	10.56	−2.92	−6.07
	(0.77)	(0.69)	(0.07)	(0.69)	(0.16)	(3.79)***
R^2	0.99	0.99	0.99	0.96	0.99	0.98
D-W	1.95	1.84	1.84	1.62	1.36	1.97
N	78	78	78	78	78	78

Note: Consult tables 4.1, 4.3, and 4.4 for definitions of variables INCOME and WAGE.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

(the absolute *t*-statistic is 2.71). Clearly, the empirical results in equation (1) reconfirm our previous result that an appreciation of the NT dollar effects Taiwan's total exports and can actually reduce them. Similarly, for Taiwan's total imports (TIMT) model, equation (2) shows that when we use RE802B as the index for REER we find empirical evidence that an increase in REER, or an overvaluation of the NT dollar, will encourage Taiwan's total imports. This is

quite consistent with our empirical results in table 4.1. In equations (3) and (4) we examine Taiwan-U.S. trade and our empirical results show that an increase in RE79A can adversely affect TEXUS, because REER2 is negative and highly significant, which is consistent with our empirical results in table 4.3. It is worth noting that in this study we have tried all four REERs but were unable to find one that had any significant impact on Taiwan's imports from the United States. By comparing our results here to those in table 4.3, one can see that REERs are less sensitive than nominal exchange rates in explaining Taiwan's quarterly imports from the United States. In equations (5) and (6) we show the results of how REER affects Taiwan's imports from, and exports to, Europe. We find empirical evidence that REER2 with specification RE79A can adversely affect Taiwan's exports to Europe (TEXE). However, as in TIMUS equation (4), we can find no REER index that had any significant effect on Taiwan's imports from Europe (TIME). Clearly, when we compare the empirical results in table 4.7 and table 4.4, we see that the nominal exchange rate between the NT dollar and the U.S. dollar is also more sensitive to changes in Taiwan's trade with Europe than are the REERs.

Finally, it is interesting to note that in equation (1) of table 4.7 we find new empirical evidence that an increase in Taiwan's productivity relative to that of other countries will enhance Taiwan's export promotion drive, because WAGE1 and WAGE3 are positive and significant in equation (1). Furthermore, equation (2) of table 4.7 reconfirms our earlier findings that an increase in Taiwan's productivity relative to that of other countries enhances Taiwan's import-substitution capability, because WAGE2 is negative and highly significant. In addition, similar to our empirical results in table 4.4, in equation (5) of table 4.7, we find empirical evidence that an increase in Taiwan's labor productivity will help local firms promote their sales in Europe, however, the D-W statistic is still too low to permit us to make a strong assertion. Generally speaking, when we compare the empirical results in sections 4.2 and 4.3, we may conclude that REER indexes seem to be more capable of affecting and explaining Taiwan's overall international trade activities than Taiwan's bilateral trade activities with a specific country or with a specific region.

4.4 Price-Competition Index and Bilateral Trade between Taiwan and Foreign Countries

We have seen that REER indexes are less capable of explaining bilateral trade activities, while the simple nominal exchange rate fails to take into account changes in relative prices. The alternative to REERs for exploring explicitly how changes in exchange rates affect Taiwan's bilateral trade with a specific foreign country is the calculation of a price-competition index (PCI) between the two countries, defined as

$$\text{PCI} = \frac{e_{dt} / P_{dt}}{e_{it} / P_{it}} = \frac{P_{it}}{P_{dt}} \cdot \frac{e_{dt}}{e_{it}}, \text{ where}$$

e_{dt} = exchange rate between \$1 U.S. and NT dollar in period t,
e_{it} = exchange rate between \$1 U.S. and country i's currency in period t,
P_{dt} = wholesale price index for Taiwan (the domestic country d) in period t, and
P_{it} = wholesale price index for foreign country i in period t.

It is clear from the above formula that the PCI is actually the exchange rate between one unit of country i's currency and the NT dollar (e_{dt}/e_{it}) deflated by the relative prices between Taiwan's wholesale price index and country i's wholesale price index (p_{dt}/p_{it}). Therefore, one can easily see that when the NT dollar depreciates with respect to the U.S. dollar and/or Taiwan's wholesale price index decreases relative to that of foreign country i, this will induce an increase in the PCI, which suggests stronger competitiveness or an exporting advantage over foreign country i for Taiwan. In contrast, an appreciation of the NT dollar with respect to the U.S. dollar and/or a relative increase in Taiwan's wholesale price index will lead to a decrease in the PCI, which suggests weaker competitiveness or an exporting disadvantage compared to foreign country i. In addition, due to our different definitions of exchange rate, there is actually a reciprocal relationship between the PCI and REER. As a result, an increase (decrease) in the PCI implies that the NT dollar is undervalued (overvalued), which implies improving (worsening) competitiveness for Taiwan over foreign country i.

In the appendixes, we present the relevant PCIs of Taiwan's 15 major trading partners included in this study. In this section, however, we shall focus our attention on selected results. In figure 4.1 we plot the Taiwan-U.S. PCI statistics against Taiwan's trading statistics with the United States. From the figure we can see that during 1980–81, the PCI was substantially lower than 100 and was accompanied by a moderate trade surplus in favor of Taiwan. However beginning in 1982, there was a dramatic increase in PCI until mid-1987. It was during this critical period that a huge trade surplus in favor of Taiwan emerged. As the NT dollar appreciated dramatically against the U.S. dollar from 1987 to 1988, one can also observe a sharp decline in the PCI and in Taiwan's competitiveness, which in turn led to a significant increase in Taiwan's imports from the United States. Although the PCI index after the end of 1988 is still substantially lower than the base period (1980–82) level of 100, its trend is unambiguously upward-sloping, which is certainly consistent with the continuously growing trade surplus in favor of Taiwan after 1988.

One major result that we obtained in the previous section is that there was a tremendous shift in Taiwan's trade composition away from the U.S. to the European market after the mid-1980s. In this section we find that an increase in PCI toward the European market could be one of the important factors that contributed to this structural shift. In figure 4.2, we plot PCIs for Taiwan and Germany, Taiwan and France, Taiwan and the United Kingdom, and Taiwan and the Netherlands. From this figure, it is clear that these PCIs after mid-

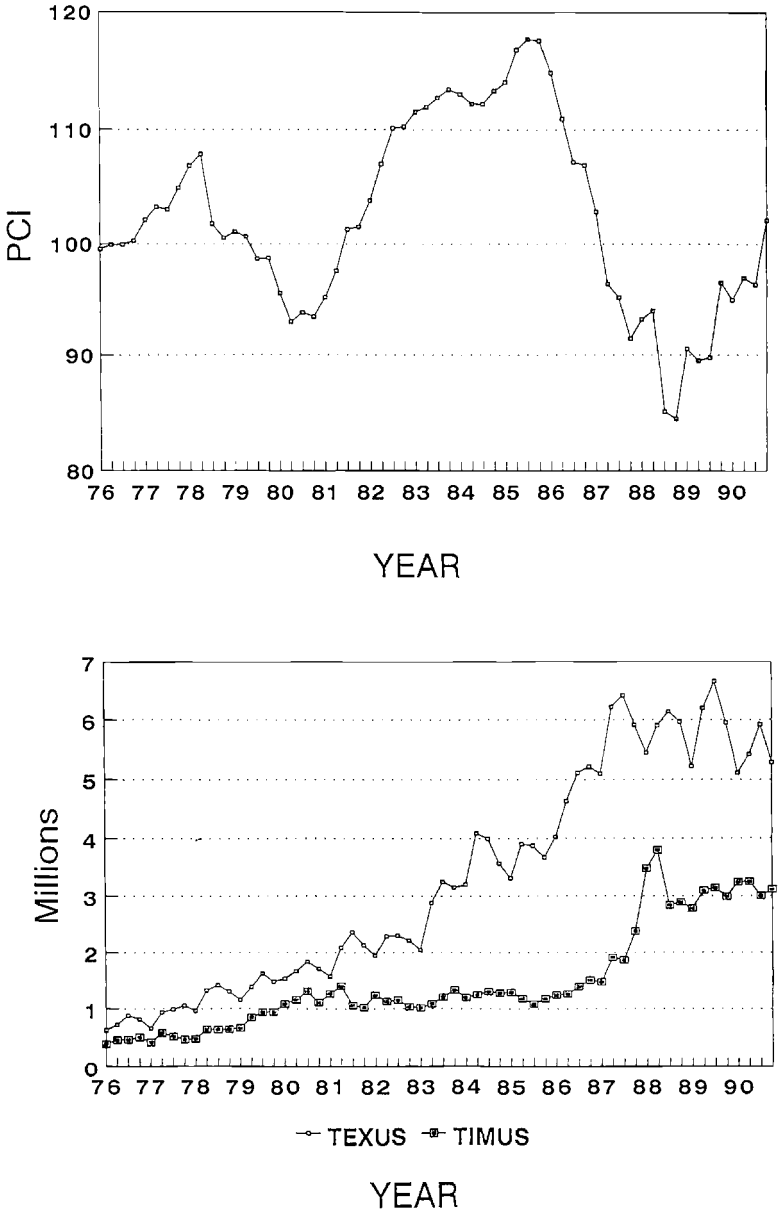

Fig. 4.1 Taiwan-U.S. price competition index (PCI) and trade statistics of Taiwan's exports to (TEXUS) and imports from (TIMUS) the United States (1976:1–1990:4)

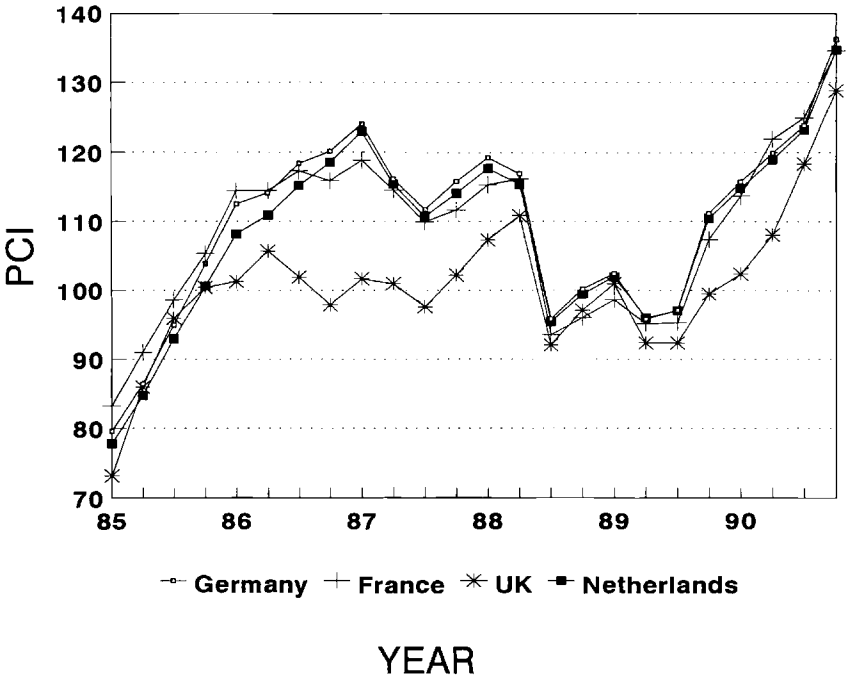

Fig. 4.2 Price competition indexes (PCIs) between Taiwan and its major European trading partners (1985:1–1990:3)

1985 are all substantially greater than 100, which implies stronger Taiwanese competitiveness, and this naturally led to greater Taiwanese emphasis on the European market. As for the basic reasons for an increase in the PCI toward European countries after the mid-1980s, one can examine the data and find that the wholesale price indexes for France, the United Kingdom, Germany, and the Netherlands increased by 7.1, 28.4, 1.9, and 1.7 percent, respectively, from early 1986 to late 1990, while Taiwan actually experienced deflation, and its wholesale price index declined by 10.1 percent over the same period. In addition, we find that the German mark, Dutch guilder, French franc, and British pound appreciated by 36.03, 36.08, 29.92, and 25.98 percent, respectively, against the U.S. dollar from early 1986 to late 1990, while the NT dollar also appreciated against the U.S. dollar by 30.07 percent over the same period. By taking these price and exchange rate factors into consideration, it is clear that Taiwan's competitiveness over European countries after the mid-1980s may have been the result of slowed growth in its wholesale prices relative to those of major European countries, or of a lesser degree of currency appreciation against the U.S. dollar, or both. It is not surprising that this increase in Taiwan's competitiveness with European countries has already translated into a sizable increase in the European share of Taiwan's total exports as we saw in table 4.2.

One phenomenon that the PCI index fails to explain is bilateral trade between Taiwan and Japan. From figure 4.3, we see that after the second quarter of 1985 the PCI increased sharply in favor of Taiwan. However this increase in Taiwan's competitiveness did not help to improve the long-standing trade deficit problem between Taiwan and Japan. On the contrary, the trade deficit between Taiwan and Japan has been widening considerably since 1989. Actually, when one examines figure 4.3 more closely, one can see that as the PCI increases during the period from mid-1985 to early 1988, there is also a considerable increase in Taiwan's exports to Japan. However, Taiwan's imports from Japan also increased at an even faster pace during the same period, resulting in a huge trade deficit problem for Taiwan. The trade imbalance problem between Taiwan and Japan may be beyond factors such as exchange rates and relative prices, which constitute the essence of the PCI. What then are the relevant factors that can enable us to explain the growing trade imbalance between Taiwan and Japan? By examining figures 4.1 and 4.3 simultaneously, one can easily see that there is a great similarity between the variations of TEXUS and the variations of TIMJ. In fact, by calculating the correlation coefficient between TEXUS and TIMJ, we find that it is as high as 0.91125. Furthermore, the correlation coefficients between TIMJ and Taiwan's exports to (West) Germany, France, and the Netherlands are 0.971, 0.986, and 0.983, respectively. Clearly, there is a very close relationship between Taiwan's exports to the U.S. and to Europe and Taiwan's imports from Japan. By examining the relevant customs statistics during this period, we see that machinery, parts, and intermediate industrial products are Taiwan's major import items from Japan. Therefore, the empirical results above seem to suggest that in addition to foreign exchange and other relevant factors, such as labor productivity, Taiwan's international edge is built on its outward sourcing of Japanese industrial equipment and intermediate industrial products. As a result, Taiwan's huge trade deficit with Japan goes hand in hand with Taiwan's growing trade surplus with the West.

Finally, it is interesting to note that the PCIs between Taiwan and Korea and such major Association of Southeast Asian Nations (ASEAN) countries as Thailand, Malaysia, Singapore, and Indonesia worsened substantially after the middle of the 1980s. One of the major reasons for the worsening of PCIs for Taiwan toward these countries is exchange rates. Statistics show that both the Korean won and Thai baht appreciated against the U.S. dollar by 19.39 and 5.24 percent, respectively, between early 1986 and late 1990, while the currencies of Malaysia, Indonesia, and Singapore actually depreciated against the U.S. dollar by about 8.63, 66.16, and 14.79 percent, respectively, for the same period. Clearly, these Asian currency changes are no comparison to the NT dollar's 30.07 percent appreciation against the U.S. dollar, which thus led inevitably to a sharp decline in PCI for Taiwan toward these Asian markets.

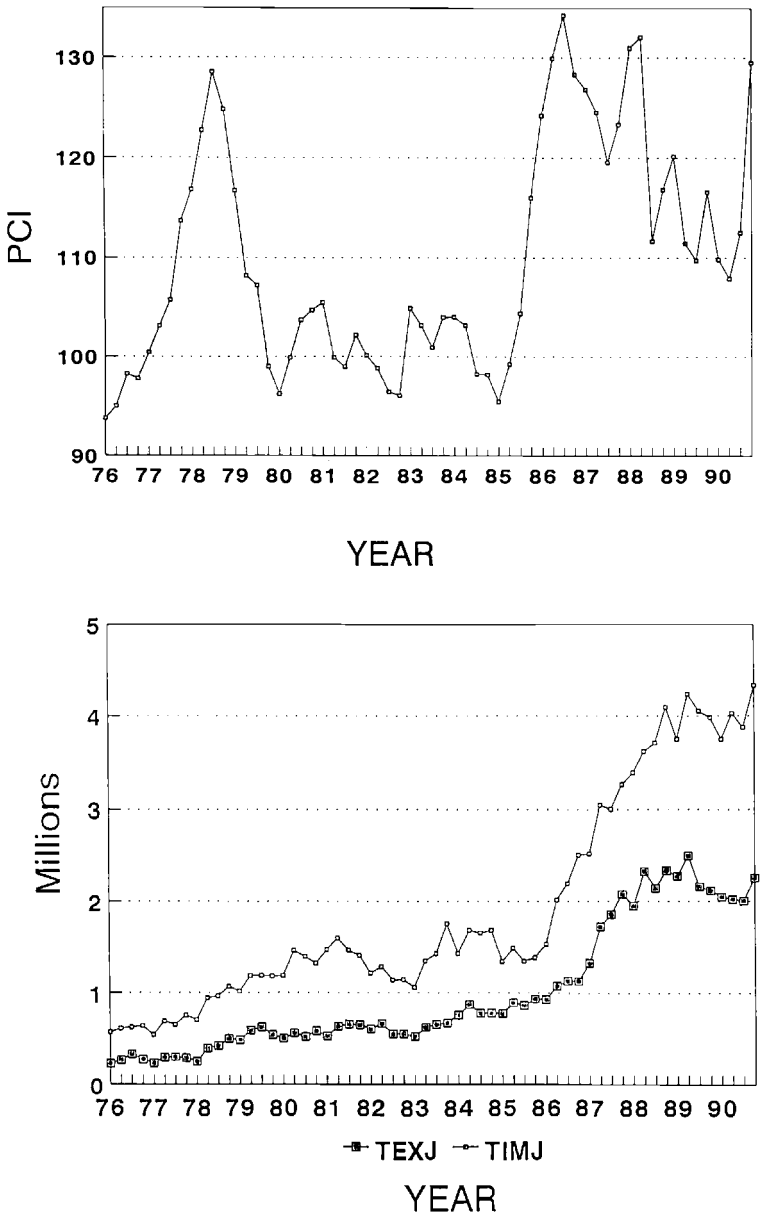

Fig. 4.3 Taiwan-Japan price competition index (PCI) and statistics of Taiwan's exports to (TEXJ) and imports from (TIMJ) Japan (1976:1–1990:4)

4.5 Summary and Conclusion

In this paper we have utilized both nominal and real effective exchange rates to examine Taiwan's external trade activities. In addition, a price-competition index was also calculated to examine Taiwan's bilateral trade activities with its major trading partners. Our empirical results on PCIs and REERs suggest that a sharp increase in Taiwan's competitiveness over the United States was due primarily to the undervaluation of the NT dollar, which inevitably resulted in Taiwan's huge trade surplus over the United States from the early to mid-1980s. This surplus, in turn, not only invited strong protectionism from the United States but also resulted in the rapid accumulation of foreign exchange reserves in Taiwan. How to deal with the enormous resulting inflationary pressure from these reserves then became a major consideration for Taiwan's monetary authorities, and this problem subsequently forced Taiwan to change its low-value-NT export promotion policy into a high-value-NT trade balance policy. As a result, the NT dollar began to appreciate rapidly from early 1987 to 1988, and since mid-1988 the NT dollar has been maintained at about $1 U.S. for less than NT$28, and a new era of a high NT dollar value has thus emerged.

The impact of a vastly appreciated NT dollar on Taiwan's external trade is enormous. From the empirical results in this paper, we found that whether one examines Taiwan's total exports using nominal or real effective exchange rates, the NT dollar will likely have a significant and adverse effect on Taiwan's exports. In addition, a stronger NT dollar was also found to have a significant effect in inducing Taiwan's total imports. Therefore, the rapid appreciation and high value of the NT dollar has become one of the most effective factors for controlling the trade surplus problem in Taiwan. The appreciation of the NT dollar also induced a enormous trade diversification of Taiwan's exports. In this paper we found that the U.S. market accounted for nearly half of Taiwan's exports (49 percent) in the mid-1980s; however in 1991 it accounted for only 29 percent of Taiwan's total exports. One of the major factors that facilitated such a dramatic change was the appreciation of major European currencies such as the German mark, French franc, British pound, and Dutch guilder between the mid-1980s and early 1990. The vast appreciation of the above European currencies, together with relatively low inflation in Taiwan, has helped Taiwan improve its competitiveness over the European market significantly. As a result, the share of the European market held by Taiwan's total exports increased from 10 percent in 1985 to 18 percent in 1991.

In this paper, we also found that it would not be easy for Taiwan to diversify its markets to other areas such as Japan or major ASEAN countries. Our empirical results found that the dramatic increase in Taiwan's PCI with Japan during the period 1985–87 could only help Taiwan control its chronic trade deficit problem with Japan. Between 1987 and mid-1990 there was a downward trend in the PCI that immediately led to a dramatic widening of the trade deficit for Taiwan. Furthermore, our empirical evidence shows that there is a very high

correlation between Taiwan's exports to the U.S. and Europe and Taiwan's imports from Japan. Thus the trade imbalance problem between Taiwan and Japan may be less related to exchange rates or relative price changes. Taiwan's overdependence on Japanese parts and intermediate industrial products is perhaps the more relevant factor in this trade imbalance. Finally, this study found that many ASEAN members such as Malaysia, Singapore, and Indonesia have depreciated their currencies considerably against the U.S. dollar, which has certainly dramatically reduced Taiwan's export competitiveness against these countries. Actually, given relative changes in exchange rates between Taiwan and ASEAN countries, as well as the accumulation of huge foreign exchange reserves and the inevitable appreciation of the NT dollar, it is more attractive for Taiwanese enterprises to place more emphasis on outward investment than on exporting. Therefore beginning in the late 1980s Taiwan became one of the major foreign direct investment countries in the region.

Technically speaking, we found that real effective exchange rates can be a fairly good indicator in explaining aggregate trade activities as well as foreign exchange reserve phenomena in Taiwan. Among the various weights and base periods used in calculating real effective exchange rates for the NT dollar, we found that 1980–82 is a better base period than 1979 and bilateral trade values are better than average export values in explaining Taiwan's multilateral trade activities.

Appendix A

Table 4A.1 **Price-Competition Indexes (PCIs) between Taiwan and Its Major Western Trading Partners, 1976–90**

Year and Quarter	Exchange Rate (NT/US)	United States	Canada	Germany	France	United Kingdom	Netherlands	Italy
1976 1	38.00	99.548	113.067	104.556	118.114	83.255	108.900	98.946
2	38.00	99.953	115.260	105.556	117.534	77.252	107.755	97.118
3	38.00	99.969	115.231	106.484	116.076	77.605	109.669	102.492
4	38.00	100.308	114.056	111.519	114.592	75.570	117.098	105.154
1977 1	38.00	102.164	112.783	112.879	115.720	82.258	118.255	106.617
2	38.00	103.288	112.000	114.118	116.150	85.050	121.723	107.516
3	38.00	103.068	111.186	116.362	116.227	88.354	124.386	109.243
4	38.00	104.975	110.153	121.437	118.212	94.463	127.134	112.735
1978 1	38.00	106.871	111.148	129.763	121.034	102.428	136.943	116.570
2	38.00	107.874	110.505	127.923	124.681	97.569	133.803	116.656
3	36.00	101.819	103.374	123.288	124.199	97.552	127.284	113.564
4	36.00	100.555	100.209	127.719	125.819	98.206	131.077	112.951
1979 1	35.95	101.095	101.115	127.380	128.561	99.334	130.627	113.603
2	36.10	100.658	102.782	122.268	125.012	101.954	122.666	113.261

Table 4A.1 (continued)

Year and Quarter	Exchange Rate (NT/US)	United States	Canada	Germany	France	United Kingdom	Netherlands	Italy
3	36.03	98.661	99.795	123.234	126.315	107.689	122.844	116.249
4	36.03	98.727	99.146	123.982	127.089	103.242	122.208	118.146
1980 1	36.06	95.530	97.055	117.279	120.898	104.218	118.306	115.905
2	36.01	92.945	93.080	112.010	114.498	104.652	112.108	110.776
3	35.93	93.790	94.520	112.286	114.900	108.716	114.051	111.772
4	36.01	93.414	92.967	103.083	108.075	107.508	104.463	105.174
1981 1	36.35	95.136	93.681	95.603	98.568	105.627	96.066	98.791
2	36.36	97.555	95.586	90.060	92.616	98.499	88.737	91.896
3	37.91	101.314	99.548	88.743	92.891	90.865	88.002	91.590
4	37.84	101.538	102.838	97.888	97.812	95.375	97.924	97.026
1982 1	38.13	103.866	104.372	96.585	96.011	97.329	96.439	96.305
2	39.39	107.039	106.361	99.054	96.924	98.179	97.917	96.748
3	39.87	110.117	109.353	98.201	91.470	98.439	98.001	96.821
4	39.91	110.247	111.253	97.741	90.714	95.193	97.837	97.174
1983 1	40.04	111.499	113.519	102.365	96.407	90.554	100.731	102.439
2	40.20	111.928	114.982	99.478	92.511	93.818	96.442	98.646
3	40.19	112.715	115.558	94.020	89.759	91.509	92.673	94.434
4	40.27	113.416	115.524	93.494	90.820	90.356	91.533	94.580
1984 1	39.92	113.017	114.099	92.150	90.967	88.323	90.765	94.009
2	39.63	112.205	110.741	91.364	92.245	86.605	90.167	94.091
3	39.18	112.186	109.809	85.313	87.781	81.095	84.202	88.900
4	39.47	113.279	111.168	83.286	86.389	77.777	81.760	87.345
1985 1	39.54	114.034	110.572	79.559	83.235	73.158	77.771	84.652
2	40.00	116.806	112.393	86.403	90.987	85.937	84.700	90.737
3	40.40	117.708	114.955	94.999	98.612	95.969	92.994	95.729
4	39.83	117.570	113.321	103.891	105.360	100.440	100.618	103.856
1986 1	38.77	114.841	111.519	112.548	114.440	101.305	108.199	112.200
2	38.09	110.911	109.610	114.128	114.466	105.724	110.933	112.600
3	36.72	107.215	106.624	118.350	117.284	101.915	115.172	116.300
4	36.29	106.949	106.712	120.127	115.891	97.919	118.522	120.200
1987 1	34.26	102.865	105.458	124.025	118.825	101.701	122.947	123.500
2	31.08	96.376	98.822	116.134	114.543	100.969	115.380	115.500
3	30.09	95.137	98.679	111.754	109.943	97.641	110.725	111.100
4	28.55	91.444	96.193	115.755	111.652	102.229	114.049	114.500
1988 1	28.64	93.170	101.067	119.199	115.266	107.325	117.651	118.500
2	28.89	93.954	104.680	116.873	116.133	110.835	115.353	116.100
3	28.97	85.025	95.141	95.885	93.526	92.067	95.485	95.800
4	28.13	84.427	95.837	100.208	96.065	97.116	99.479	101.400
1989 1	27.17	90.554	103.298	102.446	98.654	100.968	101.984	105.700
2	25.91	89.503	100.395	95.822	95.175	92.362	96.007	100.300
3	25.60	89.775	101.636	97.144	95.330	92.394	97.103	103.100
4	27.17	96.476	109.407	111.185	107.388	99.477	110.477	116.400
1990 1	26.41	94.914	105.206	115.704	113.665	102.392	114.765	120.100
2	27.20	96.931	108.950	119.874	121.875	108.059	118.935	125.100
3	27.30	96.297	108.011	123.796	124.928	118.331	123.209	127.800
4	27.11	102.114	111.735	136.238	134.625	128.858	134.724	137.400

Appendix B

Appendix B **Price-Competition Indexes (PCIs) between Taiwan and Its Major Asian Trading Partners, 1976–90**

Year and Quarter	Japan	Korea	Hong Kong	Australia	Singapore	Thailand	Malaysia	Indonesia
1976 1	93.781	92.775	109.107	103.248	91.754	103.534	106.557	88.781
2	95.029	93.529	108.730	103.360	91.878	100.308	105.891	91.033
3	98.258	94.080	111.865	104.829	91.858	100.337	106.657	93.552
4	97.774	95.120	116.147	99.474	93.100	100.684	105.356	96.641
1977 1	100.415	97.627	119.361	96.572	94.524	102.235	110.965	100.791
2	103.115	98.577	117.857	98.657	93.879	105.053	110.620	101.733
3	105.715	100.155	119.589	100.336	94.449	108.306	110.944	102.748
4	113.704	102.521	121.534	104.231	97.309	109.428	114.755	106.141
1978 1	116.860	106.736	123.652	106.797	99.124	110.672	121.654	107.671
2	122.722	107.066	121.711	106.652	98.117	110.506	117.842	105.798
3	128.576	101.905	113.464	102.710	94.902	104.911	112.881	100.304
4	124.819	101.224	109.787	102.029	95.587	102.773	114.694	85.527
1979 1	116.750	101.077	105.365	101.344	95.618	100.049	115.239	83.157
2	108.178	103.998	103.275	99.753	97.504	99.781	110.152	88.001
3	107.217	107.954	104.554	100.012	101.010	101.849	107.637	91.056
4	98.998	107.185	104.624	97.386	99.592	101.979	102.784	94.002
1980 1	96.233	96.379	99.312	93.965	100.447	100.780	100.792	92.363
2	99.890	97.765	99.173	93.384	97.166	100.321	95.621	92.991
3	103.707	96.024	99.198	97.174	99.184	99.547	96.296	93.477
4	104.699	92.803	95.907	97.295	98.261	98.311	92.573	92.511
1981 1	105.466	94.429	96.050	98.094	100.633	100.184	96.435	95.991
2	99.906	98.145	94.698	97.938	99.208	101.545	93.619	97.056
3	98.967	102.903	91.489	102.734	99.733	97.255	95.337	100.564
4	102.178	102.683	102.237	104.263	101.470	97.027	99.532	101.628
1982 1	100.133	102.720	102.744	103.277	100.742	98.043	105.445	105.388
2	98.822	103.399	107.326	105.186	101.813	100.635	107.387	108.204
3	96.464	104.541	105.585	103.779	102.271	102.490	108.455	110.670
4	96.082	104.356	104.308	102.342	100.601	103.628	108.227	109.220
1983 1	104.878	104.684	104.164	104.130	103.969	104.800	117.279	108.204
2	103.148	101.733	100.095	99.389	101.769	105.601	115.975	91.884
3	100.899	99.037	89.754	100.786	100.654	107.322	113.851	92.573
4	103.970	97.991	97.930	105.403	100.865	107.547	114.106	93.602
1984 1	104.003	96.863	97.919	107.505	100.098	102.544	117.903	95.038
2	103.164	95.582	97.807	104.511	99.379	100.199	117.481	94.047
3	98.246	95.090	98.989	98.664	96.732	100.081	115.711	92.377
4	98.174	95.355	100.741	101.680	96.395	90.578	114.021	92.589
1985 1	95.478	93.977	102.878	91.813	95.563	83.890	109.420	91.125
2	99.232	93.117	106.953	86.261	96.420	87.682	114.507	92.383
3	104.338	92.961	109.344	93.207	96.471	91.170	116.523	93.953
4	116.021	91.945	108.035	92.048	98.307	92.600	117.305	94.042
1986 1	124.190	90.724	107.940	94.618	89.1659	91.070	115.088	93.372
2	129.940	87.316	107.600	94.108	78.5748	89.070	107.831	90.078
3	134.290	86.189	105.470	81.761	76.3657	87.600	104.160	78.425
4	128.330	86.250	105.780	86.932	78.5781	87.040	103.921	64.529

Table 4B.1 (continued)

Year and Quarter	Japan	Korea	Hong Kong	Australia	Singapore	Thailand	Malaysia	Indonesia
1987 1	126.840	83.603	101.700	87.087	80.5329	84.180	102.211	66.602
2	124.530	80.559	95.660	86.629	76.4983	80.970	96.413	62.619
3	119.560	80.708	94.530	86.001	75.8724	81.480	92.534	62.119
4	123.300	78.330	92.550	82.523	73.3223	81.330	89.385	60.719
1988 1	130.970	83.514	94.540	87.468	74.6215	84.110	89.286	62.238
2	132.040	87.009	96.210	95.440	75.3461	84.930	88.353	62.178
3	111.670	79.619	87.450	88.734	65.0962	75.730	77.979	55.410
4	116.840	81.708	87.910	93.175	64.8860	76.310	76.516	54.615
1989 1	120.170	88.481	95.280	100.319	71.8691	79.830	79.402	57.520
2	111.450	87.929	95.150	91.643	70.9740	78.450	78.017	56.957
3	109.730	88.212	97.610	92.011	70.0972	80.370	79.688	57.393
4	116.610	94.347	105.950	101.913	76.5826	84.850	85.526	61.779
1990 1	109.840	89.684	105.220	98.181	76.0003	82.650	83.561	60.937
2	107.890	91.110	111.300	102.098	75.6892	84.920	86.201	61.034
3	112.505	89.520	111.470	106.032	82.1603	84.910	84.470	65.763
4	129.500	94.595	117.140	108.563	93.1283	93.500	88.314	69.142

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Comment Hideki Funatsu

This paper studies the effects of a change in the NT dollar on Taiwan's aggregate import and export using a simple econometric analysis. A change in the value of import was explained by changes in domestic income level, nominal or real effective exchange rate, and relative wage rate. For the export function, explanatory variables are the weighted average of national incomes of trading partners, nominal or real exchange rate, and relative wage rate. The final section adds a calculation of the price-competition index, defined as the relative wholesale price index multiplied by the relative exchange rate with a trading partner. The author's main argument, based on the empirical results, is that a rapid appreciation of the NT dollar against the U.S. dollar during the mid-1980s caused a shift in Taiwan's exports from the U.S. market to European markets and that the trade imbalance with Japan is not related to exchange rate. I find this paper quite interesting because it touches upon an important policy problem most East Asian countries faced during the 1980s. As a matter of fact, reading this paper reminded me of a 1987 white paper issued by the Japanese Ministry of International Trade and Industry (MITI). At that time, the effect of a rapid appreciation of Japanese yen on the huge trade surplus with the United States was a big issue. That white paper carried out a similar empirical analysis and concluded that Japanese export to the United States is so income-elastic that changing the exchange rate alone cannot correct a trade surplus problem. They advocated diversification of exports to various markets and division of labor with East Asian countries by promoting direct investment. So I can appreciate one of the author's statements in the conclusion that the "trade imbalance problem between Taiwan and Japan may be less related to exchange rates or relative price changes." I also agree with the author on most of his other

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points. Nevertheless, in order to sharpen the argument and provide a possible direction in which to extend this interesting research, I would like to make comments on the following four points.

The Interpretation of the Effect of Relative Labor Productivity on Taiwan's Export to the United States

The result reported in equations (3) and (4) of table 4.3 is that relative real wages between Taiwan and the United States have a negative effect on Taiwan's export to the United States. San provides three explanations for this phenomenon, namely, a shift to the European market, protectionism in the United States, and outward direct investments to other East Asian countries. I would like to suggest another explanation: Japanese direct investment. As San states in his conclusion, Taiwan's export relied on Japanese industrial equipment and intermediate industrial products. Therefore, some significant part of the factor content of Taiwan's exports to the United States might be intermediate input imported from Japan and also direct investment made by Japanese firms. If this is the case, an increase in the relative real wage rate in Taiwan reduces its attractiveness as an export site to the U.S. market. Japanese firms will reduce export volume from the high-wage country and move their export base to a lower-wage country. In order to obtain a more convincing result, estimation of a single equation will not be sufficient. We may have to look simultaneously at a change in the direct investment pattern.

In order to analyze such a problem, it would be helpful to use a simple trade model of duopoly. Winston W. Chang and Jae-Cheal Kim (1989) have presented an interesting theoretical model that emphasizes the leader–follower relation of monopoly exports of two countries. Japan is the leader in exporting manufacturing goods to the third market, say, the United States, and Taiwan is the follower in the sense that it must import an important part of the good from the leader. The leader can choose to export directly to the third market or indirectly through the follower. In such a model, exchange rates among the three countries affect trade flow in a manner different from that described by the traditional approach.

Interpretation of the Immediate Effect of a Change in Exchange Rate on Export and Import

An appreciation of the NT dollar was found to lead to an increase in total exports in the initial period. San's explanation is that Taiwanese exporters expect further appreciation so they are likely to deliver their shipments earlier than expected. Can we interpret the result simply in the following way? The immediate effect of appreciation of a domestic currency on the value of export denominated in a foreign currency is positive simply because trade volume cannot adjust so quickly. With some time lags, a higher price in the foreign market will reduce export volume. Generally speaking, the effect of exchange rate on the total value of export or import could be decomposed into two parts:

the effect on the foreign price and the effect on the volume of trade. It will be interesting to see how exchange rate changes affect the volume of Taiwanese trade with the United States and Europe.

Does Exchange Rate Fluctuation Matter?

As economic integration in Europe keeps a rapid pace, European economists are talking about the creation of a new central bank in Europe and a possible movement toward a single currency. The medium-of-exchange role of money is emphasized once again. A stable currency provides externality to a macroeconomy. During the 1980s, most EC members except the United Kingdom participated into the European Exchange Rate Mechanism. Because of the low inflation rate in West Germany before unification, the values of European currencies are much more stable than the U.S. dollar. In addition to the NT dollar's appreciation against the U.S. dollar, this low risk factor in trading with Europe might be another reason for the shift of export from the U.S. market to the European market. If we include the variance of exchange rate fluctuation among the explanatory variables of the estimation equation, we may see whether this risk factor has any effect on the total value of export or not.

Inclusion of a Supply-Side Factor in the Estimation

During the mid-1980s, the price of crude oil fell sharply. Resource-poor countries like Japan and Taiwan certainly benefited from the falling oil price. In the early 1980s, more than 20 percent of the total value of Taiwan's import was the bill for crude oil. This has steadily declined through the 1980s and the ratio was less than 5 percent in 1990. In order to take account of such a factor and carry out a more rigorous estimation of the import and export functions, it would be appropriate to use a simple duality framework. This approach may enable us to include oil price as an explanatory variable in addition to the productivity of labor. Hiroshi Yoshikawa (1990) wrote a short paper which studies the equilibrium yen/dollar exchange rate using such an approach. This approach would also be useful in incorporating the effect of intermediate input import from Japan on the export performance of the Taiwanese economy.

References

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Comment

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San Gee has given us an excellent paper. One learns a lot from such empirical work. All the econometric work was carefully designed, and the estimation produced powerful results, as one would expect from a casual income-and-price-elasticity model. The highlight of the paper is its confirmation that movement in the relative price variable is crucially important in explaining changes in Taiwan's trade flows. The estimates were consistent whether nominal or real effective exchange rates were used. The price competition index (PCI) also worked very well in explaining movement in bilateral trade flows, except with Japan. I have only three comments on the paper.

First of all, I thought it would have been very useful if San had noted at the outset what kinds of exchange rate systems were at work during his sample period and how they might have influenced his estimation results. What I have in mind is that the type of exchange rate regime could have had an important bearing on the exogeneity of exchange rate movement, leading to the possibility of simultaneous equation bias in the estimation.

According to Chen, Shive, and Chu's paper (chap. 9, this volume), although Taiwan switched to a flexible exchange rate system in 1979, the exchange rate was virtually fixed by Central Bank intervention until 1985. Under a fixed exchange rate regime, Taiwan's trade surplus may be interpreted as driven by an undervalued NT dollar, but under a floating exchange rate regime Taiwan's trade surplus might have been driven by movements in the capital account. Therefore Taiwan's trade flows might have been influenced by variables other than those included in the estimation equation.

My second comment concerns an estimation result that is contrary to a common expectation. That is, an improvement in Taiwan's labor productivity relative to that of the United States leads to a decline, rather than an increase, in Taiwan's exports to the United States. Why?

San proposes a number of possible reasons, including, for example, diversification of export markets into EC countries, rising U.S. nontariff barriers, shifts in production locations of some labor-intensive products to other Asian nations. But I wonder if it is, at least partly, due to some measurement error involved in measuring relative productivity. San seems to use relative productivity and relative real wage rate as perfect substitutes for each other. But I learned from Korea's experience that movement in the real wage rate can be made quite separately from movement in labor productivity, at least in the short run, as in quarterly data. Furthermore, frequent changes in exchange rate may help amplify the short-run discrepancy between real wage and labor productivity. So, I wonder if one might want to try to use a sort of profitability index, like a differential between real wage and physical productivity in the short run, on behalf of real wage or labor productivity.

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My final comment involves the possibility of an aggregation problem. I noticed that the PCI works very well in explaining the bilateral trade balance in general, but not for trade with Japan. As San indicated in his paper, the bilateral trade balance between Taiwan and Japan is apparently driven by something other than changes in exchange rates or PCI, and therefore a different model is called for. This suggests that including Japan in the data aggregation may cause an aggregation bias in the estimation. Thus, it may be useful to check the consistency of the estimates by other estimations at a disaggregated level by country, too.