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Does a J-Curve Exist for Korea and Taiwan?

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Abstract

This article examines whether the trade balance of two dynamic export-oriented economies, Korea and Taiwan, exhibits a J-curve effect. The article studies both their bilateral and aggregate trade balance during the flexible exchange-rate era. When the exchange-rate coefficients are unconstrained, we demonstrate that no J-curve effect exists either for bilateral or aggregate trade balances. Several robustness checks confirm the validity of our findings. When a polynomial-distributed lag structure is imposed on exchange-rate coefficients, a J-curve is evident in some cases. The article discusses possible explanations for the general lack of evidence in favor of a J-curve, including the response of a small country's trade balance to exchange-rate changes.

It is commonly believed that the real (effective) exchange rate is one of the major determinants of a country's trade balance. Conventional wisdom on the effect of the real exchange rate on the trade balance is described by the "J-curve effect": a real depreciation worsens a country's trade balance in the short run but improves it in the long run. The rationale behind the J-curve is that import prices adjust quickly to real exchange-rate (or relative price) changes, while import and export volumes adjust only slowly. Thus, the initial effect of a real depreciation on a country's trade balance is "perverse," because import value increases by more than the increase in export value. In the long run, however, as import and export volumes adjust to the higher (lower) import (export) prices, the trade balance will improve. Considerable research has been devoted to the J-curve, and a number of empirical studies support the existence of a J-curve effect.[1]

Rose and Yellen (1989) and Rose (1991), on the other hand, question the theoretical reasons behind the J-curve effect.[2] Their empirical findings show that there is no significant relationship between the real exchange rate (and its lags) and the trade balance of the major OECD countries. In this study, we examine whether trade between (South) Korea and Taiwan, on the one hand, and the United States, Japan, and the rest of the world (ROW),[3] on the other, displays a J-curve phenomenon. We shall concentrate on Taiwan and Korea, because both economies are export oriented and have experienced some of the highest rates of growth of exports and income in recent years. Moreover, with a few exceptions, most of the research on the J-curve has been devoted to the developed economies.[4] Since the theoretical presumption for the existence of a J-curve in the case of a developing economy is weaker, the next section presents the theoretical underpinning for the J-curve and the circumstances under which it may arise in the case of a small open economy (such as Korea or Taiwan).

Tables 1 and 2 show the recent trade performance of Taiwan and Korea vis-à-vis the U.S. and Japan. We have chosen to focus on bilateral trade with the U.S. and Japan, because they are the most significant trading partners for the Asian Newly Industrialized Countries (NICs). In particular, the U.S. represents the most significant export destination and has experienced a trade deficit with the two NICs, while Japan is the most significant supplier of capital goods for the Asian NICs and has experienced a surplus with these countries. In order to generalize and extend our results, we shall also consider the aggregate (ROW) trade balance of these two NICs.

Table 1. Exchange rates and U.S. trade balance with Taiwan and Korea 1970–1991[a,b].

Year	N.T.$–U.S.$ Exchange Rate	U.S.–Taiwan Trade Balance	Won–U.S.$ Exchange Rate	U.S.–Korea Trade Balance
1970	40.10	–7.57	310.56	88.78
1971	40.10	–103.01	347.15	72.99
1972	40.00	–220.48	392.89	9.37
1973	38.26	–201.59	398.32	90.59
1974	38.00	–226.74	404.48	28.40
1975	38.00	–95.00	484.00	115.39
1976	38.00	–454.80	484.00	–141.60
1977	38.00	–629.40	484.00	–184.10
1978	37.05	–947.70	484.00	–219.90
1979	36.05	–875.10	484.00	29.60
1980	36.01	–852.40	670.43	143.10
1981	36.85	–1,255.80	681.03	–37.10
1982	39.12	–1,508.30	731.09	–35.90
1983	40.07	–2,179.10	775.75	–407.50
1984	39.60	–3,254.90	805.98	–1,123.40
1985	39.85	–3,898.80	870.02	–1,352.30
1986	37.84	–4,755.50	881.45	–2,124.70
1987	31.84	–5,736.30	822.57	–2,962.80
1988	28.59	–4,224.30	731.47	–2,966.60
1989	26.41	–4,334.20	671.46	–2,087.90
1990	26.89	–3,278.10	707.77	–1,364.80
1991	26.81	–3,281.60	733.36	–502.20

Source: OECD *Monthly Trade Statistics*, IMF *International Financial Statistics*, and *Financial Statistics*, Taiwan District, R.O.C., various issues.

[a]Exchange rate is nominal and is defined as N.T.$/U.S.$ or Won/U.S.$.

[b]The trade balance is measured in million U.S.$. Positive (negative) trade balance means the United States has trade surplus (deficit) with Taiwan or Korea.

Table 2. Exchange rates and Japanese trade balance with Taiwan and Korea 1970–1991[a].

Year	N.T.$–Yen Exchange Rate	Japan–Taiwan Trade Balance	Won–Yen Exchange Rate	Japan–Korea Trade Balance
1970	.1114	150.52	.863	196.86
1971	.1150	213.54	.998	194.57
1972	.1319	223.61	1.296	184.85
1973	.1409	250.85	1.467	192.33
1974	.1302	353.08	1.385	362.25
1975	.1281	337.14	1.631	313.65
1976	.1282	363.57	1.632	296.16
1977	.1419	422.67	1.808	646.19
1978	.1772	611.82	2.320	1,130.77
1979	.1651	627.40	2.217	948.40
1980	.1593	950.30	2.694	780.50
1981	.1673	958.60	3.092	748.30
1982	.1572	600.60	2.939	532.30
1983	.1687	822.90	3.267	866.30
1984	.1669	925.20	3.395	1,001.90
1985	.1683	550.60	3.679	1,005.00
1986	.2253	1,060.20	5.256	1,742.50
1987	.2201	1,417.00	5.693	1,725.50
1988	.2232	1,870.70	5.711	1,205.50
1989	.1920	2,150.60	4.877	1,190.70
1990	.1865	2,311.70	4.909	1,915.70
1991	.1991	2,924.00	5.449	2,575.10

[a]See note to Table 1. The exchange rate is nominal and is defined as N.T.$/Yen or Won/Yen.

The next section presents some stylized facts about the trade performance of Korea and Taiwan and the theoretical justification for the existence of a J-curve. The following section discusses the data and some preliminary tests. The third section presents the empirical findings. It includes robustness checks, as well as an alternative test for the J-curve. The final section provides some concluding remarks.

1. Taiwan's and Korea's trade performance and the J-curve effect

1.1. Taiwan's and Korea's trade balance: stylized facts

Since the mid-1980s, the U.S. economy has experienced substantial trade deficits. The prolonged recession in the early 1990s has raised concern about reducing the U.S. trade deficit with the rest of the world. Among the world's major trading countries, the trade surpluses of Taiwan and Korea with the U.S. have figured prominently (see Table 1). Table 2 shows that, during the same period, the two NICs experienced substantial trade deficits with Japan.

While several policy instruments may be used to reduce a trade deficit, the real depreciation of the U.S. dollar against the currencies of its trading partners is believed to be highly effective, especially in the long run.[5] Since the mid-1980s, the

U.S. dollar has depreciated significantly (both in nominal and real terms) vis-à-vis Taiwan's and Korea's currencies. During the 1985–1991 period, the U.S. dollar depreciated by 33% (34%) in nominal (real) terms against the N.T. dollar (N.T. $) and by 16% (33%) against the Won. Over this period, the U.S. trade deficit with Taiwan did not change much in nominal terms but was reduced significantly in real terms: from $3,899 million in 1985 to $2,836 million in 1991. During the same period, the U.S. trade deficit with Korea was reduced significantly in both nominal and real terms: from $1,352 million to $502 million in nominal terms and from $1,351 million to $346 million in real terms.

During the last two decades, the Yen has appreciated significantly against the N.T. $ and Won in nominal terms. In real terms, however, the exchange rates between the Yen, on the one hand, and the N.T. $ and Won, on the other, have remained relatively stable. During the same time period, Japan's trade surplus with Taiwan and Korea has grown significantly in nominal terms: from $150 million to $2,924 million with Taiwan and from $196 million to $2,575 million with Korea. The increasing trade deficits with Japan have been a source of concern for Korea and Taiwan. Both countries have recently been attempting to direct trade away from Japan. Noland (1993, p. 28) reports that Japan has "... threatened to take Korea to the GATT over its 'import diversification' program." In real terms, however, Japan's trade surplus has grown more significantly with Taiwan than with Korea: from $126 million to $632 million with Taiwan and from $312 million to $450 million with Korea.

1.2. Exchange-rate changes and the trade balance: theory

One of the most popular approaches to modeling the time-series behavior of the trade balance is the "two-country" imperfect substitutes model. The underlying assumption of this model is that neither imports nor exports are perfect substitutes for domestic goods.[6] According to the model, the quantity of imports demanded by domestic (foreign) residents depends positively on real domestic (foreign) income and negatively on the relative price of imported goods. For simplicity, and without loss of generality, we assume the following import demand functions:

$$D_m = D_m(Y, p_m) = \alpha_y Y - \alpha_p p_m$$

and

$$D_m^* = D_m^*(Y^*, p_m^*) = \alpha_y^* Y^* - \alpha_p^* p_m^*, \tag{1}$$

where $D_m(D_m^*)$ is the volume of goods imported by the domestic (foreign) country; $Y(Y^*)$ is real income measured in domestic (foreign) output terms; p_m is the price of imported goods relative to domestically produced goods at home, with both prices measured in domestic currency; and p_m^* is the relative price of imported to domestically produced goods abroad, with both prices measured in foreign currency.[7]

The supply side of the model assumes that the supply of exportables depends positively on the relative price of exportables as follows:

$$S_x = S_x(p_x) = \beta_p p_x$$

and

$$S^*_x = S^*_x(p^*_x) = \beta^*_p p^*_x, \tag{2}$$

where $S_x(S^*_x)$ is the quantity of domestic (foreign) exportables supplied; p_x is the relative price of exportables at home, defined as the ratio of the price of exportables in domestic currency (P_x) to the domestic price level (P). Similarly, p^*_x is the relative price of exportables abroad, defined as the ratio of the price of exportables in foreign currency (P^*_x) to the foreign price level (P^*).

Given the above, we can define the relative price of imported to domestically produced goods at home (p_m) and abroad (p^*_m) as follows:

$$p_m = e\, P^*_x/P = q\, p^*_x$$

and

$$p^*_m = P_x/e\, P^* = p_x/q, \tag{3}$$

where e is the price of foreign exchange in domestic currency units or the nominal exchange rate and $q \equiv e\, P^*/P$ is the real exchange rate.

The implicit assumption of the imperfect substitutes model is that changes in relative prices equilibrate supply and demand at home and abroad:

$$D_m = S^*_x$$

and

$$D^*_m = S_x \tag{4}$$

The domestic real balance of trade (measured in units of domestic output) is *RTB*. It is computed as the nominal value of net exports (denominated in domestic currency) deflated by the domestic price level:

$$RTB = \frac{(P_x D^*_m - eP^*_x D_m)}{P} = p_x D^*_m - qp^*_x D_m. \tag{5}$$

The real trade balance can be expressed as a "partial reduced form" that depends only on q, Y, and Y^*. This is accomplished by solving (1)–(4) for the relative price ratios and quantity of domestic exports and imports and substituting these in (5) to yield:

$$RTB = \frac{\beta_p(\alpha_y^*)^2 (Y^*)^2 q^2}{(\alpha_p^* + \beta_p q)^2} - \frac{\beta_p^*(\alpha_y)^2 Y^2 q}{(\beta_p^* + \alpha_p q)^2} \tag{6}$$

$$RTB = \phi(q, Y, Y^*) \tag{7}$$

It is quite clear from (6) that an increase in foreign income or a reduction in domestic income improves the trade balance. When it comes to the impact of the real exchange rate, the result is ambiguous.

In order to investigate the impact of the real exchange rate on the trade balance, we compute the partial derivative of *RTB* in (5) with respect to the rate of real depreciation ($\partial q/q$) to yield the well-known "Bickerdike–Robinson–Metzler (BRM)" condition:

$$\frac{\partial RTB}{\partial q/q} = (1 + \epsilon_s)\left(\frac{\epsilon_D^*}{\epsilon_D^* + \epsilon_S}\right) D_m^* p_x - D_m q p_x^*(1 - \epsilon_D)\left(\frac{\epsilon_S^*}{\epsilon_S^* + \epsilon_D}\right), \tag{8}$$

where $\epsilon_D(\epsilon_D^*)$ denotes the absolute value of the domestic (foreign) price elasticity of demand, and $\epsilon_S(\epsilon_S^*)$ denotes the absolute value of the domestic (foreign) price elasticity of supply. In general, the sign of (8) is indeterminate. If trade is initially balanced and both supply elasticities are infinite, (8) reduces to the Marshall–Lerner condition, whereby a real depreciation improves the trade balance if the sum of the (absolute values) of the two demand elasticities exceeds unity.

The possibility for a J-curve arises when, following a real depreciation, the trade balance initially worsens, before eventually improving. The worsening may arise during the currency contract period[8] as a result of the currency in which contracts are denominated. In the event that exports are predominately invoiced in domestic currency and imports in foreign currency, the value of imports rises while that of exports remains constant. This can be easily seen in (5), where, following a real depreciation, q rises while p_x and p_x^* remain constant.

During the currency contract period, prices do not adjust to the change in currency value. On the other hand, pass-through analysis considers the ability of prices to adjust in the short run. As import prices rise domestically and the price of domestic exports abroad falls, the higher demand for (domestic) exports and lower (domestic) demand for imports should yield an improvement in the trade balance. In the short run, however, if demand elasticities are relatively low and the new prices do not elicit sufficient response, it may still be possible for the trade balance to worsen, giving rise to a J-curve effect. In summary, the initial worsening of the trade balance may be the result of the currency in which contracts are denominated during the currency contract period, or the low value of demand elasticities during the pass-through period. Nonetheless, according to the J-curve hypothesis, as the (absolute) value of elasticities increases over time, an eventual improvement in the trade balance is expected.

The above analysis is plausible in the case of developed countries that invoice exports predominantly in the exporter's currency. For most small open economies (such as Korea and Taiwan) both imports and exports are predominantly invoiced in foreign currencies so that the value of both imports and exports rises during the currency contract period. Therefore, the possibility of a J-curve is not as plausible. Nonetheless, it may still be possible to observe a short-term worsening of the trade balance, depending on the country's initial trade balance position. In the case of a small country, the condition for a depreciation of the real exchange rate to improve the trade balance becomes:[9]

$$\epsilon_S + \epsilon_D \frac{D_m q p_x^*}{D_m^* p_x} > \frac{D_m q p_x^* - D_m^* p_x}{D_m^* p_x}. \tag{9}$$

It is clear that, from an initial position of trade deficit[10] and with sufficiently low (domestic) supply and demand elasticities in the short run, (9) does not hold, and the trade balance will worsen. Over time, as the (absolute) value of the elasticities increases, (9) is expected to hold, and the trade balance improves. In conclusion, even though the case for a J-curve for Korea and Taiwan is not as strong as that for an industrial economy, the theoretical possibility still arises. It is therefore important to investigate empirically the impact of changes in the real exchange rate on the trade balance of Korea and Taiwan.

In testing for the impact of the real exchange rate on the trade balance, we follow Rose and Yellen (1989) and Rose (1991), and eschew the estimation of structural equations such as those in (1) and (2). Rather, we estimate directly a nonstructural equation, namely, the "partial reduced form" shown in (7).[11] In fact, the estimated empirical equation is the log-linear approximation to (7), including a "suitable" number of lags of the independent variables, a constant, and a random disturbance term.[12] Because a simultaneity exists between the trade balance and the current values of income and exchange rate, two-stage least squares (2SLS) will be used to estimate (7).

2. Data and preliminary analysis

The dependent variable in (7) is the real trade balance of Taiwan and Korea, either bilateral (with the U.S. or Japan) or aggregate (with the ROW). As for the explanatory variables, q is the real bilateral or the real effective exchange rate,[13] and Y is the domestic income proxied by the industrial production (IP) index, which is available on a quarterly basis. Y^* is the foreign IP index: the U.S. or Japanese IP in the bilateral case and a world IP index for the aggregate case. As defined in (5), the real trade balance is obtained by deflating the nominal trade balance by the domestic price level or CPI. All other real variables use the CPI as the price deflator.[14] In order to deal with the endogenous nature of the right-hand side variables in (7), an instrumental-variables technique (2SLS) is employed. Three instruments are used: the money supply (M1), government consumption, and the current account balance.[15] All the data are quarterly and span the period 1971QI through 1991QIV for Taiwan and 1972QI through 1991QIV for Korea. The beginning point is dictated by the availability of a consistent data series for the instrumental variables, and the endpoint is determined by the latest available data.

Two preliminary tests, namely, unit-root and cointegration tests, are applied to each variable in (7). Unit-root tests show whether a time-series variable is stationary. If unit roots are found in time-series variables, these variables are not stationary, implying that some transformation (e.g., first-differencing of the nonstationary variables) is necessary.[16] Cointegration analysis indicates whether there exists a stable linear steady-state relationship between a set of variables (e.g., the trade balance, the real exchange rate, and domestic and foreign output) when all these variables have been found to have unit roots. A set of variables is cointegrated if each individual variable is not stationary (i.e., has a unit root), but some linear combination of all the variables is stationary (i.e., does not have a unit root). If variables in (7) are found to have unit roots but are cointegrated, the hypothesis that there exists a stationary linear relationship linking the trade balance to the (logarithms of the) real exchange rate and domestic and foreign output should be accepted.

In order to test for the presence of a unit root in *RTB*, *Y*, Y^*, and q, we employ the Augmented Dickey–Fuller (ADF) test.[17] Because of the quarterly nature of the data, four augmented lags are chosen in the ADF tests. With a few exceptions, the test statistics (available on request) show that most variables have a unit root (or are not stationary) in all six pairs of countries, regardless of whether a time trend is included. This finding is consistent with the bilateral and aggregate results of Rose and Yellen (1989) and Rose (1991) for the OECD countries. It is also consistent with Noland's (1993) results for the U.S.–Korea bilateral trade balance and real exchange rate.

Given that the variables in (7) are found to have a unit root, we can then examine whether these variables are cointegrated. Two methods are used to check for cointegration. The first method uses the Engle–Granger two-step method subjecting the cointegrating residuals to the ADF test for the presence of a unit root. If the residuals are found to have a unit root, variables in (7) are not cointegrated.[18] Since most ADF test-statistics (available on request) are not significant (i.e., the null hypothesis that the residuals have a unit root cannot be rejected), variables in (7) are not cointegrated. Noland (1993) arrives at a similar result for U.S.–Korean variables using the Stock–Watson test. The second method to test for cointegration is the Johansen (1988) maximum-likelihood-ratio test to examine the number of cointegrating vectors (r) among the total cointegrating variables (m). If the hypothesis that $r = 0$ cannot be rejected, then there is no cointegration relationship among the variables in (7). If $r = m$ cannot be rejected, the hypothesis that the variables in (7) have a stationary process cannot be rejected. The hypothesis that the number of cointegrating vectors is equal to zero cannot be rejected at the 0.05 level in the Taiwan–U.S., Taiwan–Japan, and Taiwan–ROW cases. The largest number of cointegrating vectors appears in the Korea–U.S. case and is less than or equal to two. This finding is consistent with Rose's (1991) results for the OECD countries. Since the number of cointegrating vectors in every case is less than the number of cointegrating variables (which is equal to four), the variables in (7) do not have a stationary process. In summary, estimating (7) necessitates first-differencing of the variables.

3. Empirical findings

3.1. Does a J-curve exist for Taiwan and Korea?

This section presents results from estimating (7). The estimated equation of the cumulative impact of the exchange rate and output takes the following form:

$$\Delta RTB_t = \alpha + \Sigma\beta_i \Delta q_{t-i} + \Sigma\gamma_j \Delta Y_{t-j} + \Sigma\delta_j \Delta Y^*_{t-j} + u_t, \quad (10)$$

where Δ is the first-difference operator, $i = 0, \ldots, 8$ is the current and eight lags of real (first-differenced) exchange rate, $j = 0, \ldots, 2$ is the current and two lags of real (first-differences) domestic and foreign output, and u_t is a random error term.

As mentioned earlier, the estimating procedure is 2SLS applied to first-differenced variables. We report test results with current and eight (two) lags of the exchange rate (domestic and foreign output) as independent variables.[19] The estimation results for the six pairs of countries reveal that none of the exchange rate coefficients is significant and no J-curve pattern (i.e., initial negative real exchange rate coefficients turning to positive in later time periods) appears.[20]

Table 3 shows the cumulative impact of the exchange rate and domestic and foreign output variables on the trade balance of Taiwan and Korea. All the cumulative coefficients (except in the Korea–Japan case) have the expected signs, but most are insignificant. The long-run effects of a real depreciation and an increase of foreign (domestic) output are beneficial (detrimental) to Taiwan's and Korea's trade balance, but the effects are not significant.[21,22] Table 4 reports results from a Wald test of the hypothesis that the current and lagged exchange rates are jointly significant determinants of the trade balance. The Wald-statistic is not significant in any of the cases, and thus the null hypothesis [i.e., $\beta_i(i = 0, \ldots, 8) = 0$] cannot be rejected. In summary our results are similar to those of Rose and Yellen (1989) and Rose (1991) for the major OECD countries. They indicate that there is no J-curve effect in either the bilateral or aggregate trade of Taiwan and Korea. Moreover, our results show that none of the exchange rate coefficients is significant in determining the trade balance.

3.2. Robustness checks

Our results are not in conformity with those of most previous studies. Therefore, it is of interest to examine the sensitivity of our results to alternative specifications, time periods, variable definitions, etc. This is especially important, because our study uses an estimation method (first-differenced data and 2SLS) alternative to that of most previous studies.[23]

3.2.1. Different instruments, time periods, lag numbers, estimation method, and equation specification. Because there are doubts about the suitability of the

Table 3. Tests of significance for cumulative exchange rate (output) coefficients 1973QII–1991QIV.

Country	Coefficient	Estimate	Standard Error	D.W. Statistic[a]	Sargan's χ^2 Statistic[b] (degrees of freedom)
TW–US	$\Sigma\beta_i$	190,423.3	190,902.6		
	$\Sigma\gamma_j$	−161,649.2	123,760.3	2.512	0.824
	$\Sigma\delta_j$	245,268.2	192,787.1		(11)
TW–JP	$\Sigma\beta_i$	7,774.7	12,951.6		
	$\Sigma\gamma_j$	−21,522.6[c]	10,874.9	2.161	23.93[c]
	$\Sigma\delta_j$	5,156.0	13,951.2		(15)
KR–US	$\Sigma\beta_i$	1,180,001.0	1,575,438.0		
	$\Sigma\gamma_j$	−1,707,629.0[d]	1,133,463.0	2.070	14.65
	$\Sigma\delta_j$	2,840,744.0[d]	1,756,884.0		(11)
KR–JP	$\Sigma\beta_i$	−201,565.1	766,362.4		
	$\Sigma\gamma_j$	178,160.0	807,751.4	2.257	8.650
	$\Sigma\delta_j$	181,469.2	686,591.5		(15)
TW–ROW	$\Sigma\beta_i$	1,180.0	824.5		
	$\Sigma\gamma_j$	−307.3	397.3	2.436	8.507
	$\Sigma\delta_j$	40.1	586.4		(11)
KR–ROW	$\Sigma\beta_i$	17,582.8	15,648.7		
	$\Sigma\gamma_j$	−11,004.9	9,495.6	2.352	18.19
	$\Sigma\delta_j$	11,917.5	11,833.0		(11)

[a]D.W. is the Durbin-Watson statistic for first-order serial correlation.

[b]Sargan's χ^2-statistic is a general test of misspecification in the case of instrumental-variable estimation. Under the null hypothesis, the model in (10) is correctly specified and the instrumental variables are valid instruments. The statistic is computed as:

$$(y - X\hat{\beta}_{IV})' Z(Z'Z)^{-1} Z'(y - X\hat{\beta}_{IV})/\hat{\sigma}^2_{IV},$$

where y is a vector containing observations on the dependent variable, X is a matrix of observations on k explanatory variables, $\hat{\beta}_{IV}$ is the generalized instrumental variable estimator of the parameters, Z is a matrix of observations on s instrumental variables ($s \geq k$), and $\hat{\sigma}^2_{IV}$ is the instrumental estimator of the error variance. The statistic is asymptotically distributed as a chi-square variate with s-k degrees of freedom.

[c]Significant at the 0.05 level.

[d]Significant at the 0.10 level.

Table 4. Wald tests for joint significance of exchange rate coefficients 1973QII–1991QIV[a].

Country	Wald Statistic Value	Probability Level
TW–US	2.4934	.981
TW–JP	9.1520	.423
KR–US	5.4512	.793
KR–JP	12.6953	.177
TW–ROW	15.5151	.078
KR–ROW	9.7086	.375

[a]The 0.05 critical value for $\chi^2(9)$ is 16.9190.

instrumental variables used in estimating (10), we have reestimated the equation using different sets of instruments. The instruments used include various combinations of domestic and foreign money supplies, government consumption, current account balance, lagged exchange rate, and lagged output. None of the results, however, show any significant change from those reported in the previous subsection.

A second robustness test involves reestimating (10) for different time periods. We have reestimated the equation with data going back to the first quarter of 1971 for Taiwan and the first quarter of 1972 for Korea. These are the earliest quarters for which data for the lagged instrumental variables are available and include data from the adjustable peg era. An alternative estimation of (10) uses the first quarter of 1981 as the starting point for both countries. This is because the nominal exchange rate in Taiwan (Korea) was fixed prior to February 1979 (1980), after which a managed floating regime was instituted. Once more, the results do not show any significant changes from those which we reported previously.

It is possible that the number of lags for the real exchange rate and domestic and foreign output can affect the results. Therefore, (10) is reestimated with four and twelve lags of real (first-differenced) exchange rates and four lags of real (first-differenced) domestic and foreign output. In none of the cases does the exchange rate have a significant long-run effect on the trade balance. Individual coefficient estimates show that several lagged exchange rate coefficients are "randomly" significant in some cases. However, none of the signs of the exchange rate coefficients change from negative to positive as the lags increase, and we cannot detect the existence of a J-curve effect in any of the cases.

As a check on the estimation technique, we reestimate (10) via ordinary least squares (OLS). The long-run impact of the exchange rate is significant only in the Korea–U.S. case. Individual coefficient estimates show that some lagged exchange rates are significant in several cases. But again, none of the exchange rate coefficients exhibits a J-curve effect.

Finally, in order to check the sensitivity of our results to alternative dynamic specifications of the trade balance equation, we reestimate the model with four lags of the dependent variable as explanatory variables. Rose and Yellen (1989) claim that this is appropriate if the trade balance is characterized by a partial adjustment mechanism or if the trade balance adjusts only slowly to exchange rate and output changes. We find that the real exchange rate has a significant long-run effect on the trade balance in only one case, namely, Korea–U.S. Moreover, from the individual coefficient results, we cannot confirm the existence of a J-curve in any of the cases.

3.2.2. Data in level instead of differenced form. Given that most previous studies used (logs of) levels rather than differences, we have reestimated (10) with level data.[24] Both OLS and 2SLS are applied in tests of (10). Although some individual coefficients bear counterintuitive signs, the long-run effect of the exchange rate has the expected sign and is significant in four (three for 2SLS) out of six cases. Therefore, using level rather than differenced data can alter the results regarding the long-run effects of exchange-rate movements. As explained earlier, this, however, is inappropriate if variables contain unit roots. When it comes to individual exchange rate coefficients, with the exception of one coefficient in the OLS Korea–Japan case, the coefficients are insignificant in both the OLS and the 2SLS cases. Moreover, the J-curve phenomenon is not observable in any case.

3.3. J-curve and the small-country case

Because this study uses the net trade balance as the dependent variable, our results may not detect the effects of the real exchange rate on imports and exports separately. As discussed in section 1.2, the traditional argument for the J-curve rests on exports being denominated in domestic currency. Therefore, following a depreciation, the value of exports (in domestic currency) remains unchanged. On the other hand, an increase in the value of imports may be expected, since these are denominated in foreign currency. In the case of a small country, both exports and imports are denominated in foreign currency and, therefore, both are expected to increase in value (measured in domestic currency). For this reason, we have reestimated the model with real exports and real imports as separate regressands. Testing imports and exports separately should reveal whether Taiwan's and Korea's exports increase in the short run. If this is the case, (part of) the reason that we fail to find a J-curve effect may be because Taiwan and Korea are small countries.

We examine the cumulative impact of the exchange rate and foreign output on exports and the cumulative impact of the exchange rate and domestic output on imports, respectively. The results (available on request) show most output and exchange-rate coefficients have the expected sign, but only a few of them are significant. From the individual coefficient results, we do not find any significant import increase (decrease) in the short run (long run) or export increase in the long run, as predicted by the J-curve effect. We also find that neither Taiwan's nor Korea's exports (in domestic currency) increase significantly in the short run after a real depreciation. This implies that our failure to detect a J-curve effect may not be attributable to Korea and Taiwan being small countries.

3.4. An alternative test for the J-curve: the polynomial (Almon) distributed lag model

Some previous studies (e.g., Bahmani-Oskooee, 1985; Noland, 1989) have imposed smoothness priors on the exchange-rate coefficient structure. One way is to constrain the lag coefficients to lie on a polynomial (Almon) distributed lag (PDL).[25]

Because the multicollinearity between lags of the differences in the (log of the) real exchange rates is not significant, Rose and Yellen (1989) are reluctant to use PDLs.[26] However, given the tendency of many previous researchers (e.g., Helkie and Hooper, 1987; Krugman and Baldwin, 1987) to use PDL techniques, both Rose and Yellen (1989) and we in our study incorporate PDLs in OLS estimation of (10).

By imposing PDLs on non-differenced lagged exchange rates, we are able to detect a J-curve phenomenon in all cases.[27] Table 5 reports the coefficient

Table 5. Test statistics of current and lagged real exchange rates imposing Almon (8,3) on non-differenced data 1973QII–1991QIV[a].

Variable	TW–US	TW–JP	KR–US	KR–JP	TW–ROW	KR–ROW
q	17,719	3,881	-60,178	-272,670[b]	34.02	-184.71
	(1.31)	(1.38)	(-.40)	(-3.47)	(.56)	(-.16)
$q(-1)$	-3,924	-3,123[b]	-953	-82,855[b]	-.90	25.69
	(-.72)	(-2.87)	(-.02)	(-2.47)	(-.04)	(.06)
$q(-2)$	-10,009	-50,901[b]	68,510	20,260	-9.74	272.43
	(-1.19)	(-3.08)	(.71)	(.43)	(-.27)	(.38)
$q(-3)$	-5,477	-3,741[b]	140,200	60,536	-.91	548.27
	(-.78)	(-2.82)	(1.66)	(1.58)	(-.03)	(.89)
$q(-4)$	4,728	-801	206,100[b]	61,836[b]	17.16	845.97[b]
	(.91)	(-.89)	(3.33)	(2.29)	(.78)	(1.85)
$q(-5)$	15,667[a]	2,007	258,200[b]	48,025	36.05	1,158.30[b]
	(2.11)	(1.40)	(3.22)	(1.18)	(1.16)	(1.90)
$q(-6)$	22,396[a]	2,961[b]	288,490[b]	42,966	47.32	1,478.00[b]
	(2.62)	(1.73)	(3.11)	(.90)	(1.30)	(2.10)
$q(-7)$	19,973[a]	337	288,950[b]	70,521[b]	42.56[b]	1,797.80[b]
	(3.81)	(.32)	(5.04)	(2.43)	(1.72)	(4.04)
$q(-8)$	3,456	7,588[b]	251,570	154,550[b]	13.33	2,110.50[b]
	(.24)	(2.56)	(1.69)	(1.94)	(.21)	(1.78)

[a]t-ratio statistics are in parentheses below the coefficient estimates.
[b]Indicates that the coefficient of the variable is significant at the 0.05 level.

estimates of the current and lagged exchange rates of an Almon (8, 3) (Almon distribution with eight lags and third-degree polynomial) imposed on OLS estimation of non-differenced data.[28] It shows that the negative effect of real depreciation lasts from one to five quarters. The positive effect emerges after that and diminishes after the seventh quarter in all cases.[29] In addition to the expected signs, many coefficients are significant as well. When we impose the Almon (8, 3) restriction on first-differenced data (Table 6), a J-Curve phenomenon appears only in the Korea–U.S. case; weaker evidence for a J-curve appears in the Korea–Japan and Korea–ROW cases.

In order to test whether the existence of a J-curve, in the case of the non-differenced data of Table 5, is due to the restriction imposed by PDLs on the exchange rate, we have conducted an F-ratio test. The null hypothesis is that the PDL restrictions are not responsible for the J-curve effect. Table 7 reports the F-statistics for our test. All the F-ratio statistics are insignificant. Therefore, the PDL restrictions are not responsible for the J-curve effect displayed in Table 5.

4. Conclusion

This article estimates a "partial reduced form" equation for the determinants of Korea's and Taiwan's trade balance, both bilateral (with the U.S. and Japan) and

Table 6. Test statistics of current and lagged real exchange rates imposing Almon (8,3) on differenced data 1973QII–1991QIV[a].

Variable	TW–US	TW–JP	KR–US	KR–JP	TW–ROW	KR–ROW
Δq	20,618	243.2	–427,540	–125,240	74.88	–2,344.1
	(1.49)	(.08)	(–1.43)	(–1.22)	(1.12)	(–1.02)
$\Delta q(-1)$	2,763	–487.3	–182,560	–41,203	38.38	–1,221.3
	(.38)	(–.30)	(–1.19)	(–.72)	(.99)	(–1.00)
$\Delta q(-2)$	–1,558	–392.5	8,405	13,648	30.93	–399.1
	(–.19)	(–.23)	(.06)	(.21)	(.72)	(–.32)
$\Delta q(-3)$	2,928	189.1	152,740	47,065	41.18	212.0
	(.37)	(.12)	(1.08)	(.77)	(.96)	(.18)
$\Delta q(-4)$	11,493	919.2	257,830[b]	66,802	57.78	701.3
	(1.58)	(.64)	(2.05)	(1.24)	(1.39)	(.66)
$\Delta q(-5)$	19,412[b]	1,459.4	331,070[b]	80,611	69.38	1,158.3
	(2.43)	(.91)	(2.40)	(1.42)	(1.57)	(1.00)
$\Delta q(-6)$	21,956[b]	1,471.4	379,850[b]	96,245	64.62	1,672.4
	(2.57)	(.87)	(2.51)	(1.64)	(1.42)	(1.33)
$\Delta q(-7)$	14,400[b]	616.9	411,540[b]	121,460[b]	32.17	2,333.0[b]
	(1.80)	(.43)	(2.77)	(2.37)	(.76)	(1.89)
$\Delta q(-8)$	–7,875	–1,442.5	433,550	164,000	–39.33	3,229.5
	(–.52)	(–.52)	(1.69)	(1.65)	(–.59)	(1.57)

[a]See note to Table 5.
[b]Indicates that the coefficient of the variable is significant at the 0.05 level.

Table 7. F-ratio statistics for the PDL restrictions[a].

Country	F-Ratio Statistic
TW–US	.35
TW–JP	.55
KR–US	.37
KR–JP	.58
TW–ROW	.96
KR–ROW	.23

[a]The 0.01 and 0.05 critical values for $F_{5,59}$ are 3.34 and 2.37, respectively. The degrees of freedom (5,59) are the number of restrictions (which is equal to the number of lags minus the number of polynomials) and the number of observations minus the number of parameters, respectively.

in the aggregate. The primary objective of the study is to investigate the impact of real exchange-rate changes on the trade balance and to detect any J-curve effects in Korea's and Taiwan's international trade. When no PDL structure is imposed on the estimating equation, we find that the cumulative effects of the real exchange rate and domestic and foreign output have the expected sign: a real depreciation and an increase (decrease) of foreign (domestic) outupt will improve the domestic trade balance in the long run. These effects, however, are (in most cases) not significant. Wald-test statistics reveal that the hypothesis that the current and lagged real-exchange rate coefficients are jointly equal to zero cannot be rejected at the 0.05 level. Robustness checks are unable to reveal the existence of a J-curve in the unconstrained model. Our findings corroborate those of Rose and Yellen (1989) and Rose (1991) for the major OECD economies.

The model was also estimated imposing a PDL (Almon) structure on the exchange-rate coefficients. Korea's and Taiwan's trade balance (both bilateral and aggregate) reveals a J-curve when the data is not differenced. When variables are entered in first-difference form, a J-curve effect is detected in the Korea–U.S. case (and to a lesser extent in the Korea–Japan and Korea–ROW cases). In view of the presence of a unit root in the variables (discussed in a preliminary data section), first-differencing of the variables is necessary to obtain valid statistical inferences. In conclusion, with the exception of Korea–U.S. trade, our results point to a general inability to obtain a J-curve effect.

The general lack of evidence in favor of a J-curve raises an important question: why? One explanation we have explored in this article is that the traditional explanation for a J-curve may not hold in Korea's and Taiwan's case. The traditional explanation relies on a country's exports being denominated in domestic currency. Therefore, a depreciation of the real exchange rate leaves export value (in domestic currency terms) unaltered during the currency contract period. On the other hand, given that a country's imports are denominated in foreign currency, import value increases. In the case of a small country (such as Korea and Taiwan) where both exports and imports are denominated in foreign currency, both import and export values are expected to increase during the currency contract period; the net result will depend on (domestic supply and demand) elasticities and the country's initial trade position. We have explored this question using real exports and imports as separate regressands. We fail to find empirical support for the presumed positive impact of a real depreciation on exports, as the small-country case predicts.

Early studies purporting to find a J-curve relied on data in level form (nonstationary). Recent research on the trade balance of several OECD economies by Rose (1991) and Rose and Yellen (1989) has remedied this deficiency by employing stationary (first-differenced) data. These studies have not only been unable to detect a J-curve effect, but they have also shown that the change in the trade balance of these OECD economies is insensitive to changes in the real exchange rate. We arrive at a similar conclusion in this study. While our result is, on the whole, negative, we would like to echo Rose's (1991, p. 316) sentiment that it is "... also an invitation for further research to determine the source of this finding."

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Notes

1. Examples include Goldstein and Khan (1985), Helkie and Hooper (1987), Krugman and Baldwin (1987), Noland (1989).
2. Rose and Yellen (1989, p. 57) argue that no theoretical reason leads one to presume that the J-curve effect exists. They note that, "... while the conditions which lead to a J-curve may strike some as realistic, the complement (counterpart) to this set of hypotheses seems equally plausible." The conditions to which they refer are "the low short-run price elasticities of demand for imports both at home and abroad, a swift response of import prices to the exchange rate," and a long-run positive effect of real depreciation on the trade balance. Rose and Yellen refer to Mann (1986), who finds that import prices adjust slowly to exchange-rate changes, to demonstrate that the initial negative effect implied by the J-curve may not exist.
3. In this article, rest of the world (ROW) or aggregate trade includes trade with all of Korea's or Taiwan's trading partners; in other words, it includes tade with the U.S. and Japan.
4. For a study of the J-curve for developing countries, see, inter alia, Bahmani-Oskoee (1985). Rose (1990) finds that a depreciation of the real exchange rate "is not strongly associated with a significant improvement in the trade balance" for 30 developing countries. The role of the exchange rate in determining the trade performance of Taiwan and Korea has been studied by Arize and Spalding (1991), Hickok and Kligaard (1988), Moreno (1989), and O'Neill and Ross (1991). None of these studies, however, has attempted to systematically verify the existence of a J-curve effect.
5. Recent U.S. government policy reflects the belief that exchange rate changes are effective in reducing the U.S. trade imbalance. One example is the U.S. Treasury Report's accusation that the major trade surplus countries (especially in South East Asia) have purposely manipulated (undervalued) their currencies to gain a competitive advantage. Pressure has been exerted on these countries to appreciate their currencies. For a discussion see, inter alia, Baum (1992), Noland (1993, p. 21), and Park and Park (1991).
6. For a concise treatment of this model, see Goldstein and Khan (1985, pp. 1044–1050).
7. Similar linear import demand functions are presented in Argy (1994, pp. 142–149). In Argy, however, import demand is only a function of relative prices.
8. This is the period immediately following the depreciation of the currency when contracts negotiated prior to the exchange-rate change become due.
9. The derivation of (9) follows directly from (8), noting that the foreign demand and supply elasticities for a small country are infinite so that the price of imports and exports (in foreign currency) is fixed.
10. It should be noted that (with the exception of U.S.-Taiwan bilateral trade) Korea and Taiwan have experienced trade deficits, both bilateral and in the aggregate, for part or all of the period under consideration. It should also be clear that, from an initial position of trade surplus, (9) holds irrespective of the value of elasticities, and a real depreciation is expected to improve the real trade balance.
11. According to Rose and Yellen (1989), the use of a single nonstructural equation to estimate the relationship between the real exchange rate and the trade balance is much easier than the structural approach, which requires estimation of the structural parameters. They claim that another advantage of using a nonstructural equation is to resolve the simultaneity problem: choosing valid instruments in the nonstructural equation is less difficult than obtaining correct specifications of the structural price and volume equations. Finally, they note that investigators employing the detailed structural approach have frequently imposed priors in their estimation and implicitly assumed the validity of the structural equations. Use of a single nonstructural equation avoids this by imposing extensive tests for the sensitivity of the (nonstructural) model.
12. Naturally, only the right-hand side variables in (7) are entered in log form in the estimating equation, because the left-hand side variable, the real trade balance, can assume negative values.
13. In the case of bilateral trade, the real exchange rate, q, is defined as the relative price of tradables to nontradables or $(e \cdot P^*)/P$, where e is the nominal exchange rate (defined as the domestic currency price of foreign exchange), P^* is the foreign price level, and P is the domestic price level. When it comes to aggregate trade, q refers to a real effective exchange rate. We calculated it as

a weighted average of the bilateral exchange rates between Taiwan (Korea) and its ten most important trading partners. We determined the ten most important trading partners on the basis of average trade weights for four years: 1975, 1980, 1985, and 1990 for Taiwan; 1976, 1980, 1984, and 1988 for Korea. Average weights are computed so as to avoid any bias that may arise from single-year weights.

14. Data for bilateral import and export values in nominal terms are taken from the OECD *Monthly Trade Statistics*. Data for the consumer price index (CPI), the wholesale price index (WPI), the IP index, the nominal exchange rate, and the three instrumental variables are from the *International Financial Statistics* of the IMF and the *Financial Statistics*, Taiwan District, R.O.C. When calculating the real exchange rate or the real effective exchange rate, the foreign WPI is used instead of the CPI, because the WPI reflects more appropriately the price of "traded" mgoods. For some countries (France, Australia, and Malaysia), the CPI is used, because the WPI is either unavailable or the data are inconsistent.
15. Rose and Yellen (1989) and Rose (1991) use domestic and foreign interest rates as instrumental variables. During most of the 1970s and 1980s, interest rates were controlled in Taiwan and Korea and, therefore, are excluded from the instrument list. Instead, the domestic and foreign current account balances are used as instruments. Lindner (1992) argues that the current account balance is one of the factors that determines Korea's "managed floating" exchange rate.
16. Without the transformation, the regression results of these nonstationary variables will be "spurious," and the standard errors of the coefficients will be underestimated.
17. We estimate six "pairs" of trade flows (i.e., Taiwan–U.S., Taiwan–Japan, Korea–U.S., Korea–Japan, Taiwan–Rest of the World, and Korea–Rest of the World). Therefore, there are seventeen variables ($RTB(6)$, $Y(2)$, $Y^*(3)$, and $q(6)$) to be tested for a unit root.
18. Since every variable in (7) can be used as a regressand, ADF unit-root tests are applied to four groups of residuals (from four regressions) for each of six pairs of trade flows. See Engle and Granger (1987) for an exposition on this test.
19. We have used the Akaike Information Criterion (AIC) to choose the number of lags that yields the minimum value for the AIC. The AIC is calculated as $\sigma^2\exp(2K/N)$, where $\sigma^2 = \hat{u}'\hat{u}/N$, N is the number of observations, K is the number of parameters, and $\hat{u}$ is the vector of OLS estimated residuals. We find that the number of exchange rate lags (with two lags of domestic and foreign output) that minimizes the AIC is less than or equal to eight in all cases. The number of exchange rate lags is as follows: Taiwan–U.S. (6), Taiwan–Japan (4), Korea–U.S. (7), Korea–Japan (1), Taiwan–ROW (8), and Korea–ROW (2). In the next section of the article, we conduct robustness checks where we reestimate (10) with different exchange-rate (and output) lags. As will be seen, the results with different lag lengths are similar to the ones reported here.
20. Due to length constraints, these results are not reported here; they are available on request. The instruments used include an intercept term, two lags of real (effective) exchange rate, four lags of domestic and foreign (world) industrial production, current and three lags of foreign government consumption (in the Taiwan–ROW and Korea–ROW cases no government consumption instruments are used), current and three lags of domestic and foreign money supply (M1) (in the Taiwan–U.S., Korea–U.S., Taiwan–ROW, and Korea–ROW cases, only the domestic country's M1 is used), and current and three lags of domestic and foreign current account balance (in the Taiwan–ROW and Korea–ROW cases, U.S. and Japan current account balances are used as "world" current account balances). All the instruments except the current account balances are the first differences of the logged real value, with domestic and foreign CPI used as deflators. Current account balances are the first differences of the real value.
21. Table 3 reports the Durbin–Watson statistic for first-order serial correlation. The null hypothesis of lack of first-order serial correlation cannot be rejected in any of the cases. The table also presents Sargan's χ^2 statistic. The null hypothesis that the model is correctly specified and the instrumental variables are valid instruments cannot be rejected in any of the cases at the 0.05 level; it can be marginally rejected at the 0.10 level in one case.
22. It is interesting to note that Rose (1991, p. 308) also reports poor results when estimating an equation such as (10) for five OECD members: Canada, Germany, Japan, the U.K., and the U.S. He reports measures of goodness of fit that are "disappointing" and that ". . .the coefficients on both

domestic and foreign output are often insignificant and "inappropriately" signed." Noland (1993) tackles the issue of the U.S.–Korea trade balance using an alternative methodology: vector autoregressions (VAR)s for six variables, namely, the Korean–U.S. trade balance, the bilateral real exchange rate, the U.S. and Korean gross national product, and the U.S. and Korean fiscal deficit. His results (Noland, 1993, p. 37) demonstrate that the hypothesis that the U.S.–Korean trade balance "... is exogenous to the system could not be rejected." He goes on to argue, however, that "... the real exchange and the U.S. macrovariables cause the Korean macrovariables, which in turn cause the bilateral [trade] balance." Based on these results, he concludes that U.S. pressure on Korea to revalue its currency "... might not have been misplaced."

23. Due to length constraints, the robustness test results are not reported; they are available on request.
24. Examples of previous studies that use levels instead of differences include Krugman and Baldwin (1987), Helkie and Hooper (1987), Noland (1989), and O'Neill and Ross (1991).
25. An Almon distributed lag model is recommended if the number of lags of the independent variable is large and/or the collinearities between the lags are significant. See Almon (1965) for a discussion of the distributed lag model.
26. Goldstein and Khan (1985) have pointed out two problems associated with using PDLs in trade models. The first problem is the "subjective prefiltering" by researchers when choosing the number of lags, the degree of polynomials, and whether the endpoint constraints should be imposed. The second problem is the fact that when using higher order polynomials and a large number of lags, the coefficients for some of the lagged variables often have signs that are at odds with theoretical expectations.
27. Rose and Yellen (1989) also found the existence of short J-curves when the PDL smoothness priors (with endpoint constraints) are imposed in the aggregate trade cases.
28. We have chosen eight lags (without endpoint constraints) in our PDL models, because (as explained previously) the number of lags yielding the minimum value for the AIC criterion is less than or equal to eight in all cases.
29. One way of choosing the degree of polynomial is to choose the one with the lowest AIC, given that the number of lags is fixed. If we change the degree of polynomial to two, the AIC is lower in the Korea–U.S., Korea–Japan, Taiwan–ROW, and Korea–ROW cases, but is higher in the other two cases. In tests where we have used the degree of polynomial with the lowest AIC, the coefficient estimates and t-ratio statistics are similar to the ones reported in Table 5.

References

Almon, S. (1965) "The Distributed Lag Between Capital Appropriations and Expenditures." *Econometrica* 33, 78–196.

Argy, V. (1994) *International Macroeconomics: Theory and Policy.* New York: Routledge.

Arize, A. and J. Spalding (1991) "A Statistical Demand Function for Imports in South Korea," *Journal of Economic Development* 16, 147–164.

Bahmani-Oskooee, M. (1985) "Devaluation and the J-Curve: Some Evidence from LDCs." *The Review of Economics and Statistics* 67, 500–504.

Baum, J. (1992) "Too Strong Too Long: Taiwan Exporters Rail at Rising Currency," *Far Eastern Economic Review* 155 (July 30), 59–60.

Engle, R.F. and C.W.J. Granger (1987) "Co-Integration and Error Correction: Representation, Estimation, and Testing," *Econometrica* 55, 251–276.

Goldstein, M. and M.S. Khan (1985) "Income and Price Effects in Foreign Trade." In R.W. Jones and P.B. Kenen (eds.), *Handbook of International Economics.* Amsterdam: North Holland, pp. 1041–1105.

Helkie, W.L. and P. Hooper (1987) "The U.S. External Deficit in the 1980s: An Empirical Analysis," International Finance Discussion Paper No. 304, Board of Governors of the Federal Reserve System.

Hickok, S. and T. Kligaard (1988) "U.S. Trade with Taiwan and South Korea," *Federal Reserve Bank of New York Quarterly Review* (Autumn), 60–66.

Johansen, S. (1988) "Statistical Analysis of Cointegrating Vectors," *Journal of Economic Dynamics and Control* 12, 231–254.

Krugman, P. and R.E. Baldwin (1987) "The Persistence of the U.S. Trade Deficit." *Brookings Papers on Economic Activity* 1, 1–43.

Lindner, D.J. (1992) "Foreign Exchange Policy, Monetary Policy, and Capital Market Liberalization in Korea," International Finance Discussion Paper, No. 435, Board of Governors of the Federal Reserve System.

Mann, C.L. (1986) "Prices, Profit Margins, and Exchange Rates," *Federal Reserve Bulletin*, 366–379.

Moreno, R. (1989) "Exchange Rates and Trade Adjustment in Taiwan and Korea," *Federal Reserve Bank of San Francisco Economic Review* (Spring), 30–48.

Noland, M. (1989) "Japanese Trade Elasticities and the J-Curve." *The Review of Economics and Statistics* 71, 175–179.

Noland, M. (1993) "The Origins of U.S.-Korea Trade Frictions." In J. Mo and R.H. Myers (eds.), *Shaping a New Economic Relationship: The Republic of Korea and the United States.* Stanford: Hoover Institution Press, pp. 13–39.

O'Neill, H.M. and W. Ross (1991) "Exchange Rates and South Korean Exports to OECD Countries," *Applied Economics* 23, 1227–1236.

Park, Y.C. and W. Park (1991) "Exchange Rate Policies for the East Asian Newly Industrialized Countries." In Emil-Maria Claasen (ed.), *Exchange Rate Policies in Developing and Post Socialist Countries.* San Francisco: ICS Press, pp. 357–392.

Rose, A.K. (1990) "Exchange Rates and the Trade Balance: Some Evidence from Developing Countries." *Economics Letters* 34, 271–275.

Rose, A.K. (1991) "The Role of Exchange Rates in a Popular Model of International Trade," *Journal of International Economics* 30, 301–316.

Rose, A.K. and J.L. Yellen (1989) "Is There a J-Curve?" *Journal of Monetary Economics* 24, 53–68.