

## Exchange Rate and Income Effects on South Korean Exports: The US Case

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This paper analyzes econometrically the effects of direct and cross exchange rates as well as US income and Korean supply developments on the volume of Korean exports to the US. The results suggest that US demand has been the most important factor in the growth of Korean exports to the US in recent years. However, direct exchange rate effects are also important; the estimates suggest that for 1989-90, a yearly 10% real appreciation of the won against the dollar would have lowered export volume by about 10% per year relative to a baseline case. Cross exchange rate effects run counter to expectations.

### I. Introduction

The exchange rate policies of South Korea and the other newly industrialized countries (NICs) in East Asia have come under close scrutiny recently as those countries' exports to and trade balances with the US have surged.<sup>1</sup> Korea's trade relationship with the US in particular grew from a \$313 million surplus in 1982 to a \$9.7 billion surplus in 1988. Korea's overall trade balance went from a deficit of \$2.4 billion as recently as 1982 to an almost \$9 billion surplus in 1988. This turnaround in the trade account was dominated by an export surge that allowed Korea to maintain rapid economic growth and shrink its foreign debt. Korea's debt fell from fourth to seventh among developing economies, declining from \$51

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<sup>1</sup> The NICs are South Korea, Taiwan, Hong Kong, and Singapore. In this paper "Korea" is synonymous with "South Korea."

billion in 1985 to about \$30 billion by the end of 1988.

Korea, like the other NICs, has generally managed its currency with close reference to the US dollar to enhance its competitiveness in the US market. During the latter half of the 1980s, the Korean won generally followed the dollar in depreciating significantly against the Japanese yen and European currencies. As a result, Korea allegedly gained at the expense of Japan and other nations supplying the US market. Concern that the won was undervalued led the US government to press the Korean government to appreciate the won in nominal terms against the dollar. Korea responded with an 8.7 percent appreciation in 1987, and a 13 percent appreciation in 1988, but the bilateral trade surplus with the US failed to decline significantly.

This paper attempts to distinguish the effects of exchange rates from the effects of demand growth, Korean domestic supply developments, and other factors in Korean exports to the US. Most previous analysis has focused either on exports of *individual* NICs' or *aggregate* LDC exports as a group to *major* regions.<sup>2</sup> Of particular interest in the current analysis is the identification of direct versus cross exchange rate effects. This identification requires the construction of real exchange rate indices for Korea and the other major export suppliers to the US market. If Korean exports respond strongly to exchange rate changes, then policies or factors which appreciate the won in real terms against the dollar will help lower exports and US bilateral trade deficits fairly quickly. If exchange rate effects are relatively small, or if US imports are explained mainly by US demand growth, supply-side developments in Korea, or other trends, then exchange rate changes by Korea will have relatively little effect on US imports.

Section II discusses developments that probably influenced exports during the late 1980s. Section III presents the theoretical model, develops reduced-form export equations for econometric estimation, and discusses specification of the model's lag structure. Section IV evaluates the results. Section V forecasts for 1989-90 the effects of 10 and 20 percent annual real appreciation of the won against the US dollar. Section VI concludes.

## II. Determinants of South Korean Exports to the US

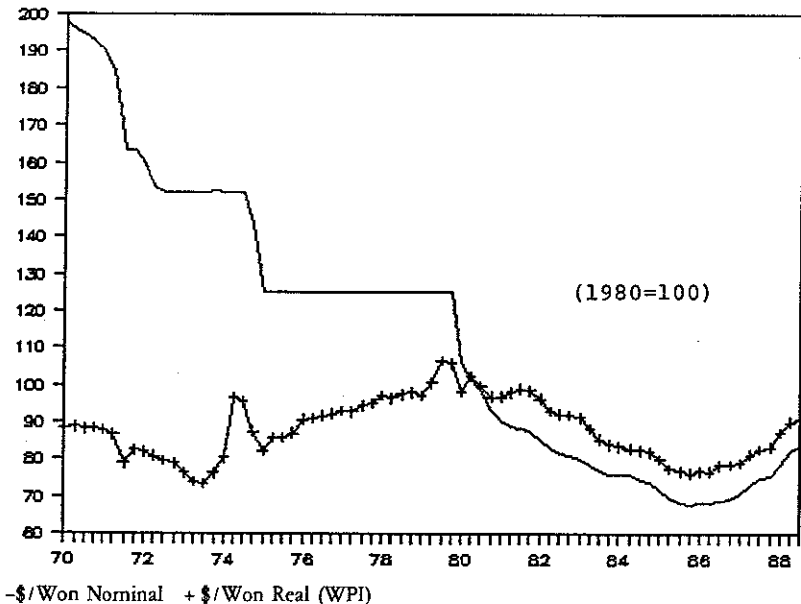
### A. *Nominal and Real Exchange Rates*

<sup>2</sup> For example, see Kim (1984), Bond (1987) and (1984), Marquez and McNeilly (1986), and Grossman (1982).

Korea managed the won with close reference to the dollar over the past two decades although the won-dollar rate did not remain constant except for the 1975-80 period (see Figure 1). Compared with other NIC currencies the won depreciated nominally the most against the dollar since 1970. The won reached 331 to the dollar by 1970 following a series of devaluations to counteract deteriorating payments balances. During the early 1975 Korea applied a crawling peg with occasional devaluations. By 1975 the won had reached 484 to the dollar and remained there until being devalued significantly in 1980 as the government reacted to strong inflationary pressures and soaring commodity prices. The won reached 890 to the dollar by the end of 1985. It gradually appreciated during 1986-88, reaching 683 by January, 1989.

Official Korean policy of the late 1980s stated that the government adjusted the won on a daily basis against the dollar relative to a basket of major currencies. Yet other indicators — current accounts, international debt levels, and domestic inflation plus bilateral political relations — were

**Figure 1**  
 \$/Won Rates 1970-88  
 (1980 = 100)

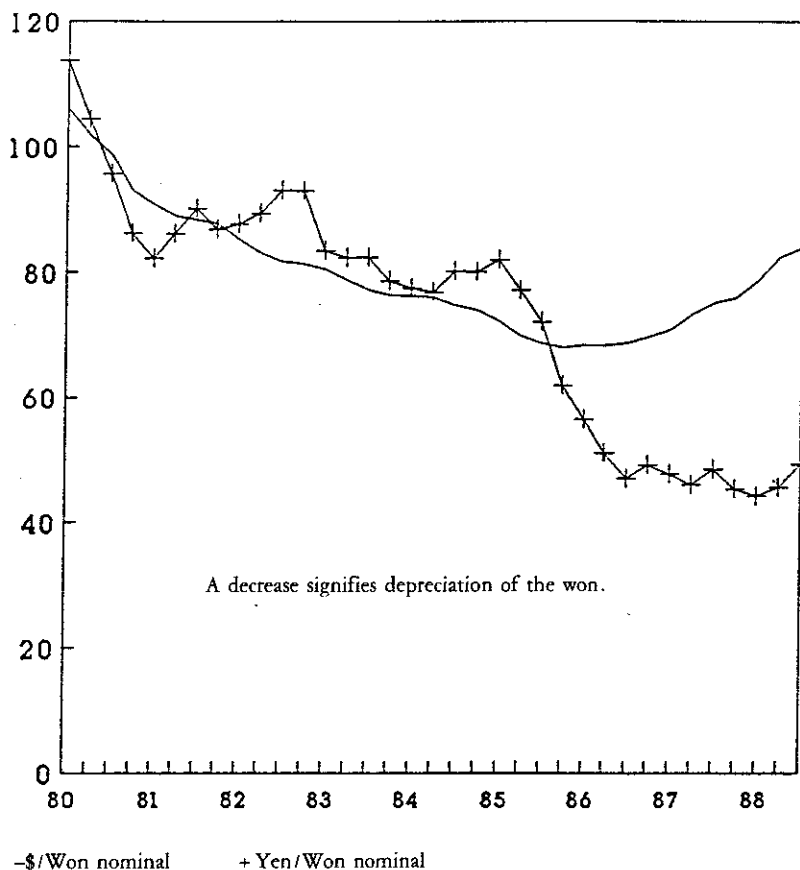


-\$/Won Nominal +\$/Won Real (WPI)  
 A decrease signifies depreciation of the won.

said to be important determinants. Tight foreign exchange controls supported the government's strict management of the exchange rate. The consequence of adjusting the won with the dollar was significant variation with respect to other currencies, particularly the yen (see Figure 2). However, Korea is said to increasingly have taken into account movements of the won relative to the yen and the currencies of other NICs, which are considered Korea's chief competitions in world export markets.

The model presented below suggests that the volume of trade is affected by real exchange rates, or nominal rates adjusted for domestic

**Figure 2**  
Yen/Won Nominal Rate  
(1980 = 100)



costs and prices.<sup>3</sup> Nominal rate changes will have varying effects on real exchange rates over time depending on the pricing behavior of producers and demand behavior of consumers in tradable and non-tradable sectors. Other government policies, macroeconomic developments, changes in productivity, labor market trends, etc. also cause real exchange rate movements.

The real exchange rate between the won and the dollar did not track closely with the nominal rate during the 1970s. (See Figure 1, which charts the real exchange rate as the nominal rate adjusted by wholesale price changes). This low correlation would lend doubt to the efficacy of nominal exchange policies as instruments for enhancing international competitiveness. But during the 1980s, Korea's real rate more closely followed nominal rates. In real terms, the won tended to appreciate against the dollar until 1980, when it began a steady depreciation. From the latter part of 1986 to late 1988, it appreciated.

The won depreciated more than other Asian NIC currencies against the dollar in real terms in the 1980s and was the only NIC currency to have depreciated significantly since the early 1970s. As shown in Figure 3, the won fluctuated with an upward trend against the currencies of ten other major US export suppliers during the 1970s, before appreciating rapidly during 1981. It remained fairly constant between 1982 and 1985 before following the dollar's rapid depreciation against other currencies. In 1986 and 1987, the won was fairly stable before appreciating significantly during 1988.<sup>4</sup>

Except for a few periods, the real won-dollar rate (henceforth called the direct exchange rate) and the real won-other suppliers rate (the cross exchange rate) have not been very closely related. A simple regression for the period 1972-86 reveals that only about 18 percent of the total variation of the cross rate was explained by variation in the direct rate. According to this result, the Korean government and industry argument that won appreciation against the dollar with cause Korea to lose competitiveness against other suppliers in the US market seems to be overstated.<sup>5</sup>

<sup>3</sup> Strictly speaking, the real exchange rate is the ratio of tradable to non-tradable goods. The real exchange rate measure used in this paper is a proxy.

<sup>4</sup> Choice of the other suppliers' list is explained in the Appendix.

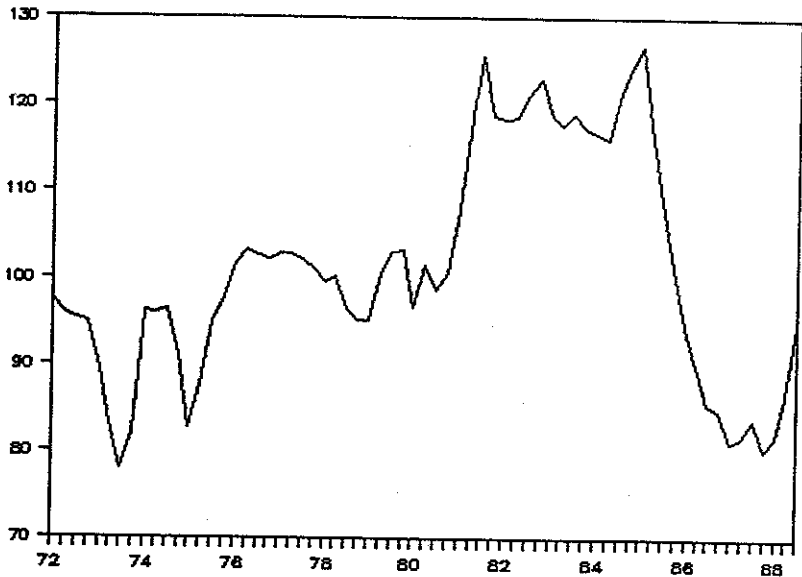
<sup>5</sup> The estimated 1972:I = 1986:III regression for the won-dollar real rate and won-other suppliers' real rate is:

$$(PK/PO) = 2.06 + .56(PK/PUS), \text{ R-Square} = .18$$

(.67) (.15)                      DW = .12

where standard errors are in parentheses. The equation is corrected for autocorrelation.

**Figure 3**  
Other Suppliers/Won Rate



Ratio of Korean WPI to multilaterally-weighted average of export prices of other major suppliers to US. See Appendix.

A decrease signifies depreciation of the won.

### *B. US Demand*

Korean exports to the US have also been encouraged by demand growth in the US. The world's largest market expanded rapidly after the 1981-82 recession, bringing along with it an expansion of imports from all major sources — particularly Korea and the other Asian NICs. US import volume from Korea grew at an average annual rate of 22 percent from 1980 to 1987. This growth was striking relative to that of slow-growth Europe, savings- and export-oriented Japan, debt-burdened Latin America, and oil-price depressed OPEC. Japanese and European import volume from Korea rose about 16 and 14 percent per year, respectively, during 1980-87, with much of this growth taking place in 1987.

### *C. South Korean Supply*

Another factor enhancing Korea's exports is expansion of export-based manufacturing output, much of it targeted at the large and open US

market. Private-sector investment assisted by inflows of foreign capital and technology, an ambitious, well-educated work force, and extensive government assistance, has prepared Korea to sell a wide range of inexpensive, high-quality products to the US. Productivity grew rapidly in the 1980s and, combined with low wage levels and intensive marketing programs, allowed Korean firms to prosper in the US market. A crucial part of Korean corporate strategy has been the trend toward higher-value-added products. This move has boosted the profitability from sales in developed-country markets and allowed Korea to adjust to increasing competitiveness from lower-wage developing countries. Much of the trade reflects expanding subcontracting arrangements with US firms and growing intra-firm transfers of US multinationals. Korea has achieved its major successes in consumer electronics, automobiles, computer equipment, steel, textiles and apparel, and footwear.<sup>6</sup>

### III. An Export Model of South Korea

Estimation of Korean export flows to the US requires the use of a simultaneous equations model. Given Korea's increased prominence in world trade, and specifically in trade with the US, it is inappropriate to assume that Korea is a small country in its major export categories. Kim (1984) and others support this conclusion. The model presented below is a country-specific version of the approach taken by Bond (1985) who estimated reduced form trade volumes for groups of exporting and importing countries.

#### A. Demand

US Demand for the volume of Korean exports (USDKE) is specified as a log-linear function of real US absorption (ABS), the price of Korean exports relative to prices of competing US goods (PKE/PUS), the price of Korean exports relative to the export prices of other suppliers to the US market (PKE/PO) and an error term,  $e_1$ :

$$(1) \quad \ln(\text{USDKE}) = \ln a_0 + a_1 * \ln(\text{PKE/PUS}) + a_2 * \ln(\text{PKE/PO}) \\ + a_3 * \ln(\text{ABS}) + e_1.$$

Assuming that traded goods are imperfect substitutes,  $a_1$  should be negative

<sup>6</sup> The literature on Korean export-led growth is voluminous. A useful review of recent experience is provided by Dornbusch and Park (1987).

since an increase in the price of Korean goods relative to US goods reduces demand. The  $a_2$  coefficient denotes a cross price elasticity, and its sign is ambiguous. Generally one expects  $a_2$  to be negative because an increase in Korean export prices, relative to the export prices of other suppliers in the US market, shifts US demand away from Korea, *ceteris paribus*. However, if Korean goods are complements for many of the other suppliers' products, then  $a_2$  could be positive.<sup>7</sup> The absorption elasticity of demand,  $a_3$ , is expected to be positive.

### *B. Supply*

The supply of Korean export volume to the US (KEXPS) is a function of the relative price of Korean exports to Korean domestic goods (PKE/PK), Korean industrial conditions (KPROD) and an error term,  $e_2$ . In the log-linear form supply is:

$$(2) \quad \ln(\text{KEXPS}) = \ln b_0 + b_1 * \ln(\text{PKE/PK}) + b_2 * \ln(\text{KPROD}) + e_2.$$

The desirability of exporting increases with the profitability of producing and selling exports relative to producing and selling at home. Moreover, using domestic goods prices as a proxy for domestic variable costs, we expect that increases in the price of exports relative to costs induce greater export supply —  $b_1$  should be positive. The variable KPROD, measured by the ratio of Korean production to its trend, is intended to capture changes in the ability of Korea to export. More specifically, it proxies for Korean export production capacity. Its coefficient,  $b_2$ , is expected to be positive.<sup>8</sup>

### *C. Reduced Form*

In equilibrium, Korean export supply to the US equals US demand for Korean exports:

$$(3) \quad \ln(\text{USDKE}) = \ln(\text{KEXPS}) = \ln(\text{KEXP})$$

Substituting (1) and (2) into (3), we obtain the reduced form equation for

<sup>7</sup> The cases of complementarity and the role of trade in production components are important for evaluation of Korean trade with other major industrial regions. For example, Korea competes against Japan in many product lines, but also sells components of products to Japan. Japan then sells the final product to the US. If Japanese export prices fall, there is an increase in the demand for both Japanese goods and Korean components. Therefore, we would expect to see an increase in Korean exports to Japan.

<sup>8</sup> See Moran (1988) for a discussion of measurement of production capacity for developing country export supply functions.



the endogenous variable PKE. Substituting PKE into (1) yields equation (4), the reduced form for Korean exports to the US:

$$(4) \quad \ln(\text{KEXP}) = c_0 + c_1 * \ln(\text{PK} / \text{PUS}) + c_2 * \ln(\text{PK} / \text{PO}) \\ + c_3 * \ln(\text{ABS}) + c_4 * \ln(\text{KPROD}) + e_3$$

where  $c_1 = (a_1 b_1)(1/B)$  (-),  $c_2 = b_1 a_2(1/B)$  (-/ +),  $c_3 = (b_1 a_3)(1/B)$  (+),  $c_4 = -b_2(a_1 + a_2)(1/B)$  (+), and  $B = (b_1 - a_1 - a_2)$  (+).<sup>9</sup>

All variables are expressed in US dollar terms. The signs following each expression denote the signs of the partial derivatives. Since we are dealing with a reduced form equation both supply and demand considerations for Korea exports are taken into account when discussing the partial derivatives. The elasticities discussed are the comparative static elasticities or impact multipliers. Identification of the structural elasticities associated with equations (1) and (2) requires application of two-stage least squares or another simultaneous equation technique. That task is outside the scope of this paper.

The two relative price terms (henceforth called real exchange rate effects) in equation (4) allow the model to distinguish direct effects of changes in South Korea's competitiveness in the US market from the cross effects of Korean price changes relative to other exporters in the US market. An increase in Korean domestic prices relative to US prices has two effects, *ceteris paribus*: (1) it reduces the profitability of Korean exports; and (2) it causes a substitution away from Korean goods and into US goods. This suggests a simultaneous decrease in supply and demand, respectively, thereby reducing Korean export volume. The direct exchange rate effect,  $c_1$ , should be negative. The cross exchange rate effect,  $c_2$ , which shows the effects of an increase in Korean domestic prices relative to other suppliers' export prices, can be positive or negative. If Korean exports are substitutes of other suppliers' goods,  $c_2$  is negative. On the other hand, if many of these goods are complements, there may be an increase in demand that overwhelms the effects of substitution; the coefficient  $c_2$  would be positive.

US absorption and Korean industrial conditions should have positive effects on export volume, since an increase in the former increases demand and an increase in the latter augments supply.

<sup>9</sup> B is positive because we assume that the absolute value of  $a_2$  is less than the absolute value of  $a_1$ .

#### *D. Model Specification*

An important issue in a quarterly trade equation estimation is the form and length of the lag structure for exchange rate and absorption effects. We assume that US export demand adjusts to exogenous variables with a lag because of long-term contracts, transaction costs associated with changing suppliers, recognition lags, etc. Economic theory provides little explicit information about how these lags operate.

A partial adjustment or Koyck model indicates the following lag structure that we estimate:

$$(5) \quad \ln(\text{KEXP})_t = d_0 + d_1 * \ln(\text{PK/PUS})_t + d_2 * \ln(\text{PK/PO})_t + \\ + d_3 * \ln(\text{ABS})_t + d_4 * \ln(\text{KPROD})_t + d_5 * \ln(\text{KEXP})_{(t-1)} + v_t.$$

The partial adjustment lag structure restricts the coefficients for all of the independent variables to follow the same geometrically declining weight scheme. If the lag structures for price and absorption are different, the model is misspecified. The appropriateness of the partial adjustment restriction is tested by comparing equation (5) with an "unrestricted" equation which includes an additional lag for all predetermined variables.<sup>10</sup>

Krugman and Baldwin (1987) suggest that trade flows respond more quickly to income changes than price changes. In their "Book-of-the-Month Club" model, importers lock into long term agreements with suppliers once the choice of supplier has been determined. Thereafter quantities demanded from an existing supplier may vary according to economic conditions such as changes in absorption; a quarterly reduction in US absorption reduces demand immediately from an existing Korean supplier. Only significant and long-lasting changes in relative prices lead to a demand shift between Korean, US and other suppliers in the US market.

On the supply side, producers face production lags and play a wait and see game before shifting production between export and domestically consumed goods. Moreover, industries that have been established for the purpose of exporting are unlikely to shift production away from exports when facing rising input costs. A short term reduction in profits is a more likely outcome. Therefore, Korean exporters may react to changes in relative prices with a lag.

In addition to the lag length for the direct and cross exchange rate

<sup>10</sup> See Marquez and McNeilly (1988)

terms, the structure of the adjustment process needs to be specified. The Krugman and Baldwin argument above suggests an inverted-V or quadratic lag structure rather than a linear form. Therefore, as a alternative to the partial adjustment structure, an Almon polynomial distributed lag model is estimated. The reduced form equation in lag form becomes:

$$\begin{aligned}
 (6) \quad \ln(\text{KEXP})_t = & \ln f_0 + \sum g_{i+1} * \ln(\text{PK/PUS})_{(t+i)} \\
 & + \sum_{i=0}^n h_{i+1} * \ln(\text{PK/PO})_{(t+i)} \\
 & + \sum_{i=0}^n j_{i+1} * \ln(\text{ABS})_{(t+i)} \\
 & + f_1 * \ln(\text{KPROD})_{(t)} + u_{(t)}^{11}
 \end{aligned}$$

The sum of the individual elasticities for each exchange rate and income term measures the comparative static elasticities for the time frame in question.

The selection of lag length for the absorption and exchange rate variables in the Almon model rely on Akaike's final prediction error (EPE) and Schwarz' Bayesian Information Criterion (SBIC).<sup>12</sup> These techniques weigh the bias associated with too short a lag versus the inefficiency concurrent with too long a lag. The estimations were kept manageable by choosing maximum lag lengths of one, two, and three years. Upon selecting the lag length, the appropriate polynomial degree is chosen, as demonstrated by Johnston (1984).<sup>13</sup>

As with the partial adjustment specification, the overall dynamic restrictions imposed by the final selection of Almon lag length and form is tested by estimating an "unrestricted" version of the model and compar-

11 In the present study we do not test for the reasonableness of the log-linear or homogenous form of export equation. This form has been shown to be a reasonable choice in most empirical trade studies. Log-linearity can be evaluated with Box-Cox techniques and homogeneity can be tested with a version of the F-test. We assume that the error term,  $u(t)$  is normally distributed and homoscedastic.

12 The FPE and other lag length selection criteria have been used in recent international trade studies by Belongia (1986), Batten and Belongia (1987), and Haley and Krissoff (1988).

13 A third model which incorporates both secular and cyclical components of income or expenditure has been suggested by Marquez and McNeilly (1986) and Goldstein and Khan (1985). Haynes and Stone (1983) criticize this approach and recommend instead spectral regression analysis. O'Neill and Ross (1988) used the secular/cyclical approach to estimate the same export model studied here, but found the results added nothing to the estimation results.

ing it to the restricted version. Data construction and sources are described in the Appendix.

#### IV. Estimation Results

Table 1 summarizes estimation results for the partial adjustment lag and the polynomial distributed lag models. The equations were estimated over the period 1972:I to 1986:III and were corrected for first-order autocorrelation with the Yule-Walker method. Given a maximum lag of one year, both the FPE and SBIC selection criteria choose contemporaneous (one quarter) adjustment for absorption and exchange rates. When the maximum period of adjustment is extended to two years, the SBIC criterion still selects the contemporaneous model. However, the FPE criterion selects a one year lag for direct exchange rate effects and two years for absorption and cross exchange rate effects. Further testing to discern the polynomial degree indicates that both exchange rate effects are linear, whereas absorption follows either a quadratic or cubic form.

With a three year maximum adjustment period, the SBIC criterion selects contemporaneous adjustment for direct exchange rate effects, two years adjustment for cross rate effects, and two years (nine quarters) for absorption effects. The polynomial degree is linear for the cross effect and cubic for absorption. The FPE criterion selects ten quarters for direct rate effects, two years for cross effects, and nine quarters for absorption. The polynomial degree choice is linear for direct and cross effects and cubic for absorption.<sup>14</sup> Our F-tests of the validity of the dynamic adjustment of all the models indicate that they are appropriately specified.<sup>15</sup>

##### *A. In-Sample and Out-of-Sample Forecasting Performance*

To compare the six model specifications in terms of the forecasting abilities, in-sample and out-of-sample prediction errors were analyzed. Each model was estimated for the period 1972:I to 1986:III, and in-sample

<sup>14</sup> The imposition of endpoint constraints, which is desirable to reduce multi-collinearity, can not be rejected for either the exchange rate terms or absorption, when the cubic form is used. However, the endpoint constraint can be rejected at .001 for the quadratic form on absorption.

<sup>15</sup> The test compares our models against unrestricted models which include one additional lag on all of the predetermined variables. An F-test evaluates whether the coefficients on the additional lags are zero. If so, the model is appropriately specified. An obvious drawback to this technique is that although the dynamic specification can be tested versus the unrestricted alternative, it does not enable one to choose among several plausible models.



Table 1 (Continued)

	Long Run Elasticities			Quarterly Dummies(c)	Korean Product Capacity	R-Bar Squ.	DW	Prob. Value Unrestricted Model (d)
	Cross	Direct	Absorption					
SBIC3C (b)	1.5	-1.28	6.35	D1 = .21 D2 = .18 D3 = .14	0.83 (.44)	0.99	0.69	0.09
	s.e. L,D	(.34) (0,0)	(.32) (9,3)					
FPE3C (b)	1.97	-.189	3.35	D1 = .21 D2 = .16 D3 = .14	0.53 (.45)	0.99	0.56	0.07
	s.e. L,D	(.41) (10,1)	(.54) (10,3)					

(a) Adjustment coefficient = .08. Mean Lag = 12.5 quarters.

(b) Corrected for first-order serial correlation using Yule-Walker method.

(c) D2 = 1 for 2nd quarter, D3 = 1 for 3rd quarter, D4 = 1 for 4th quarter. Dummy variables were significant at .01 for all models.

(d) Probability value indicates the probability that all coefficients on the lagged predetermined variables equal zero.

(e) PDL Model Names: FPE-Final Prediction error method; SBIC-Schwarz' Bayesian Information Criteria; CONT—0 lags according to FPE and SBIC at 1 year maximum adjustment lag and SBIC at 2 year lag; 2,3—2 or 3 year maximum adjustment lags; Q, C, L—Quadratic or Cubic adjustment to absorption.

errors were calculated for Korean export volume for 1984:IV-1986:III. Out-of-sample errors were calculated for 1986:IV-1988:III.

Table 2 reports the mean absolute error (MAE) and root mean square error (RMSE). The partial adjustment model and three-year FPE (FPE3C) model with cubic absorption adjustment significantly under-perform the others and their results are not discussed further. The two year FPE

**Table 2**  
In Sample and Out of Sample Forecasting Errors (a)

		Mean Absolute Error	Root Mean Square Error
Koyck Model			
	In Sample (b)	0.725	0.729
	Out of Sample (c)	1.274	1.28
PDL Models (d)			
CONT	In Sample	0.114	0.161
	Out of Sample	0.029	0.311
FPE2Q	In Sample	0.123	0.154
	Out of Sample	0.507	0.512
FPE2C	In Sample	0.165	0.186
	Out of Sample	0.534	0.543
SBIC3C	In Sample	0.105	0.117
	Out of Sample	0.057	0.0657
FPE3C	In Sample	1.92	1.92
	Out of Sample	1.979	1.979

(a) Regression period; 1972:1-1986:III.

(b) In sample forecast period; 1984:IV-1986:III.

(c) Out of sample forecast period; 1986: IV-1988:III.

(d) See Table 1 for key to PDL model names.

(FPE2C) model has higher error statistics, and is also rejected. The forecasting performance of the contemporaneous (CONT), two-year FPE with quadratic absorption (FPE2Q), and three-year SBIC with cubic absorption (SBIC3C) models cannot be distinguished unambiguously. Regression estimates for these models are discussed below. An interesting result is the relatively strong out-of sample forecasting performance of the CONT and SBIC3C models, which both indicate very rapid direct exchange

rate effects.<sup>16</sup> This is particularly interesting in light of numerous studies postulating lagged behavior in international trade. Based on the contemporaneous model our results indicate that a general case can be made for rapid adjustment of Korean exports — thus lending support to the Krugman and Baldwin hypothesis of rapid adjustment to income changes but less support for the hypothesis of slower adjustment to exchange rate changes.

### *B. Direct Exchange Rate Effects*

The long-run direct exchange elasticities are  $-1.06$  and  $-1.28$  in the FPE2Q and SBIC3C models, respectively. This implies that a 10 percent appreciation of the won with respect to the dollar would eventually yield a 10.6 to 12.8 percent decline in Korean export volume to the US. The elasticity for the CONT model equals  $-0.25$  but is statistically insignificant after correcting for autocorrelation.

### *C. Cross Exchange Rate Effects*

The cross exchange rate elasticity is 1.5 in the SBIC3C model and 2.32 in the FPE2Q model. These estimates imply that a 10 percent won appreciation against other suppliers' currencies would *increase* Korean exports by from 15 to 23 percent. (The elasticity is positive, equal to .43, though insignificant after correcting for autocorrelation in the CONT model.) The positive elasticity sign obtained is surprising given the commonly held view that won appreciation against other suppliers' currencies should hurt Korean sales in the US market. Other econometric work has obtained similar results for US imports from developing countries.<sup>17</sup>

We noted in Section III that complementarity in US demand could produce a positive cross elasticity. Korea competes with other East Asian countries in the US market in many products such as consumer electronics, textiles and apparel, and computer equipment. But the cross exchange rate variable used here incorporates several European economies, some of whose exports may complement Korea's. An example is a US apparel manufacturer who uses West German sewing machinery and man-made fabric from Korea. The model aggregates several diverse economies in the construction of the cross exchange rate variable, and may disguise

<sup>16</sup> Under the SBIC3C model, the estimated lag structure indicates that 100 percent of the direct exchange rate effect and 70 percent of the absorption effect takes place within two quarters.

<sup>17</sup> See Marquez and McNeilly (1986).



the substitution effects between the won and other East Asian currencies.

The large portion of Korean imports from the other 10 suppliers, which are components and subassemblies for the production of Korean exports, may also help explain the result. For examples, Korean imports from Japan in 1986 reached \$11 billion and consisted primarily of crucial inputs for Korea's electronics, automobile, and other export industries. Won depreciation against the yen or other suppliers' currencies raises Korean imported input costs and reduces the competitiveness of Korean exports, *ceteris paribus*. In the case of Korean exports to the US, this effect may be large enough to offset the competitive advantage won depreciation provides to Korea.

#### *D. US Absorption Effects*

Our estimates suggest that US demand growth is the most important factor in the growth of Korean exports to the US. The elasticity is highly significant in all three models and varies between 5.3 and 7.3

#### *E. Korean Productive Capacity Effects*

The estimates vary in sign, size, and statistical significance for the three models. Elasticities for the SBIC3C and FPE2Q models are .83 and .45, respectively — with the latter statistically insignificant. The negative and statistically significant coefficient of the CONT model is contrary to expectations, and suggests that changes in Korean production may be consumed domestically or in the form of exports to countries other than the US.

### **V. Forecasting the Effects of Won Appreciation**

#### *A. Assumptions*

Based on the strength of its out-of-sample forecasting and highly significant coefficients we chose the SBIC3C model for forecasting purposes. Using the estimates from the SBIC3C model we forecast the export volume to the US for the two year period 1988:IV-1990:III. We examined 10 versus 20 percent real appreciations of the won against the US dollar. The forecasts assume that the South Korean authorities undertake exchange rate and other macroeconomic policies such that the direct real exchange rate (PK/PUS) appreciates by 10 or 20 percent per year during 1989 and 1990.

To simulate changes in the cross exchange rate (PK/PO), we assume that Korean domestic and other suppliers' export prices remain constant relative to each other. Consequently, the real cross rate varies solely by nominal movements in the won relative to the weighted average of other suppliers' currencies. To calculate this, we combined the 10 and 20 percent won-dollar assumptions with DRI forecasts of the dollar against competitor currencies in nominal terms for 1989 and 1990.<sup>18</sup> By construction, the cross exchange rate appreciates by 3.8 and 5.6 percent in 1989 and 1990 given a 10 percent won-dollar appreciation versus 13.8 and 15.6 percent in 1989 and 1990 with a 20 percent won-dollar appreciation.

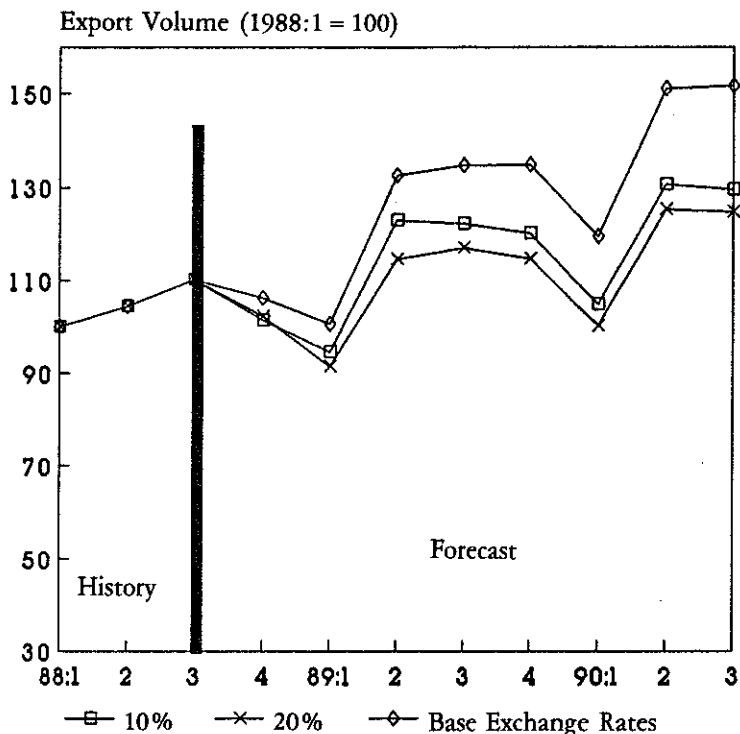
US real absorption for 1989 and 1990 is also obtained from DRI forecasts. For simplicity, the Korean industrial production variable was assumed to remain at its average value for 1988. To the extent that capacity, domestic demand, and other conditions vary over the forecasted 2 years, this assumption will distort estimates.

### *B. Results*

The forecast includes a baseline case, which assumes that the two exchange rate variables stay at their 1988:III levels. Figure 4 shows results for the three scenarios. The three paths reflect the low importance of exchange rates relative to seasonal changes and absorption in explaining quarterly changes in Korean exports to the US. Exports increase, if haltingly, over the next two years even with moderate real appreciation of the won against the dollar. But exports are distinctively lower than in the baseline case. With 10 percent appreciation, exports are 7 percent lower than the baseline in 1989 and 13 percent lower in 1990. With 20 percent appreciation, 1989 exports are 10 percent lower and 1990 exports are 17 percent lower. In the forecast, negative direct rate effects overcome positive cross rate effects because the assumed direct rate appreciation is greater than the assumed cross rate appreciation and because direct rates have strong negative effects on exports during *each* quarter, while cross rate effects are more lagged (see Table 1 lag lengths for the SBIC3C model).

<sup>18</sup> See DRI (1989). The cross rate calculation used DRI's forecast effective nominal depreciation of the US dollar for 1989 and 1990 as a proxy for the weighted average movement of other suppliers' currencies. DRI forecasts an effective dollar depreciation of 6.2 percent in 1989 and 4.4 in 1990. This forecast of the cross rate is a substitute for preferred structural- or time series-based forecasts.

**Figure 4**  
 10 & 20% Appreciation  
 88:1-90:3



\* Export volume effects of 10 and 20% real won revaluation against the dollar in 1989 and 1990.

## VI. Conclusion

The above regression and forecast results suggest that the Korean economy has been highly geared toward the US market and that exports to the US are very responsive to US demand. Although we have focused only on the Korean export side — the estimates suggest that a slowdown in US demand growth would be a major contributor to a rapid and significant decrease in the trade deficit with Korea. Estimates of direct exchange rate effects show that won appreciation against the dollar in real terms would, *ceteris paribus*, have fairly rapid negative effects on exports to the US.

Direct and cross exchange rates (in real terms) have shown little correlation with each other over the past two decades. Moreover, estimated cross exchange rate effects run counter to expectations. When the won appreciates relative to the currencies of other major US suppliers, Korean exports to the US are increased. This may be the result of substantial complementarity in consumption between Korean and other suppliers' products in the demand functions of US importers. Also, Korea's substantial component sourcing from non-US suppliers implies that won appreciation against non-dollar currencies helps Korean exporters by lowering their production costs. For these reasons, Korean concerns over losing US markets to other Asian NICs or Japan following a unilateral appreciation of the won against the dollar may be exaggerated.

We have attempted to take into account Korean industrial developments in the supply side of the current model. The modeling probably can be improved by more explicitly incorporating improvements in Korean industrial competitiveness or other time-dependent trends. Previous discussion about component sourcing suggests that incorporating imported inputs into the export supply function could be fruitful.<sup>19</sup>

<sup>19</sup> A recent study by Riedel (1988) indicates the importance of more explicit modeling of supply behavior for NIC manufacturing exports. Riedel's conclusion that supply behavior dominates industrial country demand behavior in explaining Hong Kong's exports, suggests that the current paper would be improved by identifying structural supply parameters.

## Appendix

### Data Requirements

The volume of real Korean exports to the US (KEXP), is obtained by deflating the value of Korean exports to the US by 1980 Korean export prices at 1980 exchange rates. Korean trade data are highly seasonal — large drop-offs or slowdowns in exports usually occur in the first quarter. We corrected for seasonality with quarterly dummy variables. The data sources for export volume and the other variables are provided at the end of this Appendix.

Real US expenditure (ABS) is used as the activity variable in demand for exports even though empirical trade analysis often uses real GNP. Magee (1975) emphasized that trade theory provides no expected sign for GNP's effect on import demand, whereas it does for real expenditure. The choice between absorption versus national income or production depends on whether a utility-maximizing or cost-minimizing structure is assumed when deriving the export demand equation. In one recent study, Hooper and Mann (1987), the choice of absorption versus income was shown to make little difference in regression results. In this study absorption is measured in real terms using the US GDP deflator (1980 = 100).

The real exchange rate between South Korea and the US (PK/PUS) is the ratio of South Korean wholesale prices to US wholesale prices, adjusted by the dollar-won exchange rate. When working with relative prices in international trade the choice of a deflator is a concern because price indices for domestic tradables do not exist. Choices of a deflator include the consumer price index (CPI), the wholesale price index (WPI), the GNP deflator and unit labor costs. The CPI excludes intermediate goods like steel that make up some of south Korean exports to the US. The GNP deflator includes a multitude of services that are not traded and thus do not compete with South Korean exports. A unit labor cost index for manufacturing is probably preferable, but series were unavailable for Korea for the time period estimated. The producer price index (PPI) for the US is chosen as a suitable proxy because it encompasses prices of manufactures most likely to compete with South Korean products, although some included products are non-traded. For similar reasons, the South Korean WPI is preferred as the proxy for Korean non-exported goods prices and costs used in the export supply function.

The cross exchange rate variable (PK/PO) is constructed by taking the ratio of Korean wholesale prices to a geometrically weighted average of the

other suppliers' export prices, all measured in dollars (1980 = 100). Weights for the other suppliers were chosen from a list of the fourteen leading exporters of manufactured exports (other than Korea) to the US during 1984-86. Manufactured exports are defined as categories 5-8 less category 68 of the Standard International Trade Classification. The weights are shown in the data sources section of this Appendix. The order of countries on such a list changes over time, although examination of analogous data for 1977-79 shows little difference in the weights. Generally speaking, there is no consensus as to what year or years to chose. Belongia (1986) recommends a year in which absolute purchasing power exists, but the required calculations are impractical.

Another concern with building such a cross exchange rate index is the choice of country weights. Multilateral export trade weights, rather than bilateral export weights, are used here. Bilateral weights stress bilateral trade and ignore third market effects. Multilateral weights incorporate such effects, which are crucial to the study of changes in regional export allocation. Index construction for real exchange rates usually uses total trade shares (exports plus imports). We choose only export shares because export flows are our concern.

Data on the export prices used in the cross exchange rate variable are either unit value indices or export price indices. Export price indices, like consumer price indices, come from survey data and are considered more reliable than unit values. Export price data are available for seven of the ten countries used in the cross exchange rate index. We assume that the aggregate export price indices of the ten exporters provide reasonable proxies for their export prices in the US. Our estimation assumes that the ten export prices and Korean wholesale prices are independent of the price of Korean exports, which is important because the latter is used in the calculation of the dependent variable, export volume.

As a representation for production capacity, we use the ratio of the index of Korean industrial production to its trend, the latter being calculated from an OLS regression against time. Similar representations have proven useful in other trade studies (see Somensatto (1985)). Some studies have also shown that industrial production or output capacity in non-ratio form provide positive and statistically significant coefficients in trade equations (see Kim (1984) and Goldstein and Khan (1978)). Our attempts to use industrial production in non-ratio form indicated severe multi-collinearity between Korean production and the US absorption variable. While this does not present a problem for the overall estimation abilities of the equation, it does prevent the identification of the theoretically important effects of changes in absorption.

The variable KPROD is related to the variable time, which is often used to identify the trend effects of several factors influencing trade, including changing worker skills and effort, capital intensity, and technological development, as well as shifts in tastes and trends in trade protection.

### Data Sources

KEXP IMF *Direction of Trade, International Financial Statistics*, (IFS) various issues.

ABS, PK, PUS, KPROD IFS

PO IFS, *Financial Statistics*, Republic of China Ministry of Finance, various issues, *UN Trade Data Base* and author's calculations.

Multilateral Weights used in the calculation of the other suppliers' real exchange rate variable:

West Germany	.29
Japan	.17
Italy	.15
France	.13
UK	.10
Switzerland	.06
Taiwan	.04
Sweden	.04
Singapore	.01
Canada	.01

Hong Kong, Mexico, Brazil, and China were excluded owing to data unavailability or inconsistency.

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