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**Determinants of Korean Trade Flows and their Geographical Destination**

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**Abstract**

This paper investigates the behavior of Korean trade flows during the last three decades and presents estimates of aggregate export and import equations. In particular, it considers different choices for scale and price variables and assesses the relative merits of these alternative specifications in terms of stability and forecasting performance. It also provides an assessment of the drastic change in the geographical destination of Korean exports during the 1990s.

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## SUMMARY

A distinguishing feature of the strong economic performance enjoyed by Korea and other newly industrializing Asian economies has been the rapid growth of export and import flows. In recent years, the growing weight of East Asian countries in the world economy and their increasing trade integration have been accompanied by a substantial change in the geographical destination of Korea's exports. While growth in Korean exports to member countries of the Organization for Economic Cooperation and Development (OECD) has slowed down considerably, exports to other East Asian countries have boomed. This paper examines the extent to which the Korean experience can be explained within traditional trade models. It provides evidence on how exports and imports react to changes in relative prices and in foreign and domestic demand, and investigates the determinants of the direction of Korean exports.

Two important issues are dealt with differently from previous studies. First, in light of the high weight of raw materials and capital goods in Korea's imports, the hypothesis that investment expenditure is the most important explanatory variable for import demand is examined. Second, export demand and supply elasticities are obtained by estimating a simultaneous structural model in which the long- and short-run dynamic properties of the data are fully specified.

Estimation results indicate that real consumption and investment are important determinants of aggregate imports in Korea and that a specification that employs aggregate expenditure implicitly underestimates the relative importance of investment. The demand for Korean exports exhibits high elasticity with respect to foreign income and relative export prices. The decline in the share of exports to industrial countries is linked not only to the decline in the relative importance of OECD countries in world trade, but also to the increased penetration of industrial countries' markets by other Asian developing countries.

## I. INTRODUCTION

Korea's growth performance during the past three decades has been impressive. The economy has evolved from a closed and backward agricultural economy to an industrial country member of the OECD. An increasingly outward-oriented development strategy has played an important role in Korea's strong growth performance. During the past 25 years, the volume of Korean exports has grown at an average annual rate of over 15 percent; as a result, Korea's share of world trade is now over 2 percent, four times higher than 20 years ago. Are traditional explanations of the dynamics of trade flows consistent with these observations? This paper addresses this question by investigating the determinants of Korean trade flows and their geographical destination during this period of substantial economic transformation.

The export performance of fast-growing Asian developing countries has been the subject of numerous empirical studies, whose primary focus has been the measurement of short- and long-run scale and price elasticities, in particular for export demand.<sup>2</sup> For these countries, studies have typically found an elasticity of exports with respect to foreign demand that is considerably higher than the elasticity of imports with respect to domestic demand. This finding is consistent with the fact that, notwithstanding the higher growth rate in Asian economies, import and export volumes have grown at similar rates without a significant deterioration in their terms of trade (see, for example, Houttakker and Magee (1969) and Krugman (1989)). Other issues that have been studied include the degree of competition in manufacturing exports among NIE countries (Muscatelli, Stevenson and Montagna (1994)) and the importance of product differentiation and innovation effects on export demand (Muscatelli, Stevenson and Montagna (1995)).

This paper presents evidence on how export and import flows react to changes in relative prices and in foreign and domestic demand both in the short- and in the long-run, and examines the stability of these relations. In addition, it addresses two important questions. The first concerns the specification of the import demand function: as an alternative to traditional specifications that use domestic income or absorption as the scale variable, consistently with a consumer demand model, we examine the hypothesis that investment demand is the most important scale variable.<sup>3</sup> The second concerns the determinants of the *direction* of Korean exports. The increasing trade integration among East Asian countries is by now well documented (see, for example, Ito et al. (1996)). In Korea, this process has implied a substantial change in the direction of exports over the last decade: the share of total

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<sup>2</sup>The term "country", as used in this paper, does not in all cases refer to a territorial entity that is a state as understood by international law and practice; the term also covers some territorial entities that are not states, but for which statistical data are maintained and provided internationally on a separate and independent basis.

<sup>3</sup>See Warner (1994) for an empirical study of the link between world investment and consumption demand and US exports.

exports going to industrial countries has fallen from 80 percent in 1987 to around one half in 1995, and the share of exports going to developing Asian economies has increased during the same period from 12 to 37 percent. We examine whether differences in growth rates and relative price behavior can account for this phenomenon.

Our main findings can be summarized as follows. Both real consumption and real investment expenditure are important determinants of aggregate imports in Korea, but an aggregate specification implicitly underestimates the relative importance of investment as demand variable. A statistically significant impact of relative prices on import demand can be detected only when GDP is used as scale variable. The demand for Korean exports exhibits a high elasticity with respect to foreign income, as one would expect given the growth differential between Korea and its main trading partners. We also find that the price elasticity of export demand, when relative export prices are used, is relatively high (above 2). In examining the direction of trade flows, we find evidence that the fall in the share of Korean exports going to industrial countries is associated not only with the decline in the relative importance of the OECD in world trade, but also with increased penetration of other Asian countries' exports in industrial countries' markets.

The paper is organized as follows. Section 2 presents an overview of the evolution of the current account, imports, exports and the exchange rate in Korea over the past 25 years. Section 3 contains a brief discussion of modeling issues. Section 4 presents evidence on the determinants of import demand. In Section 5 estimation results of a system of demand for and supply of Korean exports are discussed, leaving the details of the specification process to Appendix I. Section 6 considers a breakdown of exports by destination; it documents the shift in the direction of exports in recent years, compares these developments with those in partner countries, and analyzes the determinants of the shift. Section 7 summarizes the main conclusions. Description and sources of the data employed can be found in Appendix II.

## **II. AN OVERVIEW OF EXTERNAL SECTOR DEVELOPMENTS**

During the 1960s, Korea ran large trade deficits, averaging over 10 percent of GDP. Initially, these deficits were mainly financed through unilateral transfers, later increasingly through foreign borrowing. The trade and current account balances deteriorated following the first oil shock in 1974, but then improved as terms of trade recovered in the second half of the decade. The second oil shock, a bout of political instability and a bad agricultural crop caused a widening of current account imbalances and a deep recession in 1980. Current account imbalances were gradually reduced in the following years. A large real depreciation of the currency and the fall in oil prices in 1986 helped trade and current account balances move into large surpluses, thus allowing Korea to substantially reduce its external indebtedness. In response to a rebound in the real exchange rate and to rapid growth of domestic demand, the trade and current account balances reverted to deficits in 1989. During the 1990s, Korean trade and current account imbalances have until very recently been more modest.

### **A. Exports**

As a result of rapidly expanding exports and imports, trade shares in GDP have risen over time. The volume of exports grew at an average rate of over 15 percent over the last 25 years, and the share of exports of goods and services in GDP rose from less than 3 percent in 1961 to over 30 percent in 1995. During this period, the commodity composition of exports has also changed substantially. In the early 1960s, primary products accounted for over 80 percent of total exports. By 1970, over 80 percent of total exports were manufactured goods, of which traditional exports (textiles and garments) accounted for 41 percent. By 1995, the share of textiles and garments was below 15 percent while exports of electronic products and machinery and equipment accounted for a third of total exports. This shift in the composition of exports reflected in part the so-called heavy and chemical industry drive initiated in 1973, aimed at fostering the development of internationally competitive industries in industrial machinery, shipbuilding, electronics, steel and petrochemicals.

### **B. Imports**

The volume of imports grew at an average rate of 12 percent during the past 25 years. The largest category of imports, industrial raw materials, accounted for half of total imports in 1995, down from 65 percent in 1980. During the same period, the share of capital goods rose from under 30 to around 40 percent of total imports. The Korean import regime has undergone substantial changes during the last thirty years, in particular since the late 1970s. In 1978, a comprehensive import liberalization program was initiated. This gradually brought about a significant reduction in restricted imports (i.e., those for which import licences are not automatic), from around half of total imports in 1978 to 23 percent in 1982, and less than 2 percent in 1995. At the same time, the (unweighted) average tariff was reduced from 41 percent in 1978 to 24 percent in 1982 and below 8 percent in 1995.

### **C. Real Exchange Rate**

Although its real exchange rate has undergone substantial fluctuations over the past 25 years, Korea, like other East Asian countries, has avoided persistent overvaluation.<sup>4</sup> Arguably, the competitive exchange rate management policy has played an important role in the country's remarkable export performance. Korea's real exchange rate gradually depreciated during the first half of the 1970s, and then appreciated in the second half of the decade. During the 1980s, real exchange rate fluctuations were more pronounced, with a substantial real depreciation in the period 1983-88 and a subsequent large appreciation. During the 1990s, Korea's real effective exchange rate has been less volatile, and has followed a modest depreciating trend. This trend is more pronounced for the measure based on wholesale price indices, because in the 1990s the differential between CPI and WPI inflation in Korea has been higher than in trading partners (see Charts 2 and 6).

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<sup>4</sup>For a discussion of the links between real exchange rate behavior and the sustainability of current account deficits in East Asia and Latin America, see Milesi-Ferretti and Razin (1996).

### III. MODELING STRATEGY

The theoretical foundation of export and import equations can be found in the “imperfect substitutes” model (see the discussion in Goldstein and Khan (1985)). This model is based on the simple observation that imported goods are imperfect substitutes for domestically produced goods and that exported goods are imperfect substitutes for other countries’ domestically produced goods, or for third countries’ exports. The demand functions can be thought of as being derived from a consumer utility maximization problem. Import demand will depend on domestic (permanent) income and the relative price of imported goods vis-à-vis domestic goods; export demand will depend on foreign (permanent) income and on the relative price of domestic exports vis-à-vis other countries’ exports and/or vis-à-vis domestic prices in the countries of destination of exports. The assumption that the country is a price taker in export markets may not, however, be warranted. Therefore, an export supply equation may be specified, in which exports depend positively on productive capacity and export prices, and negatively on domestic costs. In the earlier trade literature, intertemporal aspects, which have become prominent in more modern approaches to the study of international capital flows, are ignored, although “classic” theoretical specifications of (long-run) import and export demand functions are consistent with intertemporal optimization.<sup>5</sup> For example, given that imports and income possess permanent components, for the theoretical model of import demand to be consistent with the properties of the data, imports and income must share the same permanent component, or, in the language of time series econometrics, imports and income must cointegrate. The recent development of nonstationary time series methods allows researchers to test directly the long-run implications of optimizing models such as the one just described.

An excellent survey of the earlier empirical literature of trade equations can be found in Goldstein and Khan (1985). A major difference between those studies and more recent empirical work emerges in the specification of the dynamic adjustment of actual variables towards their steady state, or long-run equilibrium levels. Given that theoretical models are in general not informative regarding the formulation of the dynamic specification, the practice has been to formulate a “reasonable” adjustment mechanism in order to accommodate the degree of serial correlation in the data. Earlier empirical applications typically postulated a partial adjustment mechanism. Despite its popularity, this mechanism imposes a very restrictive dynamic structure in the data, which would be more desirable to test rather than impose a priori (Hendry (1995)). More recently, the realization that variables such as real income and imports can be decomposed into a nonstationary (or permanent) and a stationary (or cyclical) component has called for the adoption of more flexible dynamic specifications to

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<sup>5</sup>See, for example, Reinhart (1995). Razin (1995) and Obstfeld and Rogoff (1995) present useful surveys of the literature examining the intertemporal approach to the current account.



accommodate the possibly complicated dynamic interactions between permanent and cyclical components of the data.<sup>6</sup>

In the next sections, which deal with the empirical implementation of import demand and export demand and supply equations, the dynamic specification is chosen consistently with the nonstationary nature of the data and following a general-to-specific approach, that is, starting from a general dynamic specification of the joint properties of the data and gradually testing down for more restrictive dynamic structures. This approach is in general preferable to the a priori imposition of an adjustment mechanism, given the difficulties that may arise in making inference from dynamically mis-specified models.

#### IV. IMPORT DEMAND

##### A. Previous Studies and Choice of Variables

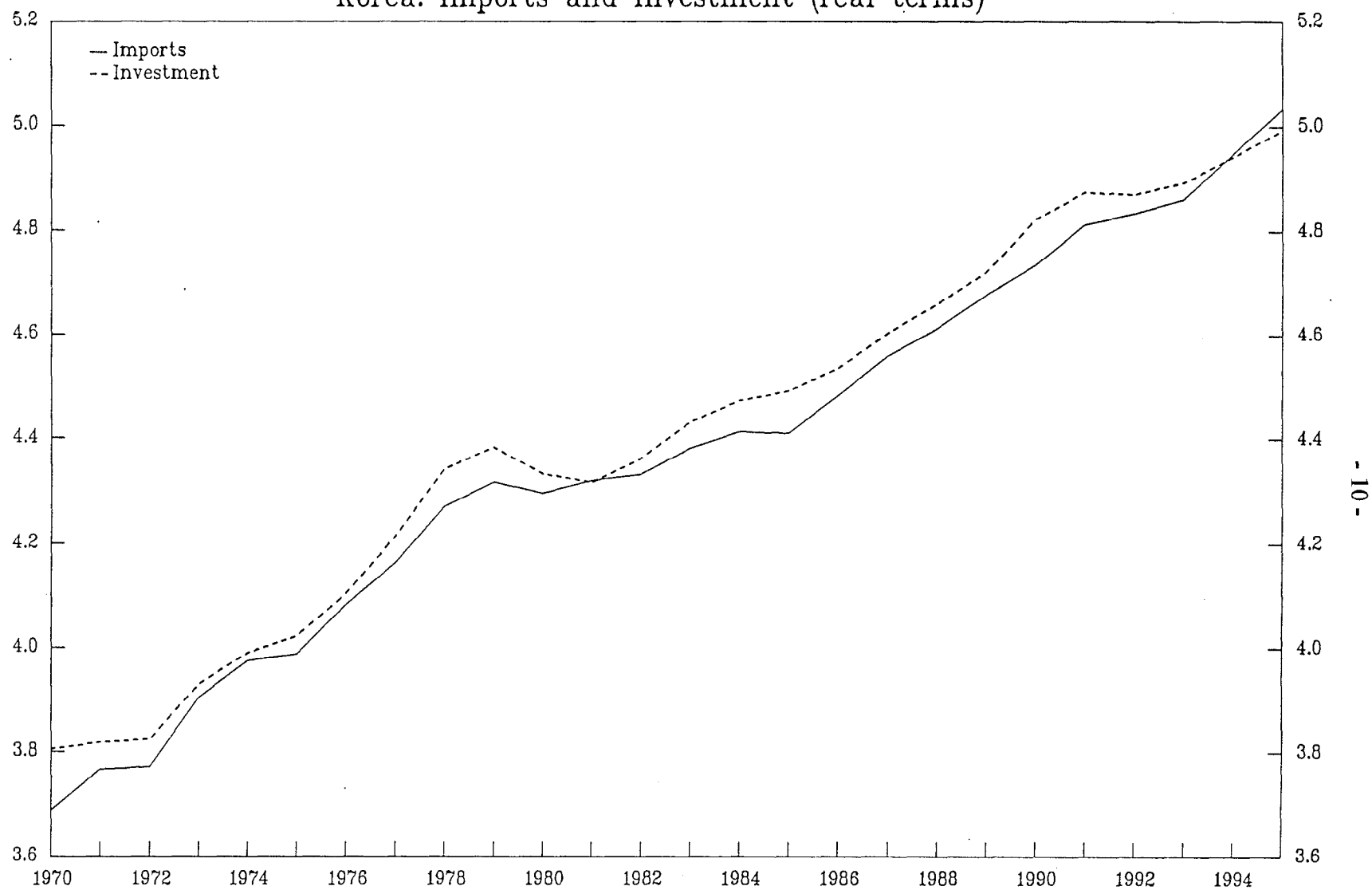
The behavior of imports in Korea and other newly industrialized countries has not received as much attention as the behavior of their exports. Balassa (1991), using annual data from 1973 to 1988, found an income elasticity of import demand of 1.14 and relative price elasticities ranging from -0.28 (with domestic prices represented by the wholesale price index) to -0.5 (with domestic prices represented by the price index for traded goods). Mah (1993) examined evidence of structural change in import demand behavior in Korea associated with import liberalization since the early 1980s. The relative price measure he employed was the import price (inclusive of tariffs) relative to the domestic wholesale price index. The results, based on quarterly data, suggest that the elasticity of Korean imports with respect to income and relative prices has increased following import liberalization. In a recent study, Bayoumi (1996) estimates a long-run income elasticity of import demand of 1.36 and statistically insignificant short- and long-run price elasticities, with the real effective exchange rate used as the price index for imports.

In all of the above studies, real income, as a proxy for permanent income, was chosen as the scale variable. If the goal is to explain what determines expenditure for consumption goods, permanent income is undoubtedly the appropriate scale variable. However, for the case of Korea and other developing countries imports are predominantly raw materials and capital goods that are used for domestic investment purposes. Although the relative importance of consumer goods has increased in the period under examination, these goods only account for about 10 percent of total imports. In a study of the determinants of US exports, Warner (1994) finds that world investment demand is much more important than global consumption demand or output. Chart 1 supports the conjecture that fixed investment may indeed be the most relevant scale variable in Korea's import equation. Consequently, the present study employs fixed investment (*INV*) and consumption expenditure (*CONS*) in real terms as scale

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<sup>6</sup>Nonstationarity issues have become central in much of the empirical work on macroeconomic time series, following the seminal work by Nelson and Plosser (1982).

Chart 1  
Korea: Imports and Investment (real terms)



variables for the import demand equation, as an alternative to real GDP ( $Y$ ).<sup>7</sup> The relative merits of the specifications comprising alternative scale variables will be established in terms of stability and forecasting ability of the underlying relation.

To check the robustness of our results, we also use several alternative measures of the relative price of imports with respect to domestic goods (Chart 2). We use the unit value of total imports ( $P^M$ ) as a measure of import prices; results using the price of imports were similar. For domestic prices we use the wholesale price index (WPI) and the consumer price index (CPI). All price indices are measured in dollar terms. Finally, we use two alternative indices of the real effective exchange rate: one based on relative consumer price indices ( $RER^{CPI}$ ) and one based on relative wholesale price indices ( $RER^{WPI}$ ). We do so in order to check whether these indices, that are often used in evaluating competitiveness, exhibit a correlation pattern with import volumes that is analogous to the one of the relative price measures discussed above.

## B. Specification and Estimation

As a first step in the empirical analysis, we conducted tests for nonstationarity on quantity and price variables. These tests do not reject the null hypothesis that the variables in question are indeed non-stationary.<sup>8</sup> In a second step, we estimated different specifications of the long-run import demand equation with the goal of comparing the relative magnitude of long-run import demand elasticities across scale and price variables. The typical estimated equation is of the form:

$$m_t = \delta + \beta' w_t + e_t \quad (1)$$

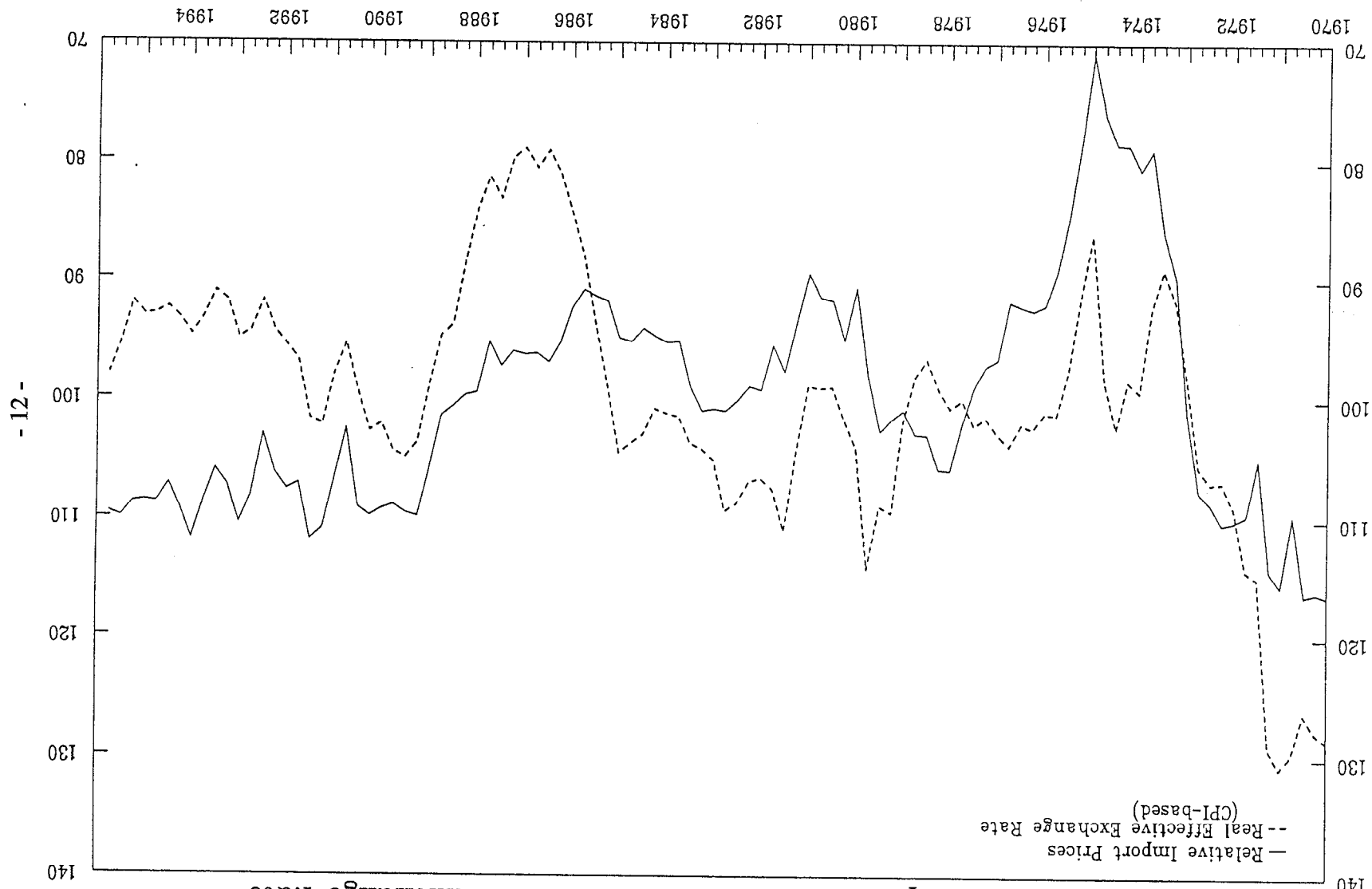
where  $m$  represents the log of import demand,  $w$  is a vector comprising the log of the scale variable ( $y$ ) and of relative prices ( $p$ ), and  $e$  is a stationary error term. The vector of coefficients  $\beta$  represents long-run import demand elasticities. Given the nonstationarity of the variables in question, estimation of the levels regression with OLS produce consistent estimates, but is subject to simultaneity and small sample bias. We therefore employ the dynamic OLS (DOLS) procedure of Stock and Watson (1993). This procedure consists in adding in the level regression leads and lags of first differences of the explanatory variables, so as to orthogonalize the dependence typically present between the (first-difference of the) explanatory variables ( $\Delta w_t$ ) and the residual of the cointegrating relation ( $e_t$ ). Notice that if errors are serially uncorrelated, asymptotic Gaussian inference readily applies to the standard t-ratios computed from DOLS.

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<sup>7</sup>Throughout the paper, our convention is to use upper-case letters for the level of variables, and lower-case letters for their logarithm. Note that to the extent to which domestic investment includes spending on imported goods, there is a common component in  $I$  and  $M$ .

<sup>8</sup>Results of these tests are available from the authors.

Chart 2  
Korea: Relative Import Prices and Real Effective Exchange Rate



Tables 1 and 2 report estimates of long-run elasticities, using annual and quarterly data, respectively for the period 1973-1995.<sup>9</sup> With quarterly data, when the scale variable is real GDP, the scale elasticity of import demand is in the range of 1.2 - 1.4, depending on the relative price measure being used. When the relative prices are measured using the ratio of unit value of imports ( $p^m$ ) to the domestic wholesale price index expressed in dollar terms ( $wpi$ ), the price elasticities of imports are close to unity and are significant at the 5 percent level. When the CPI-based real effective exchange rate ( $rer^{epi}$ ) is used, the price elasticity is also significant at the 5 percent level but smaller in magnitude. Using annual data the results are analogous: the only exception is the coefficient on the real effective exchange rate, which is now smaller and less precisely estimated. All these results are in broad agreement with existing estimates of elasticity of imports for Korea.

The second specification uses real fixed investment as the scale variable. Results show a unitary elasticity of imports with respect to this scale variable, while relative prices are either statistically insignificant or have the wrong sign. These results may be partly due to the existence of a common component in imports and investment that tends to bias towards zero the coefficient on relative prices. Finally, the third specification uses the two components of domestic absorption, aggregate real consumption ( $cons$ ) and real domestic (fixed) investment ( $inv$ ), as scale variables. Results presented in Table 1 for quarterly data show that both are statistically significant, and that their coefficients are similar in size. This result is not consistent with a specification of import demand that uses absorption ( $abso$ ) as a scale variable, because the latter would entail a higher elasticity of imports with respect to aggregate consumption than to aggregate investment, given the considerably larger share of consumption in absorption (see Warner (1994)). Price elasticities are smaller and more imprecisely estimated, as can also be seen from Table 2, that presents the regressions with annual data.

To compare the relative merits of the different long-run import demand specifications we examined their stability and their forecasting ability. When the import equation is estimated recursively using GDP as the scale variable, there is evidence of a decline in the income elasticity after 1978, the starting point of the process of import liberalization. The decline is modest and gradual, and could be related to the phased removal of import restrictions, as well as a relaxation of "liquidity constraints" as Korea became richer. The specification using absorption, or its components, appears unstable, contrary to the specification that uses fixed investment as a scale variable.<sup>10</sup> In an attempt to discriminate further the different specifications, we estimated the relationships until the end of 1991 and

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<sup>9</sup>For all the long-run equations estimated we found stationary residuals, which, given the presence of nonstationarity, is per se evidence of the existence of a cointegrating relationship. Such evidence is also confirmed by more formal tests for the existence of a long-run relationship (as in Johansen (1988) and Pesaran, Shin and Smith (1996)) which were run but not reported in the text for brevity.

<sup>10</sup>Plots of the recursive long-run elasticities are available from the authors on request.

**Table 1. Import Demand Equation: DOLS Estimation of Long-Run Elasticities  
Equation (2) With Quarterly Data, 1973:1-1995:2**

Constant	$\gamma$	<i>abso</i>	<i>cons</i>	<i>inv</i>	$p^m/wpi$	$ref^{pi}$	R <sup>2</sup> -adj.	LM-AR(5)	Stability $\chi^2_{(18)}$
-3.60 (<0.01)	1.24 (<0.01)				-1.07 (<0.01)		0.99	0.01	>0.10
-13.45 (<0.01)	1.40 (<0.01)					-0.69 (<0.01)	0.99	<0.01	>0.10
-6.18 (0.04)		1.29 (<0.01)			-0.65 (>0.10)		0.99	<0.01	<0.01
-10.78 (>0.10)		1.38 (<0.01)				-0.14 (>0.10)	0.99	<0.01	<0.01
-5.22 (<0.01)			0.66 (<0.01)	0.54 (<0.01)	-0.47 (>0.10)		0.99	0.01	0.02
-7.57 (<0.01)			0.59 (<0.01)	0.63 (<0.01)		-0.005 (>0.10)	0.99	0.01	<0.01
-6.32 (<0.01)				1.03 (<0.01)	0.22 (>0.10)		0.99	<0.01	>0.10
-4.07 (<0.01)				0.98 (<0.01)		+0.18 (>0.10)	0.99	<0.01	>0.10

**Notes to table:** The dependent variable is the log-level of the volume of imports ( $m$ ). The other variables are defined in the text (all variables are expressed in log-levels). DOLS is the Dynamic OLS estimation procedure of Stock and Watson (1993). The values in parenthesis underneath each estimated coefficient are p-values obtained using consistent (parametric) estimates of the standard errors. R<sup>2</sup>-adj is the coefficient of determination adjusted for the degrees of freedom; LM-AR(5) is a Lagrange Multiplier test for the presence of residuals autocorrelation of the fifth order (p-values for the F-type test are reported); Stability is a test of forecasting stability of the relationship after 1992:1 (the figures reported are p-values for the  $\chi^2$ -type test with 18 degrees of freedom).

**Table 2. Import Demand Equation: DOLS Estimation of Long-Run Elasticities Equation (2) With Annual Data, 1973-1994**

Constant	$y$	$abso$	$cons$	$inv$	$p^m/wpi$	R <sup>2</sup> -adj.	LM-AR(2)	Stability $\chi^2_{(3)}$
-4.36 (0.10)	1.20 (<0.01)				-1.19 (0.02)	0.99	>0.10	0.06
-8.26 (0.03)		1.33 (<0.01)			-0.67 (>0.10)	0.99	>0.10	<0.01
-9.23 (0.01)			0.71 (0.11)	0.54 (0.09)	-0.07 (>0.10)	0.99	>0.10	>0.10
-6.65 (0.02)				1.02 (<0.01)	0.01 (>0.10)	0.99	>0.10	>0.10

**Notes to table:** The dependent variable is the log-level of the volume of imports ( $m$ ). The other variables are defined in the text (all variables are expressed in log-levels). DOLS is the Dynamic OLS estimation procedure of Stock and Watson (1993). The values in parenthesis underneath each estimated coefficient are p-values obtained using consistent (parametric) estimates of the standard errors. R<sup>2</sup>-adj is the coefficient of determination adjusted for the degrees of freedom; LM-AR(2) is a Lagrange Multiplier test for the presence of residuals autocorrelation of the second order (p-values for the F-type test are reported); Stability is a test of forecasting stability of the relationship after 1992 (the figures reported are p-values for the  $\chi^2$ -type test with 3 degrees of freedom).

used the estimated elasticities to evaluate the forecasting performance of each model in the period from 1992 to 1995. According to the joint significance tests of the prediction errors reported in the last column of Table 1 (and Table 2), the more stable specifications appear to be the ones that use real GDP and fixed investment as scale variables. Yet, between the last two specifications, a slightly better out-of-sample fit is achieved when using real GDP, as shown in Chart 3.

Once a stable long-run import demand equation is obtained, the short-run dynamics and the adjustment towards the long-run equilibrium can be estimated following the seminal work of Engle and Granger (1987). These authors have established that there exists an isomorphism between cointegration and error-correction models (ECM), so that the presence of cointegration implies the existence of an ECM and vice versa. In our context, the ECM for (the log of) import demand ( $m_t$ ) can be written as:<sup>11</sup>

$$\Delta m_t = \delta_0 + \gamma_0^w \Delta w_t + \alpha(m_{t-1} - \delta - \beta' w_{t-1}) + \sum_{i=1}^s (\gamma_i^w \Delta w_{t-i} + \gamma_i^m \Delta m_{t-i}) + \epsilon_t \quad (2)$$

where the symbol  $\Delta$  denotes the first difference operator,  $\beta$  is the vector of long-run elasticities, i.e., the cointegrating vector; the loading coefficient  $\alpha$  is a speed of adjustment parameter and determines the proportion of (last period's) deviation from long-run equilibrium ( $m_{t-1} - \delta - \beta' w_{t-1}$ ) that is absorbed by the current change in imports;  $\gamma_0^w$  represents the vector of impact elasticities, while the other  $\gamma$ 's capture the short-run dynamic properties of  $m_t$ ;  $\epsilon_t$  is an uncorrelated error term.

The estimation of equation (2) with annual data (see Table 3) confirms previous evidence that short-run scale and price elasticities are smaller in magnitude than their long-run counterparts. Comparing the specification that uses GDP with the one that uses fixed investment as the scale variable, the short-run price elasticity is insignificant (and wrongly signed) in the latter, and the speed of adjustment towards equilibrium (measured by the coefficient on the lagged error-correction term,  $\alpha$ ) in the formulation with GDP is almost twice as fast as in the one with investment. Overall, the fit of the regression, measured by the  $R^2$ , is higher in the first specification. While these findings do not unambiguously point towards a preferred specification of the import demand function, the one using GDP as a scale variable has the appealing feature of recovering significant price effects from the data.

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<sup>11</sup>Other authors have used the ECM to model import demand equations. See, for example, Clarida (1994) for an application using industrial country data and Reinhart (1995) for an application using developing country data.



Chart 3.a Long-run Import Demand Equation (logs): Scale Variable is GDP.  
Quarterly Data, Estimation: 1973:1 - 1991:4. Forecasting: 1992:1 - 1995:4.

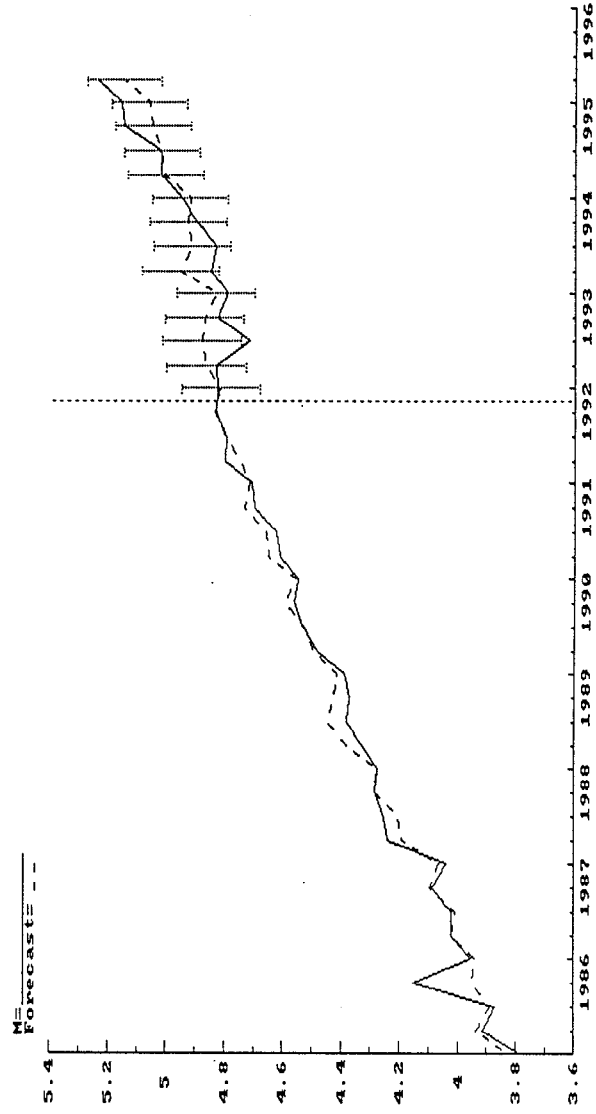
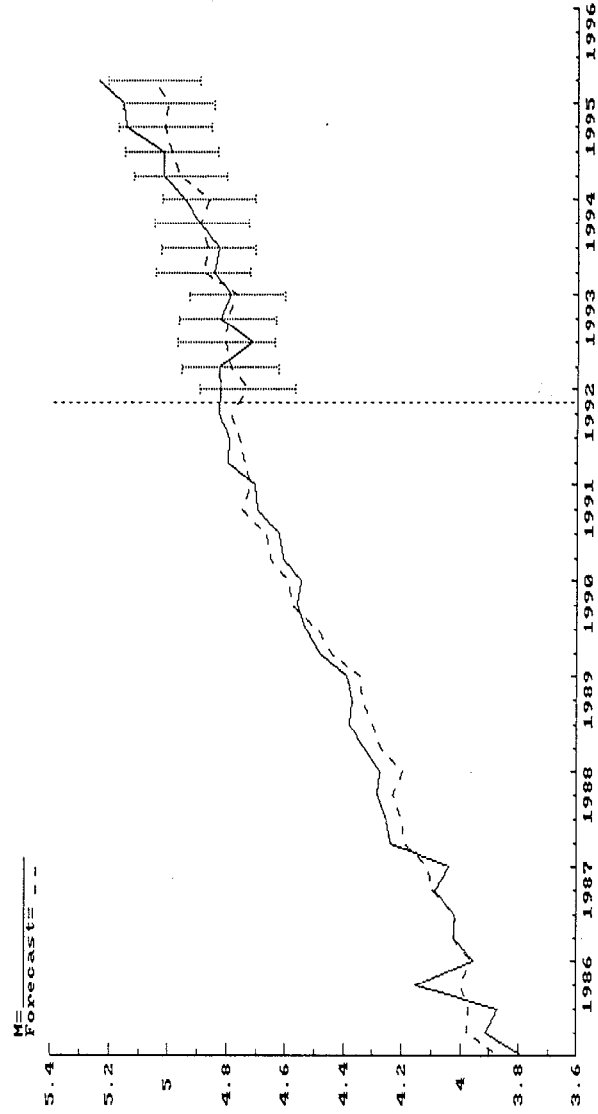


Chart 3.b Long-run Import Demand Equation (logs): Scale Variable is Investment.  
Quarterly Data, Estimation: 1973:1 - 1991:4. Forecasting: 1992:1 - 1995:4.



**Table 3. Import Demand Equation: OLS Estimation of Short-Run Elasticities  
Error-Correction Equation (1) With Annual Data, 1973-1994**

Constant	$\Delta y$	$\Delta inv$	$\Delta(p^m/wpi)$	lagged EC term	R <sup>2</sup> -adj.	LM- AR(2)	White	RESET
-0.01 (>0.10)	1.09 (<0.01)		-0.53 (<0.01)	-0.64 (<0.01)	0.79	>0.10	>0.10	>0.10
0.01 (>0.10)		0.82 (<0.01)	0.06 (>0.10)	-0.38 (0.08)	0.66	>0.10	>0.10	>0.10

**Notes to table:** The dependent variable is the log-first difference of the volume of imports ( $\Delta m$ ). The other variables are defined in the text and are also expressed in differences except for the error-correction term, which is the deviation of the actual log-level of imports from the estimated implied long-run log-level (see Table 2). The values in parenthesis underneath each estimated coefficient are p-values obtained using consistent (parametric) estimates of the standard errors. R<sup>2</sup>-adj is the coefficient of determination adjusted for the degrees of freedom; LM-AR(2) is a Lagrange Multiplier test for the presence of residuals autocorrelation of the second order (p-values for the F-type test are reported); White is a general test for residuals heteroskedasticity (p-values for the F-type test are reported); RESET is Ramsey's functional mis-specification test (p-values for the F-type test are reported).

## V. EXPORT DEMAND AND SUPPLY

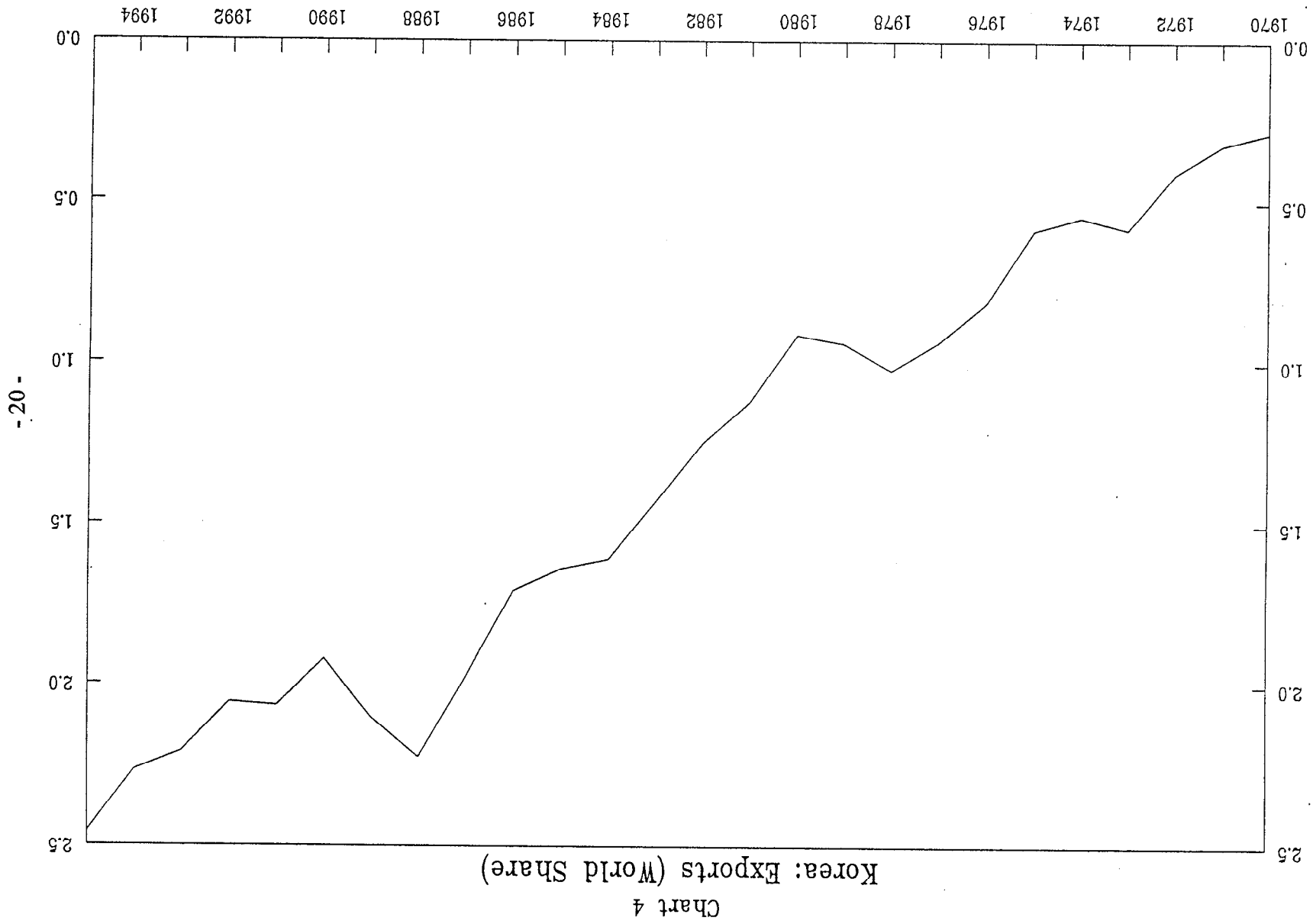
### A. Previous Studies

Numerous studies have provided estimates of the demand for developing countries' exports. For rapidly developing Asian economies, the most debated issue in this context is the relative importance of scale and price elasticities in explaining the behavior of exports. The fast growth in export volume has not been accompanied by a persistent deterioration in their relative prices vis-à-vis the rest of the world. This implies that either the price elasticity of export demand is very high, so that modest increases in competitiveness are sufficient to ensure increased demand for exports, or the elasticity of export demand with respect to "foreign" income is high, so that slower-growing "foreign" countries absorb an increasing proportion of these countries' exports. In support of the first thesis, Riedel (1988) and Athurokala and Riedel (1991) present estimates of the demand for and supply of Korean and Hong Kong manufactures and find that these exports are supply-determined, and that the demand elasticity with respect to world income is low and the price elasticity of demand high. In contrast, for a group of three Asian newly industrialized countries, including Korea, Muscatelli, Srinivasan and Vines (1994) find a demand elasticity with respect to world imports consistently above 2 (which implies an even higher elasticity with respect to world income), and price elasticities of demand between -0.7 and -2. On the supply side, they estimate the long-run price elasticity between 0.7 and 1.9, and a capacity elasticity at around 1.5. Similar results on individual East Asian countries, including Korea, are presented in studies by Muscatelli, Stevenson and Montagna (1994, 1995). Using more recent data, Bayoumi (1996) estimates a single demand equation and finds a long-run scale elasticity above 3 with respect to world income and a statistically insignificant elasticity with respect to the real effective exchange rate.<sup>12</sup>

The increasing penetration of Korean exports in world markets is documented in Chart 4. Our interest in providing yet another set of estimates for the determinants of Korean exports has several motivations. First, most existing studies do not cover the most recent years; for example, the estimation period used by Muscatelli et al. is 1966-1987. A longer time series should allow us to characterize long-run trends more accurately, especially in a country whose economic structure has evolved as rapidly as Korea. The study by Bayoumi (1996) includes data up to 1993, but uses relative price measures that are only indirectly related to competitiveness. Second, all these studies use annual data; more precise inference may be achieved using higher frequency data. Third, none of these studies has explored causes and implications of the change in the direction of Korean export flows in the late eighties and early nineties (see Section 6).

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<sup>12</sup>See also Arize (1990) and Balassa (1991) for other studies of Korean export behavior.



## B. Specification Issues

The (long-run) export demand and supply equations that we formulate in this study conform to an established tradition in the literature, according to which the demand for (the volume of) exports ( $x_t$ ) responds to a foreign demand variable ( $y_t^w$ ) and to relative prices ( $p_t^x$ - $p_t^w$ ), while the supply is determined by domestic prices ( $p_t^x$ ), domestic variable costs ( $c_t$ ) and a productive capacity variable ( $k_t$ ). All variables are in logs. For example, we can write the two static equations as:

$$\begin{aligned} x_t &= \beta_0^d + \beta_1^d p_t^x + \beta_2^d p_t^w + \beta_3^d y_t^w + u_t^d \\ p_t^x &= \beta_0^s + \beta_1^s x_t + \beta_2^s c_t + \beta_3^s k_t + u_t^s \end{aligned} \quad (3)$$

where, in general, the (possibly autocorrelated) error terms  $u^d$  and  $u^s$  are contemporaneously correlated. The signs of the coefficients  $\beta_1^d$  and  $\beta_3^s$  are expected to be negative, and the signs on  $\beta_2^d$ ,  $\beta_3^d$ ,  $\beta_1^s$  and  $\beta_2^s$  are expected to be positive. Furthermore, we expect the coefficients  $\beta_1^d$  and  $\beta_2^s$  to be equal in magnitude (but with opposite sign). Notice also that in (3) the supply equation has been inverted, so that it is normalized by the domestic price.

The foreign demand variable ( $y^w$ ) that we use in the export demand equations is the log of world real GDP.<sup>13</sup> As a measure of relative prices ( $rx^w$ ) we use the log of the relative price of Korean exports with respect to the price of "world" exports. Alternatively, to capture the degree of competition between Korean products and those exported from Korean's competitors, the log of the relative price of exports with respect to industrial and Asian developing countries ( $rx^{in}$  and  $rx^{as}$ , respectively) is used. The log of the price of Korean exports ( $p^x$ ) is measured by the log of the unit value of exports in U.S. dollar terms. The log of foreign export prices is proxied by the logs of trade-weighted price indices for world exports ( $p^w$ ), as well as for industrial ( $p^{in}$ ) and Asian developing countries' ( $p^{as}$ ) exports, respectively.<sup>14</sup> A sensitivity analysis with respect to the relative price measures adopted was also carried out. The alternative measures tested were the log of the CPI-based real effective exchange rate ( $rer^{cpi}$ ) and the log of the real effective exchange rate based on wholesale prices ( $rer^{wpi}$ ).

In the specification of the export supply equations, we employed the log of the domestic wholesale price index, expressed in US dollars, as a measure of domestic costs ( $c$ ). We also tried to use domestic wages expressed in dollars (WG) as a measure of domestic costs, but the equation performed very poorly. Finally, the domestic capacity variable ( $k$ ) is a

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<sup>13</sup>Quarterly data on world GDP were obtained by interpolating the annual real world GDP series with a cubic spline. Results were robust to the interpolation method adopted.

<sup>14</sup> We also used a trade-weighted WPI price index as an alternative to export prices for the countries of export destination, in line with the idea that Korean goods compete with domestic goods, rather than other export goods, in world markets. Results, however, were poorer than with the specification adopted in the paper.

measure of the log of the real capital stock and was calculated following a perpetual inventory method (see Appendix II).

The simultaneous estimation of the system of demand and supply is complicated by the presence of nonstationary variables and the lack of a priori knowledge of the joint dynamic properties of the data. Previous studies have either estimated single demand equations (for example, Reinhart (1995)), or followed a two-step procedure whereby, first, the long-run cointegrating relationships in (3) are independently estimated, and, then, the implied short-run error correction model is tested allowing for simultaneity across regressions (see, for example, Muscatelli et al. (1995)).<sup>15</sup> In the presence of strong simultaneity it is not guaranteed that this two-step procedure would yield similar parameter values to the ones obtained by jointly estimating the long- and short-run parameters of the demand and supply equations. In this study, we proceed by this last route and specify a vector error-correction model (VECM), i.e., a general dynamic representation of the data which accommodates the presence of both nonstationary variables, of which some may be cointegrated, and stationary variables. A VECM for the demand and supply system can be written in compact notation as:

$$\Delta Z_t = \mu + \Pi Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \dots + \Gamma_s \Delta Z_{t-s} + u_t \quad (4)$$

where  $Z_t$  is the vector comprising all the variables appearing in the system (3), namely  $Z_t = [x_t, p_t^x, c_t, k_t, p_t^w, y_t^w]'$ ,  $\mu$  is the vector of constant terms,  $\Pi$  is the matrix of long-run coefficients, the  $\Gamma$ 's are the matrices of short-run coefficients, and the error terms contained in the vector  $u_t$  are serially independent, but possibly contemporaneously correlated. Theoretical considerations suggest that there should be at least two cointegrating relationships among the  $Z_t$  variables, i.e. a long-run demand and a long-run supply equation (see equations (3)).

The final estimation results are discussed in the next sub-section, while more details on the specification process and the estimation procedure adopted can be found in the Appendix I.

### C. Estimation Results

The variables (all in logs) employed in the estimation of the unrestricted version of the VECM (4), augmented by a set of seasonal dummies and one oil shock dummy (for the first quarter of 1974), were the volume of exports ( $x$ ), the price of Korean and world exports ( $p^x$  and  $p^w$ , respectively), world real GDP ( $y^w$ ), the Korean WPI index expressed in US dollars ( $c$ ) and a measure of the real capital stock ( $k$ ). For  $s=4$ , Table 4 summarizes the main results for the demand and supply system of Korean exports. Given that no plausible long- and short-run results could be obtained using the original six variable VECM and given that the capacity

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<sup>15</sup>In contrast to these other approaches, Muscatelli, Stevenson and Montagna (1994) first estimated long- and short-run export demand elasticities with single equation methods and OLS and, successively, tested for the presence of (super) exogeneity of a stable price equation.

variable,  $k_t$ , was always insignificant,<sup>16</sup> we decided to model a reduced system that excludes  $k_t$  from the vector  $Z_t$ .

The long-run elasticities were obtained by treating the world variables and the cost variable as non-modeled, or exogenous, and imposing the presence of two cointegrating relations constrained by a set of overidentifying restrictions suggested by economic theory.<sup>17</sup> For this specification, in Panel I of Table 4 the long-run scale elasticity for export demand is estimated to be equal to 3.2, while the relative price elasticity is -2. For the supply, the price elasticity is very high (7.1) indicating that the supply curve is fairly “flat,” while the long-run cost elasticity with respect to export prices is estimated to be equal to -0.6.

The remaining step consists in the joint estimation of the model’s short-run parameters and the testing of possible (short-run) over-identifying restrictions. The FIML estimation results of the tested-down short-run model are presented in Panel II of Table 4. The main features of the model are as follows: first, the degree of simultaneity between demand and supply shocks is very limited (when no contemporaneous first-differenced endogenous variables are included as regressors in both the demand and the supply equations, the correlation between estimated errors is -0.14, and when they are included they are insignificant); the price homogeneity restriction is accepted also in the short-run demand equation, and the magnitude of the elasticity is -0.36; the magnitude of the elasticity of the world expenditure variable in the demand equation is very high (6.3); from the estimated supply equation, the short-run cost elasticity is low (0.3), but significant, and the world price variable enters also very significantly and with a positive sign, perhaps capturing a short-lived pass-through effect of world prices on domestic export prices; further, both error correction terms enter significantly with low loading coefficients (lower for the supply equation), indicating a slow adjustment towards long-run equilibrium. It is worth emphasizing that the low degree of contemporaneous correlation between demand and supply shocks implies that single equation estimation of export demand and supply relations for Korea may not be subject to severe bias distortions.

Finally, the stability and forecasting performance of the model are illustrated by the plots of the (dynamic) out-of-sample simulations for the log-levels of export quantities and prices of Chart 5. The fitted demand equation provides good out-of-sample forecasting, while the supply equation (which is normalized on prices) does not fully capture the recent slowdown in Korean export prices, although it has a good in-sample fit.

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<sup>16</sup>The insignificance of the capacity variable occurred both when using joint estimation methods, i.e., with FIML-Johansen, and when using single equation methods, i.e., an Autoregressive Distributed Lag model or Stock and Watson’s (1993) DOLS, and may result from a poor measurement of productive capacity.

<sup>17</sup>See Appendix I for a discussion on the choice to not model the cost variable, for the test results on the dimension of the cointegration space, and for a description and tests of the overidentifying restrictions imposed on this space.

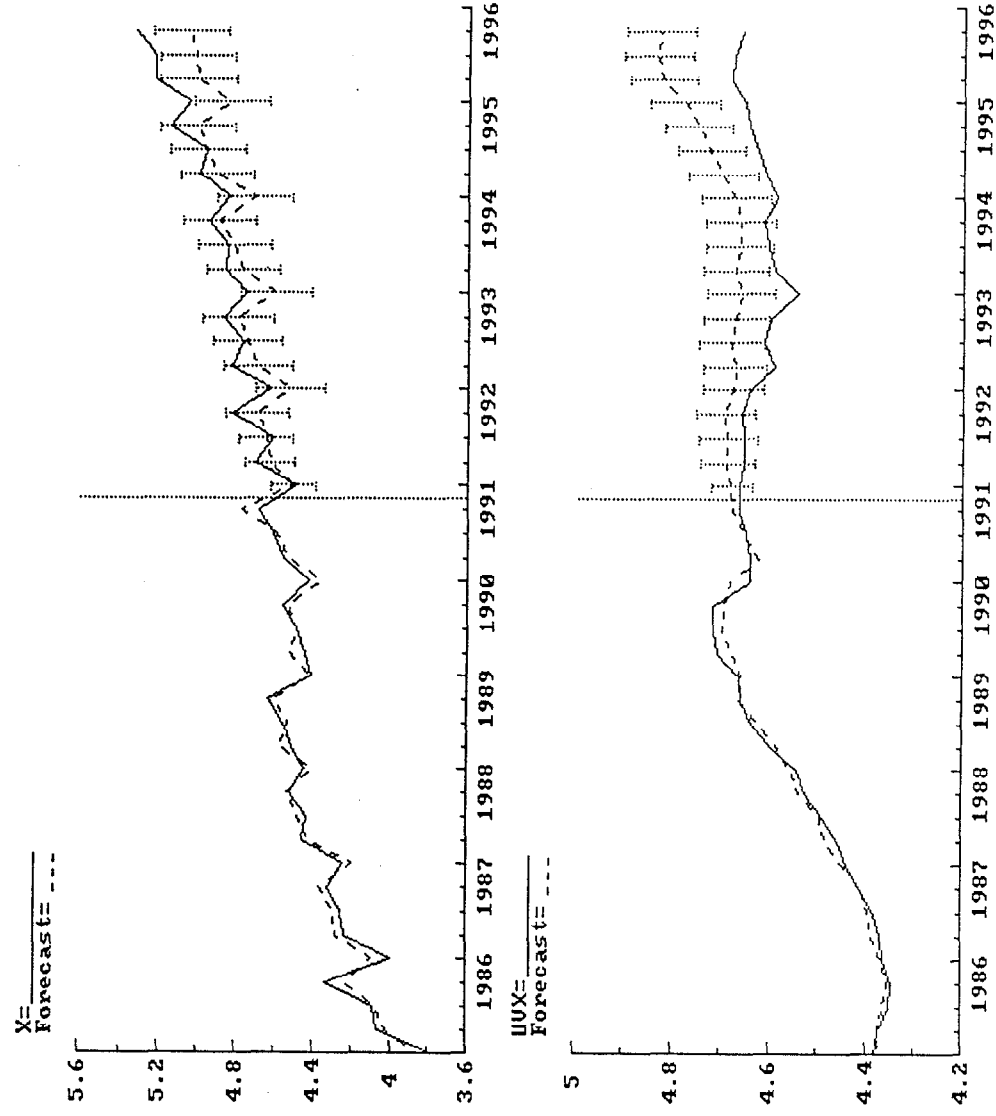
**Table 4. System of Demand and Supply of Exports: Vector Error Correction Model (4) With Quarterly Data, 1971:1 - 1995:4**

Panel I. Testing about the Cointegration Space, r=2					
(S.E. in parenthesis)					
Modeled Variables of the System (endogenous):			$x, p^x$		
Non-Modeled Variables (restricted in the cointegrating space):			$c, p^w, y^w$ and intercept		
Other Non-Modeled Variables (unrestricted):			$\Delta c, \Delta p^w, \Delta y^w$ , Oil and seasonal dummies		
Cointegrating vectors in presence of over-identifying restrictions					
$x$	$p^x$	$c$	$p^w$	$y^w$	intercept
1.000	1.972 (0.450)	-	-1.972	-3.156 (0.140)	9.682 (0.646)
-0.135 (0.045)	1.000	-0.640 (0.127)	-	-	-4.004 (0.206)
Panel II. Full Information Maximum Likelihood Estimation of VECM (4)					
(P-values in parenthesis)					
Modeled Variables of the System (endogenous):			$\Delta x, \Delta p^x$		
Non-Modeled Variables:			$\Delta c, \Delta p^w, \Delta y^w$		
Other Non-Modeled Variables:			$ec\_d, ec\_s$ , intercept and seasonal dummies		
Demand Equation					
$\Delta x = 0.01 - 0.34(\Delta x_{-1}) + 0.05(\Delta p^x_{-1}) + 0.47(\Delta p^x_{-2}) - 0.88(\Delta p^x_{-3}) +$ <p style="text-align: center;">(&gt;0.10) (&lt;0.01) (&gt;0.10) (0.04) (&lt;0.01)</p> $0.36(\Delta p^w) + 6.35(\Delta y^w) - 0.21(ec\_d_{-1})$ <p style="text-align: center;">(-) (&lt;0.01) (&lt;0.01)</p>					
Residual Diagnostics:					
S.E. of Regression 0.054					
AR(1-5)		pval>0.10	ARCH		pval>0.10
Normality		pval>0.10	Heteroskedasticity		pval>0.10
Supply Equation					
$\Delta p^x = 0.0001 + 0.24(\Delta p^x_{-1}) + 0.02(\Delta x_{-1}) + 0.07(\Delta x_{-2}) + 0.08(\Delta x_{-3}) +$ <p style="text-align: center;">(0.02) (0.01) (&lt;0.01) (0.05) (0.02)</p> $0.32(\Delta p^w) + 0.29(\Delta wpi) - 0.14(ec\_s_{-1})$ <p style="text-align: center;">(&lt;0.01) (&lt;0.01) (0.01)</p>					
Residual Diagnostics:					
S.E. of Regression: 0.021					
AR(1-5)		pval>0.10	Correlation of Estimated Residuals: -0.14		
Normality		pval>0.10	ARCH		pval>0.10
			Heteroskedasticity		pval>0.10
LR Test of Short-run Price Homogeneity: $\chi^2_{(1)} = 0.002$ (pval>0.10)					
LR Test of Over-identifying Restrictions: $\chi^2_{(8)} = 5.879$ (pval>0.10)					

**Notes to table:** The list of variables entering each VAR and their status is reported case by case within the table. The maximal lag order choice for all the estimated VAR's was  $s=4$ . Critical values for Johansen's (1988) maximal eigenvalue and trace statistics of Panel A.I are obtained from "Microfit." The switching algorithm employed for the estimation of the cointegration space under general over-identifying restrictions (whose results are presented in Panel II.A) is described in Doornik and Hendry (1994). In Panel II,  $ec\_d$  and  $ec\_s$  denote, respectively, the demand and supply error correction terms obtained from Panel A. In the same panel, AR(1-5) is a Lagrange Multiplier test for the presence of residuals autocorrelation up to the fifth order (p-values for the F-type test are reported); ARCH is a Lagrange Multiplier test for Autoregressive Conditional Heteroskedasticity of the estimated residuals, while Heteroskedasticity is a general test for residuals heteroskedasticity (p-values for both F-type tests are reported); Normality is a test for the presence of deviation from Gaussianity of the residuals (p-values for the F-type test are reported).



Chart 5. Dynamic Simulation of the System of Long-run Export Demand (Top Panel) and Supply (Bottom Panel): Quarterly Data, Estimation: 1971:1 - 1990:4. Simulation: 1991:1 - 1995:4.



Given the lack of strong simultaneity between demand and supply shocks, and the fact that the estimated supply curve is almost flat, the estimation of alternative specifications of the world demand equation for Korean exports was carried out using single-equation methods. These specifications always include world income as scale variable. An alternative scale variable could be export market potential, measured as trading partners' imports (see, for example, Muscatelli et al. (1994, 1995)). However, it was found that measure of world imports volume performs considerably less well as an explanatory variable of Korea's aggregate exports (results available from the authors). This study presents instead specifications relying on alternative relative price variables (see Chart 6). The first specification uses the relative price of Korean exports with respect to world exports as relative price variable ( $rx^w$ ), as in the supply-demand system estimated above. The second specification includes separately two trade-weighted relative export price measures: one vis-à-vis industrial countries ( $rx^{in}$ ) and one vis-à-vis Asian developing countries ( $rx^{as}$ ). This specification aims at addressing the question of whether Korean goods are mainly competing with industrial countries' exports or with exports of other Asian developing countries. Results presented in Muscatelli, Stevenson and Montagna (1994) suggest that competition between rapidly growing Asian economies (captured by relative export prices) affects the volume of Korea's total exports more significantly than price competition with industrial countries' exports. The third and fourth specifications use as relative price variables two alternative real effective exchange rate measures, one based on CPI ( $rer^{cpi}$ ) and the other on WPI ( $rer^{wpi}$ ). Estimation of these formulations can help us shed light on whether real exchange rates based on aggregate price indices, as opposed to export prices, have predictive power for export volumes.

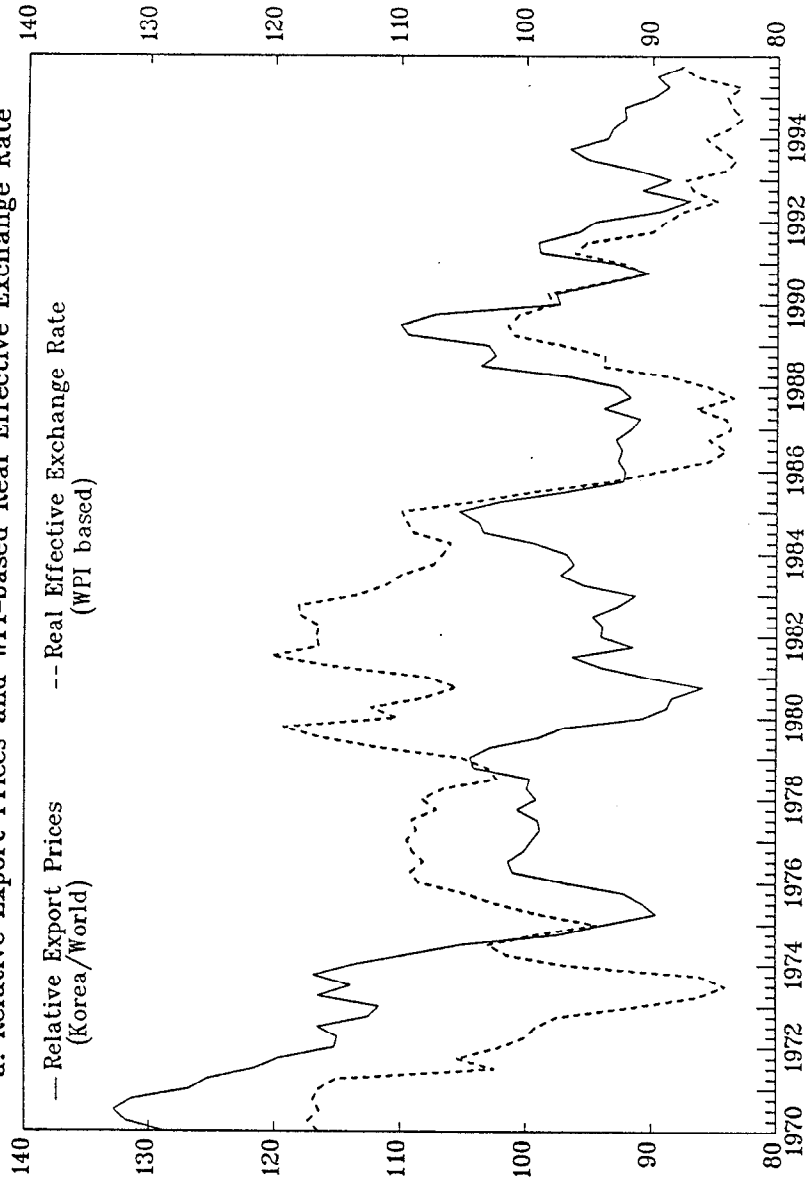
We present estimates of long-run price and scale elasticities, as well as of the speed of adjustment to the long-run equilibrium, in Table 5. The first two equations were initially estimated without imposing any homogeneity restriction (coefficients on domestic and "foreign" export prices being equal but with opposite sign). Long-run homogeneity restrictions were then tested using a likelihood-ratio test, and were not rejected. We therefore report results for the restricted equations. Estimation results of the first specification (row 1), the one that includes world GDP and  $rx^w$ , are comparable to the ones obtained using system estimation methods (see Table 4). In the second specification (row 2), both the relative price of Korean exports with respect to Asian countries and with respect to industrial countries enter significantly in the demand for Korean exports. Note also that the magnitude of the estimated coefficients is in line with the price elasticity estimated with respect to world export prices (row 1).<sup>18</sup> The evidence is consistent with the notion that the products of other Asian developing countries are important competitors for Korean exports. Indeed, if Korean exports responded equally to the prices of Asian and industrial country competitors, the relative price coefficients should be equal to the aggregate relative price coefficient times the weight of Asian (industrial) countries' prices in the overall "world" price index, implying a higher coefficient on the relative price vis-à-vis industrial countries.

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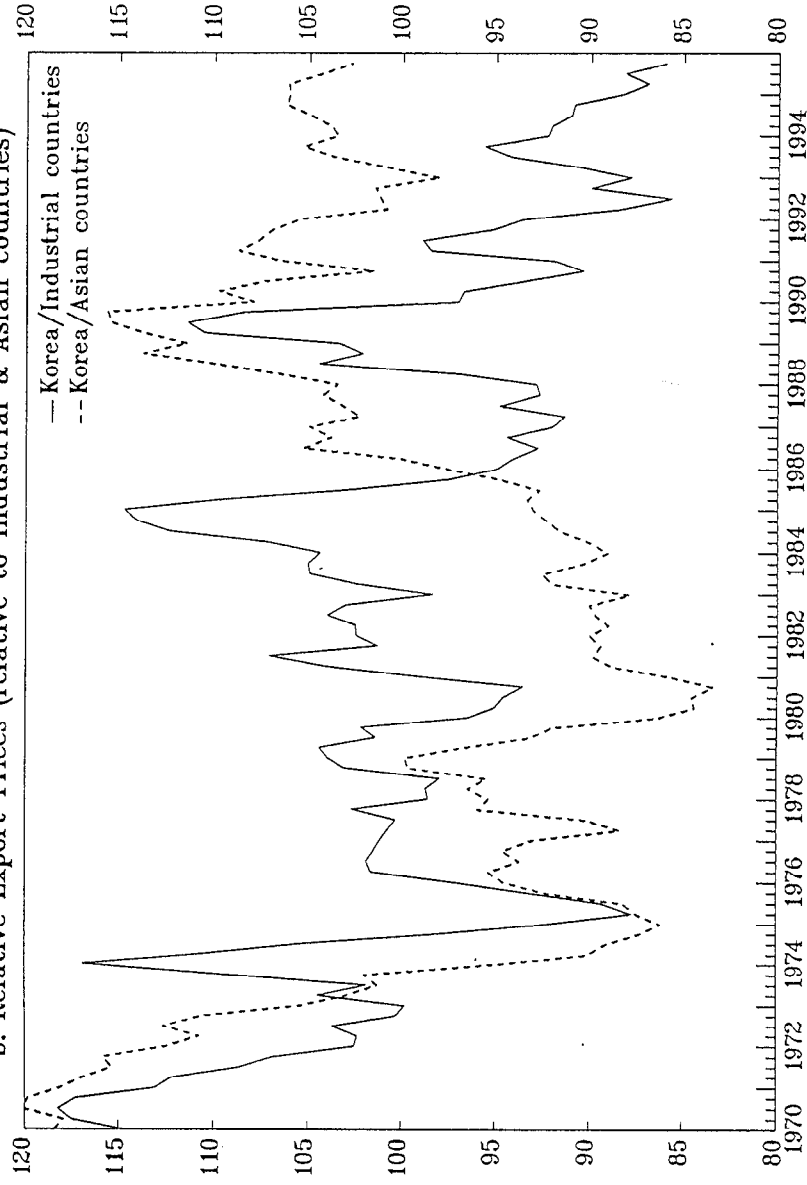
<sup>18</sup>Since variables are expressed in log terms, the appropriate comparison is between the coefficient on  $rx^w$  and the sum of the coefficients on  $rx^{as}$  and  $rx^{in}$ .

## Chart 6. Korea

a. Relative Export Prices and WPI-based Real Effective Exchange Rate



b. Relative Export Prices (relative to Industrial & Asian countries)



**Table 5. Export Demand Equation: Estimates of Long-Run Elasticities  
from an Unrestricted Error Correction Equation  
Quarterly Data, 1972:1-1995:4**

Constant	$y^w$	$rx^w$	$rx^{in}$	$rx^{as}$	$rer^{epi}$	$rer^{wpi}$	lagged EC term	R <sup>2</sup> -adj.	LM- AR(5)
-10.2 (<0.01)	3.22 (<0.01)	-2.25* (<0.01)					-0.36 (<0.01)	0.86	>0.10
-1.71 (>0.10)	3.66 (<0.01)		-0.90* (<0.05)	-1.35* (<0.01)			-0.35 (<0.01)	0.87	>0.10
-7.86 (>0.10)	3.30 (<0.05)				-0.51 (>0.10)		-0.14 (<0.05)	0.83	>0.10
-9.54 (>0.10)	3.24 (<0.10)					-0.67 (>0.10)	-0.13 (<0.05)	0.83	>0.10

**Notes to table:** The dependent variable is the log-level of the volume of exports ( $x$ ). The other variables are defined in the text (all variables are expressed in log-levels). The "lagged EC term" coefficients are the loading coefficients of the ECM and measure the speed of convergence towards long-run equilibrium. The values in parenthesis underneath each estimated coefficient are p-values obtained using consistent (parametric) estimates of the standard errors. R<sup>2</sup>-adj is the coefficient of determination adjusted for the degrees of freedom; LM-AR(5) is a Lagrange Multiplier test for the presence of residuals autocorrelation of the fifth order (p-values for the F-type test are reported). A starred superscript indicates that long-run relative price homogeneity restriction is not rejected at the 95 percent significance level.

In contrast, when competitiveness is measured with either of the two real effective exchange rates (rows 3 and 4), we do not find a statistically significant long-run impact on trade volumes. Estimates of the elasticity with respect to world income are consistently in the 3.2 - 3.6 range, but there are differences in the estimated speed of adjustment to the long-run equilibrium between the first two and the last two specifications, i.e., those that incorporate relative export prices and those that use real effective exchange rates. The overall fit of the regressions using real effective exchange rates is somewhat poorer than the fit using relative export prices; indeed, encompassing tests (not reported for brevity) suggest the superiority of the first two specifications. In conclusion, these findings suggest that the estimated response of export volumes to relative price changes crucially hinges on the measure of competitiveness being used, and that the elasticity of Korean exports with respect to relative export prices is economically and statistically significant.

## VI. DIRECTION OF EXPORTS

As noted in the introduction, the behavior of the aggregate volume of Korean exports masks large shifts in the commodity composition of exports and in their geographical destination. In 1970, exports to the United States and Japan accounted for 3/4 of Korean total exports; by 1995, they accounted for only 1/3. The relative decline of exports to industrial countries has been accompanied by a rapid expansion of exports to developing Asian economies. This shift in the direction of exports has been particularly striking since the late eighties (Chart 7). Exports to industrial countries were stagnant in current dollar terms between 1988 and 1994, while exports to Asian developing countries tripled during the same period. In particular, exports to China, now Korea's third trading partner, have grown very rapidly. Exports to other developing Asian economies have boomed in this period as well.

Does this shift in the direction of exports reflect increasing regional integration between developing Asian economies? Chart 8 presents data on the direction of exports for Korea's other main trading partners in Asia: Hong Kong, Indonesia, Malaysia, Singapore, Taiwan Province of China, and Thailand. The data reveal a broad overall trend towards increasing trade between these countries. This trend is very pronounced since the late eighties for Hong Kong and Taiwan Province of China, and also for Singapore and Thailand.

Upon closer examination, however, the notion that the evolution of Korean export shares is solely the reflection of increased regional integration appears less convincing. The data presented in Chart 8 refers to the evolution of export shares. Turning to the examination of export levels, one finds that only Taiwan Province of China shows a pattern very similar to Korea's; that is, sluggish export growth to industrial countries and booming exports to Asian countries. For other Asian developing countries, exports to industrial countries have increased rapidly during this period, especially those of China, Malaysia, Singapore and Thailand. Overall, Asian exports to industrial countries doubled in dollar terms between 1989 and 1995, while Korean exports to these countries increased by less than a third, mostly in 1995. In sum, Korea lost OECD market share to other Asian rapidly developing countries, but turned

Chart 7  
Korea: Direction of exports

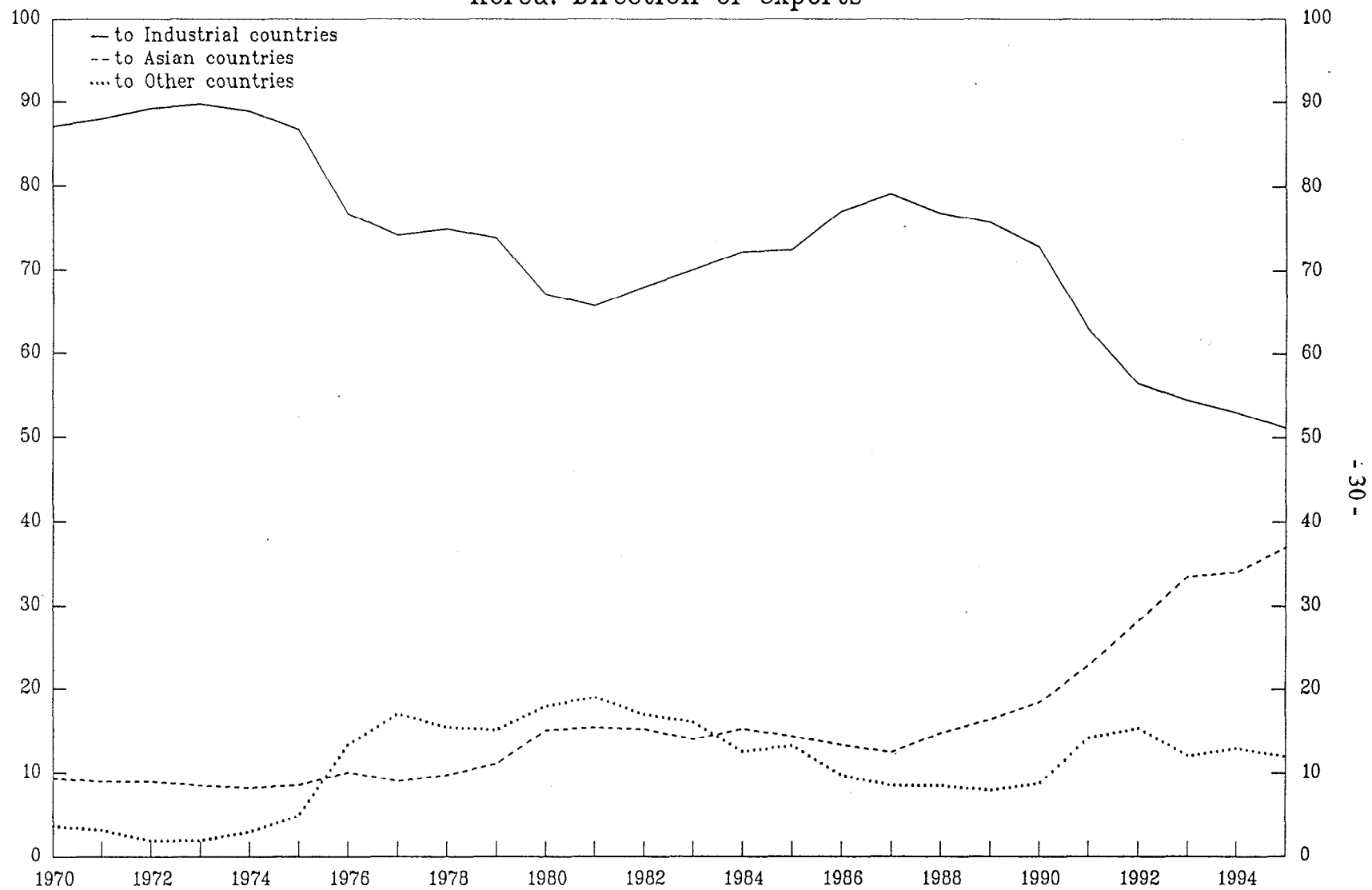
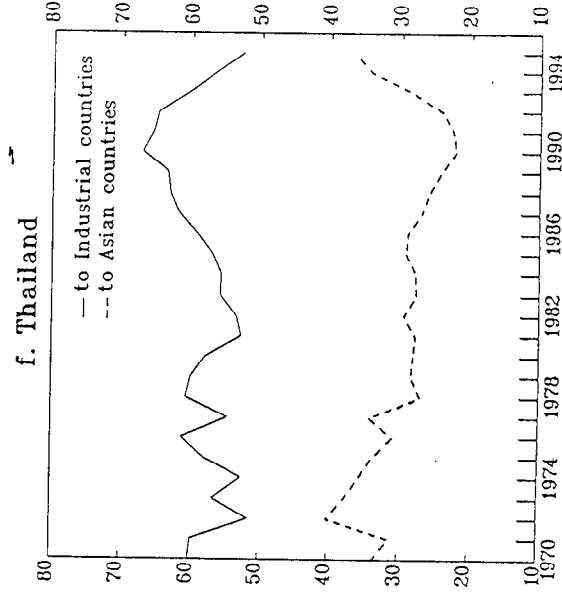
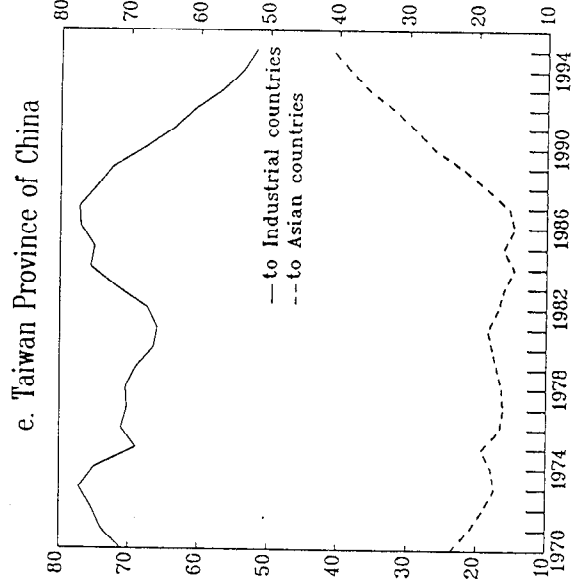
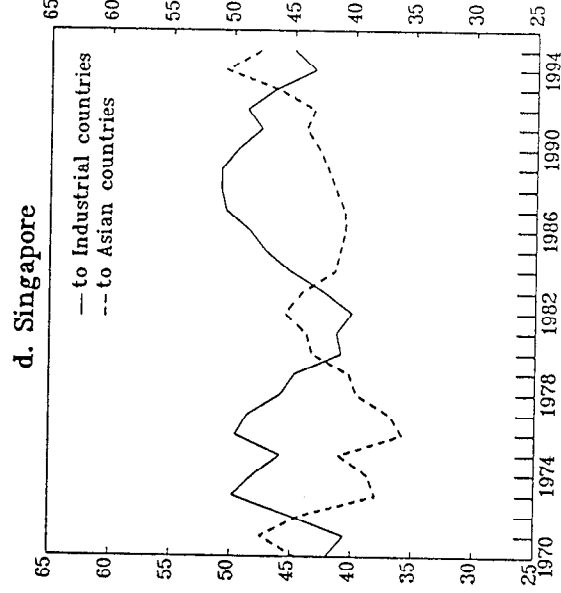
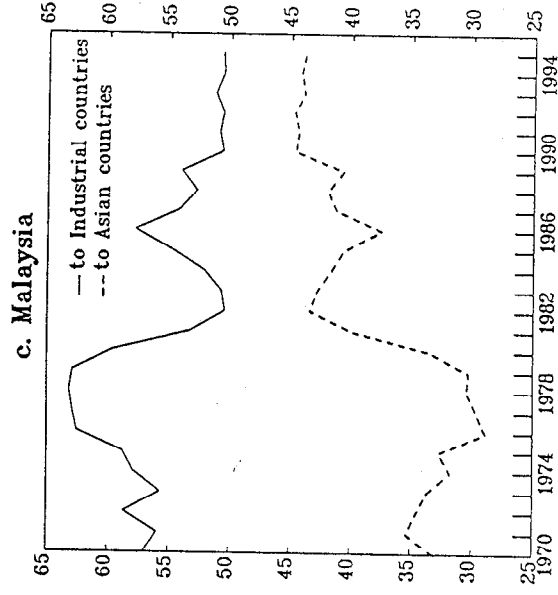
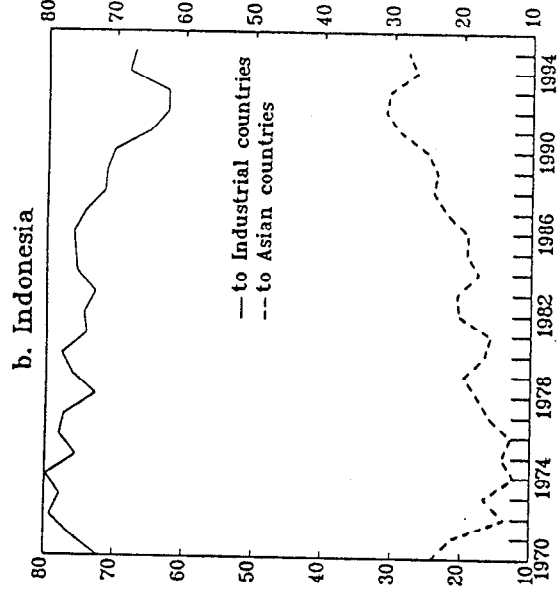
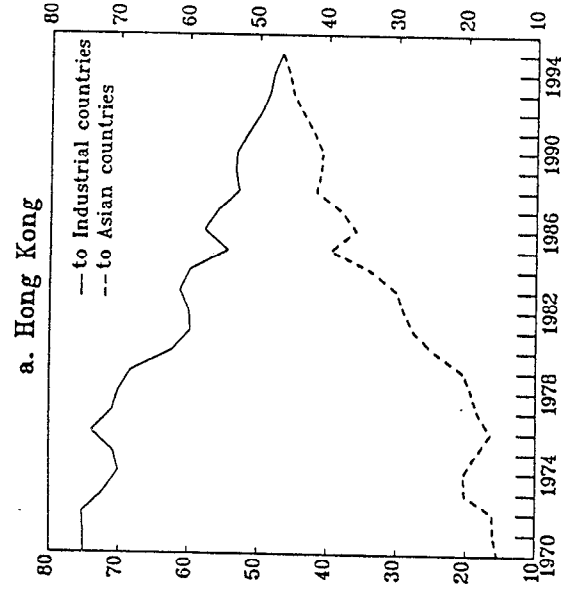


Chart 8. Asian countries: Direction of Exports



into a major exporter to these same countries.<sup>19</sup> To understand the degree to which the behavior of Korean exports follows broader international trends, Chart 9 plots the export shares going to Asian developing economies (i.e. excluding Japan) and industrial countries, respectively, together with the share of Asian countries' imports in world imports and the share of industrial country imports in world imports, respectively. The chart does suggest an underlying association between Korean external trade and these broader trends, but shows clearly that such trends cannot fully account for the change in Korean export shares during the 1990s.

To our knowledge, the only study that has examined the determinants of the direction of Korean exports is Jen (1992). He finds that industrial countries' demand for Korean exports has a higher income elasticity (above 3) and a lower price elasticity (-0.3) than developing countries' demand for Korean exports (1.3 and -0.6, respectively). The problem that we face in estimating the demand for Korean exports coming from Asian ( $x^{as}$ ) and industrial countries ( $x^{in}$ ), respectively, is that a long-run specification analogous to the one adopted for aggregate exports, namely (in obvious notation)

$$\begin{aligned} x_t^{as} &= \beta_0^{as} + \beta_1^{as} y_t^{as} + \beta_2^{as} rx_t^{as} + v_t^{as} \\ x_t^{in} &= \beta_0^{in} + \beta_1^{in} y_t^{in} + \beta_2^{in} rx_t^{in} + v_t^{in} \end{aligned} \quad (5)$$

is consistent with the aggregate long-run specification (as, for example, the first equation in (3)) only under restrictive conditions on the evolution of export and output shares. With respect to the scale variable, for example, this would require that the shares of Korean exports going to industrial and Asian countries, respectively, remained proportional to the output shares of Asian and industrial countries in world GDP.<sup>20</sup> This condition is clearly violated during the 1990s. Of course, it is possible in principle that the disaggregated demand equations (5) are correctly specified and that the aggregate equation is misspecified. However, the estimation results of Section 4 show no sign of instability or functional misspecification. To illustrate further this point, we examined the stability of single-equation estimates of (5). While we were unable to recover from the data a meaningful long-run relationship for the exports to industrial countries in any sample period, single-equation estimates of Asian countries' demand for Korean exports, for the period during which conditions on the evolution of the shares were not clearly violated (i.e., 1971-1989), yielded reasonable

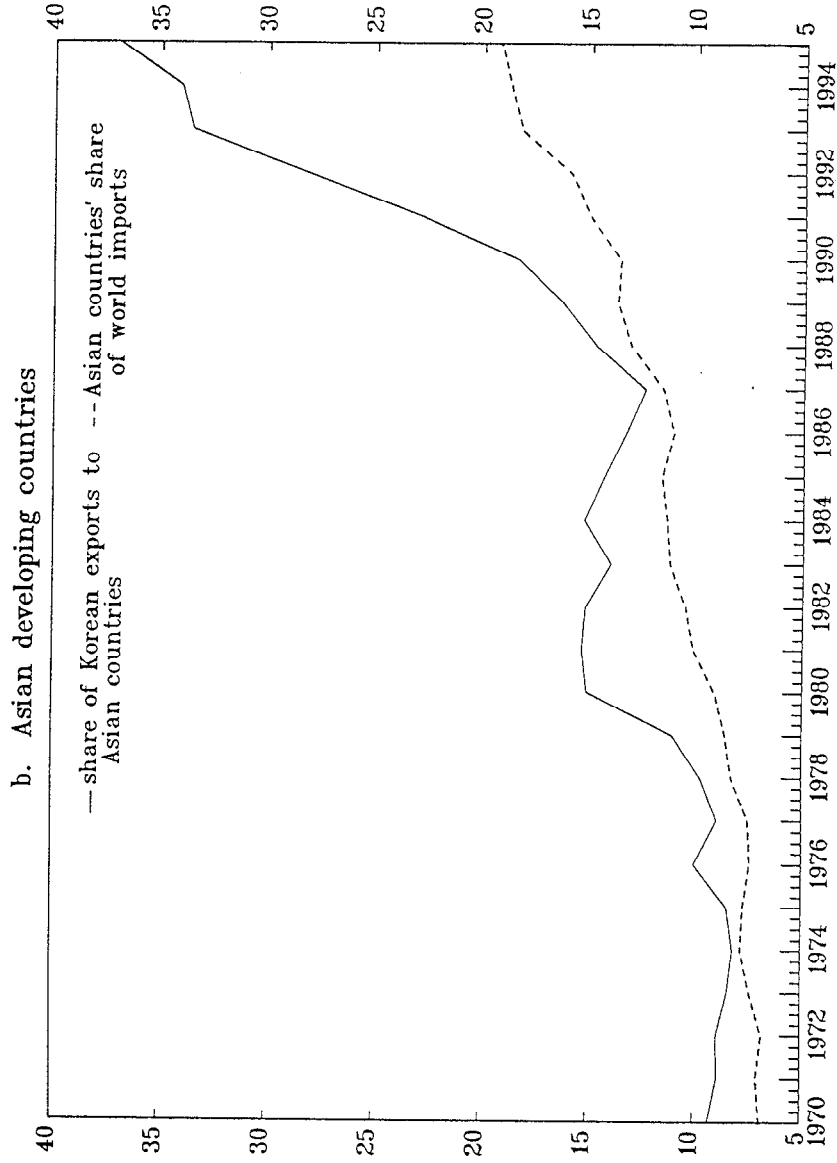
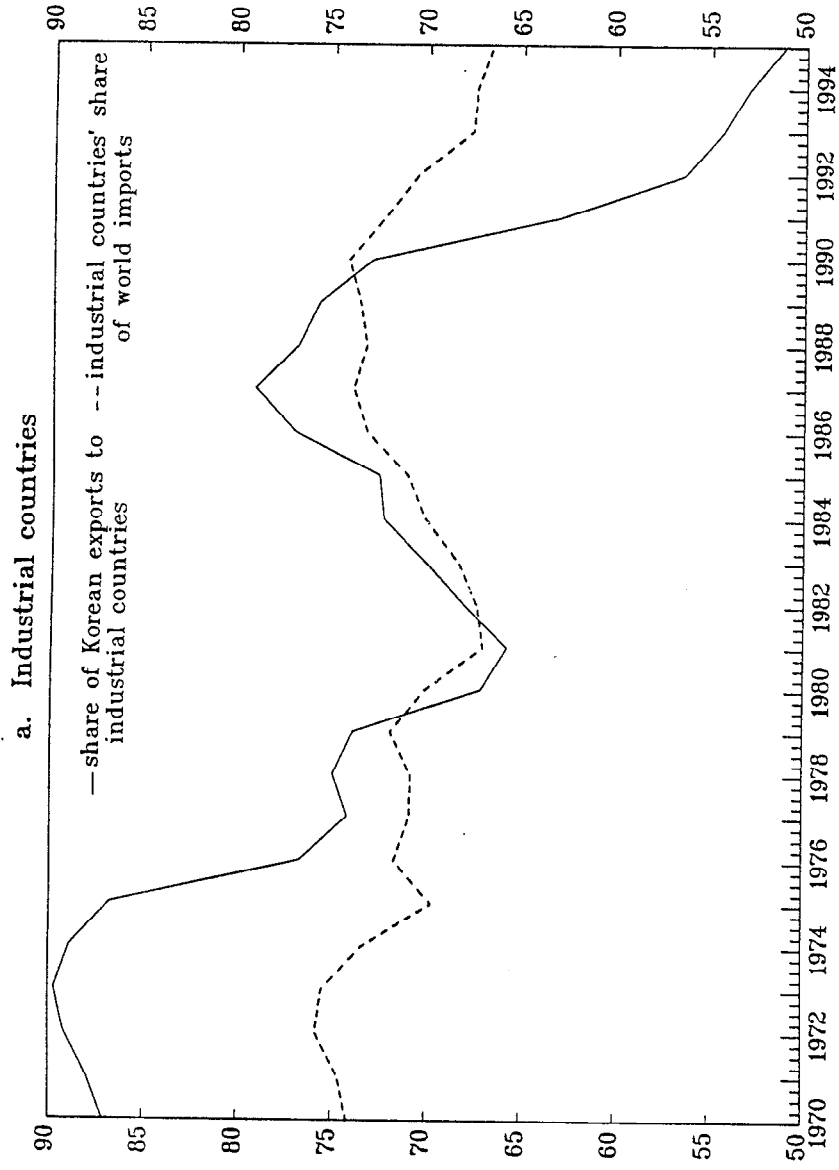
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<sup>19</sup>It should also be noted that the share of Asian developing countries' exports which is going to Korea has not increased significantly. This reflects the fact that the geographical composition of Korean imports has changed in a much less drastic fashion than the composition of exports: industrial countries still account for 67 percent of Korean imports in 1995, although down from over 80 percent in 1970. This suggests that relative price shifts, in addition to differences in growth rates between industrial and Asian countries, may have played a role in explaining Korea's pattern of trade.

<sup>20</sup> Khan (1975) discusses aggregation issues for the calculation of price elasticities.



Chart 9. Korea: Composition of exports and Direction of world trade



long-run elasticities (see Table 6). Interestingly, the forecasting ability of the latter equation for the period 1990-1995 is good.<sup>21</sup> Overall, these results corroborate the view that both the time variation of Korean export shares and its divergence from Asian and industrialized countries' output (and import) shares introduce instability in the disaggregated demand equations.

We next attempt to explain empirically what determines the behavior of Korean exports to industrial countries. As recalled above, for the log-linear specification of the aggregate demand equation to be consistent with the disaggregated equations, the ratio of the share of the level of Korean exports to industrial countries ( $XSH^m = X^m/X$ ) must be linearly related to the ratio of the level of industrial countries' output to world output ( $YSH^m = Y^m/Y^w$ ). Hence, we, first, estimated a simple linear relationship between these two shares during 1971-1989, a period of relative stability (see, again, Chart 9). A better explanatory power was achieved by using the share of industrial countries imports in world trade, i.e.,  $MSH^m = M^m/M^w$ , instead than the output shares. Therefore, in Table 7 we present estimation results only for the latter specification.

Although the significance of the link between the two variables is very strong, there are clearly other determinants that have been left out from the estimated equation. This becomes more apparent if we plot the out-of-sample forecast of the share of Korean exports to industrial countries. Chart 10.a shows that the dramatic drop in the export share cannot be fully accounted for by movements in the share of industrial countries' imports. This was expected, given that the share of industrial countries imports in world trade has contracted only moderately in the 1990s. It was recalled earlier that an important development in the map of trade flows of this decade has been the strong increase in the demand for exports of Asian developing countries, other than Korea, from industrial countries. To test whether this growth in exports by competing countries may account for the drop of Korean exports to OECD countries we added to the share equation the ratio of industrial countries' imports from Asian economies (other than Korea) to total OECD imports ( $MSH^{in+as} = M^{in+as}/M^{in}$ ).<sup>22</sup> Although the variable enters with the correct sign (an increase in demand of other Asian developing countries' exports from OECD countries crowds out Korean exports to those markets), it is significant only at the 93 percent confidence level. These results are not as sharp as those characterizing aggregate trade flows. Nevertheless, a similar forecasting exercise to the one performed above (see Chart 10.b) clearly shows that higher competition among Asian developing countries, in addition to their increasing importance in world trade, has contributed to the erosion of Korean's export shares in OECD countries.

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<sup>21</sup>One reason for this is that although the growth rate of Korean exports to Asia has increased in the later period, the ratio between the rate of growth of Asian GDP and the rate of growth of Korean exports to Asia has remained fairly stable across the two sub-periods.

<sup>22</sup> We also tried including relative prices in the share regressions, but they did not enter significantly.

**Table 6. Estimates of Long-Run Elasticities of Demand for Korean Exports to Asian Developing Countries Quarterly Data**

Constant	$y^{as}$	$rx^{in}$	$rx^{as}$	lagged EC term	R <sup>2</sup> -adj.	LM-AR(5)	White	RESET	Stability $\chi^2_{(24)}$
1971:1-1989:4									
3.91 (0.01)	2.58 (0.02)	-2.24 (0.06)	-2.60 (0.02)	-0.26 (0.01)	0.67	>0.10	>0.10	0.02	>0.10
1971:1-1995:4									
3.52 (0.01)	2.69 (<0.01)	-2.07 (<0.01)	-2.37 (<0.01)	-0.28 (<0.01)	0.64	>0.10	>0.10	0.01	-

**Notes to table:** The dependent variable is the log-level of the volume of exports to Asian developing countries ( $x^{as}$ ). The other variables are defined in the text (all variables are expressed in log-levels). The "lagged EC term" coefficients are the loading coefficients of the ECM and measure the speed of convergence towards long-run equilibrium. The values in parenthesis underneath each estimated coefficient are p-values obtained using consistent (parametric) estimates of the standard errors. R<sup>2</sup>-adj is the coefficient of determination adjusted for the degrees of freedom; LM-AR(5) is a Lagrange Multiplier test for the presence of residuals autocorrelation of the fifth order (p-values for the F-type test are reported); White is a general test for residuals heteroskedasticity (p-values for the F-type test are reported); RESET is Ramsey's functional mis-specification test (p-values for the F-type test are reported); Stability is a test of forecasting stability of the relationship after 1990 (the figures reported are p-values for the  $\chi^2$ -type test with 24 degrees of freedom).

**Table 7. Share of Korean Exports to Industrial Countries  
Quarterly Data, 1971:1-1989:4**

Constant	$MSH^{as}$	$MSH^{as+in}$	R <sup>2</sup> -adj.	LM-AR(5)	White	RESET	Stability Chow-F
-110.9 (0.02)	2.62 (<0.01)		0.66	<0.01	<0.01	<0.01	<0.01
-74.38 (0.08)	2.29 (<0.01)	-1.80 (0.07)	0.77	<0.01	>0.10	0.01	0.04

**Notes to table:** The dependent variable is the (level volume) share of Korean exports to industrialized countries ( $XSH^m$ ). The explanatory variables are: the share of industrialized countries' imports to world imports ( $MSH^{in}$ ) and the share of industrial countries 'imports from Asian developing countries, other than Korea, to industrial countries imports ( $MSH^{in+as}$ ). The values in parenthesis underneath each estimated coefficient are p-values obtained using consistent (parametric) estimates of the standard errors. R<sup>2</sup>-adj is the coefficient of determination adjusted for the degrees of freedom; LM-AR(5) is a Lagrange Multiplier test for the presence of residuals autocorrelation of the fifth order (p-values for the F-type test are reported); White is a general test for residuals heteroskedasticity (p-values for the F-type test are reported); RESET is Ramsey's functional mis-specification test (p-values for the F-type test are reported); Stability is Chow's test of forecasting stability of the relationship after 1990 (the figures reported are p-values for the F-type version).

Chart 10.a      Share of Demand of Korean Exports to Industrialized Countries.  
Specification 1.  
Quarterly Data, Estimation: 1971:1 - 1989:1. Forecasting: 1990:1 - 1995:4.

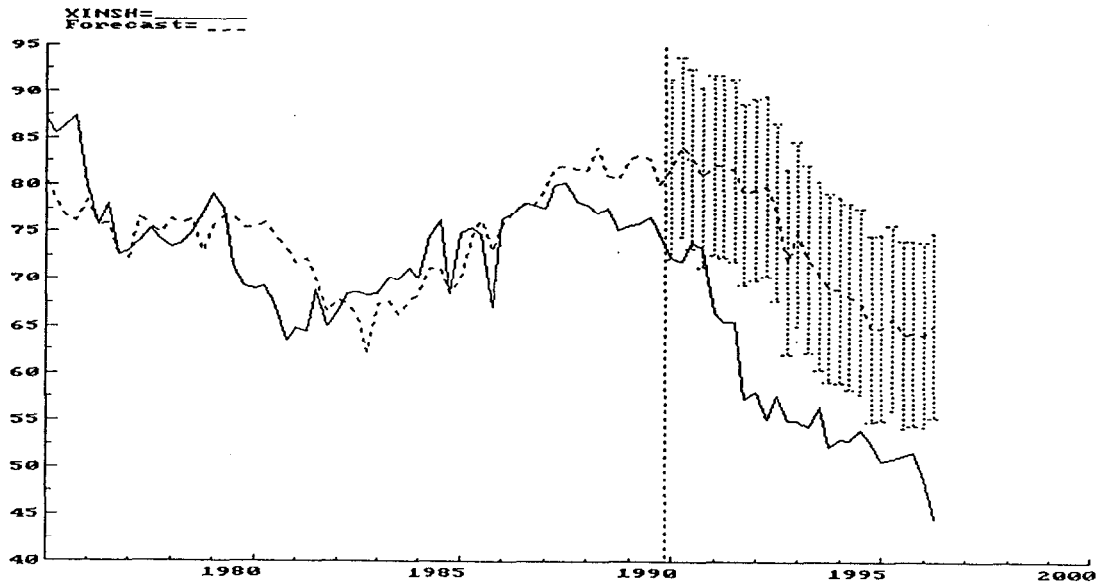
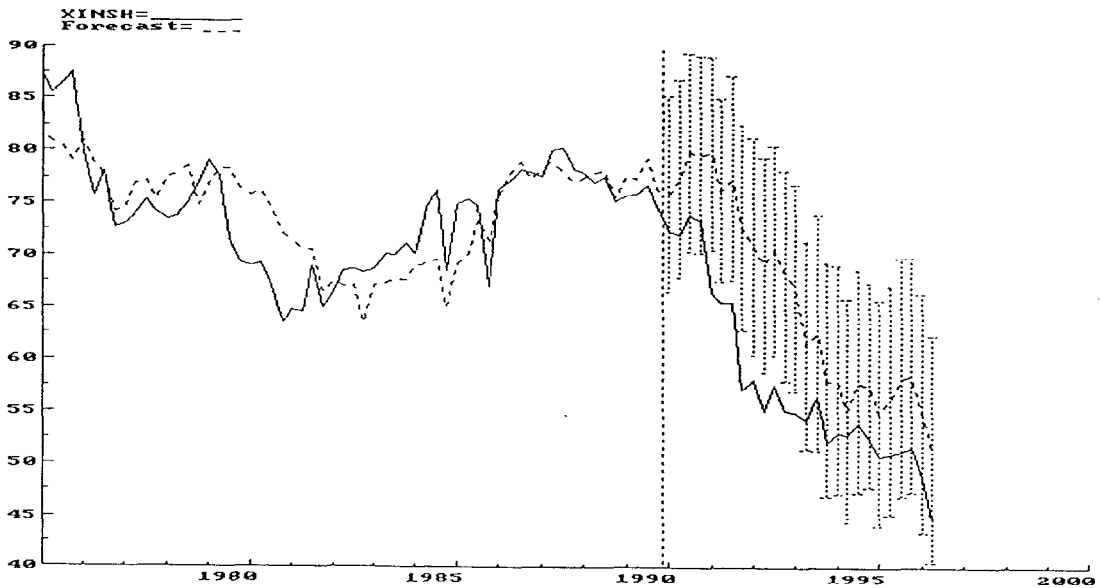


Chart 10.b      Share of Demand of Korean Exports to Industrialized Countries.  
Specification 2.  
Quarterly Data, Estimation: 1971:1 - 1989:1. Forecasting: 1990:1 - 1995:4.



## VII. CONCLUSION

This paper examined the determinants of Korean exports and imports. The estimates of income and price elasticities are consistent with other studies and with estimates for other Asian newly industrialized economies. For imports, the elasticity with respect to domestic income is around 1.3, while the price elasticity is relatively low (below unity). These low elasticities may partly reflect the fact that primary commodities and raw materials constitute a large fraction of Korean imports. Not surprisingly, Korean imports are strongly correlated with domestic investment. When investment is used as a scale variable instead of domestic income, relative prices become statistically insignificant.

The elasticity of Korean exports with respect to foreign demand is high, reflecting the growth differential between Korea and its trading partners. When relative export prices are used as price variable, the price elasticity of the demand for Korean exports is high (above 2); there is also evidence that relative prices vis-à-vis both industrial and Asian developing countries influence Korean export volumes. In contrast, it is difficult to detect significant effects of relative prices on exports when using WPI- or CPI-based real effective exchange rate measures.

The examination of the direction of Korean exports suggests that the decline in the share of exports to industrial countries is linked not only to the decline in the relative importance of OECD countries in world trade, but also to the increased penetration of industrial countries' markets by other Asian developing countries. Korea's export performance has been sustained by booming exports to these Asian countries, which are found to be driven by their high growth, the high elasticity of their demand for Korean exports, and relative price developments. The evolution of trade flows in Korea and other East Asian countries remains an important topic for future research. Given the rapidly evolving export structure of these countries, a better understanding of this phenomenon probably requires the use of more disaggregated data, particularly on export commodity composition.

### MORE ON THE SPECIFICATION AND ESTIMATION OF THE EXPORT MODEL

The VECM for the demand and supply system was written in Section V as:

$$\Delta Z_t = \mu + \Pi Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \dots + \Gamma_s \Delta Z_{t-s} + u_t$$

where  $Z_t$  is the vector comprising all the variables appearing in system (3), namely  $Z_t = [x_t, p_t^x, c_t, k_t, p_t^y, y_t^y]'$ ,  $\mu$  is the vector of constant terms,  $\Pi$  is the matrix of long-run coefficients, the  $\Gamma$ 's are the matrices of short-run coefficients, and the error terms contained in the vector  $u_t$  are serially independent, but possibly contemporaneously correlated. As said above, theoretical considerations suggest that there should be at least two cointegrating relationships among the  $Z_t$  variables, i.e. a long-run demand and a long-run supply equations (see equations (3)). The presence of cointegration imposes particular restrictions on  $\Pi$ , so that, if  $r$  denotes the number of cointegrating vectors,  $\text{rank}(\Pi) = r$  with  $0 < r < k$  and  $k = \text{number of variables in } Z_t$ .<sup>23</sup> The rank deficiency of  $\Pi$ , arising in presence of cointegration, implies that  $\Pi = \alpha\beta'$ , with  $\alpha$  and  $\beta$  two  $k \times r$  matrices containing, respectively, adjustment and long-run coefficients. In particular, each column of  $\beta$  contains an individual cointegrating vector. Notice that unless a priori restrictions are imposed on the matrix  $\beta$ , the cointegrating vectors are not identifiable. This can be easily seen by noticing that for any non-singular  $r \times r$  matrix  $Q$ ,  $\Pi = \alpha Q^{-1} Q' \beta' = \alpha_q \beta'_q$ , so that any unrestricted estimate of the cointegrating vector  $\beta$  cannot be distinguished from an alternative estimate  $\beta_q$  using data alone. In general,  $r^2$  restrictions are needed for exact identification of the  $r$ -dimensional cointegration space. Within the Johansen procedure, a set of  $r$  normalizing restrictions is supplemented with  $r^2 - r$  additional ("orthogonalization") restrictions in order to identify  $\beta$ . As Pesaran and Shin (1994) put it, these additional restrictions are imposed for their "mathematical convenience and not necessarily because they are meaningful from the perspective of long-run structural economic modeling." In our context, in the presence of two cointegrating vectors, one restriction per vector, in addition to the usual normalizing restrictions, is needed to achieve identification. Such restrictions could be, for example, the exclusion of  $c_t$  from the (long-run) demand equation, and the exclusion of  $y_t^y$  from the (long-run) supply equation. Given a set of just-identifying restrictions, further (over-identifying) restrictions, such as the exclusion of  $k_t$  from the demand, and/or the exclusion of  $y_t^y$  from the supply, and/or the homogeneity of prices in the demand, can be tested following the methodology detailed in Pesaran and Shin (1994).

While Section V.C presented the main estimation results from a reduced version of the above general VECM, the remainder of this Appendix will focus on the description of the steps taken to reduce that general version of the export demand and supply model. The results of these intermediate steps are presented in Table A.1.

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<sup>23</sup>Notice that if  $\text{Rank}(\Pi) = 0$ , there are no cointegrating relationships, and if  $\text{Rank}(\Pi) = k$ , all the variables appearing in the system are stationary, so that the system is trivially cointegrated.

**Table A.1 Specification Process of the System of Demand and Supply of Exports:  
Vector Error Correction Model (4) with Quarterly Data, 1971:1 - 1995:4**

Panel I. A. Cointegration Space							
Modeled Variables of the System (endogenous):				$x, p^x, c, p^w, y^w$			
Non-Modeled Variables (restricted in the cointegrating space):				intercept			
Other Non-Modeled Variables (unrestricted):				Oil and seasonal dummies			
Maximal Eigenvalue Null Alternative		Statistic	95% Critical Value	Maximal Eigenvalue Null Alternative		Statistic	95% Critical Value
$r=0$	$r=1$	53.37	34.40	$r=0$	$r \geq 1$	112.54	75.98
$r \leq 1$	$r=2$	43.08	28.27	$r \leq 1$	$r \geq 2$	59.18	53.48
$r \leq 2$	$r=3$	11.47	22.04	$r \leq 2$	$r \geq 3$	16.09	34.87
$r \leq 3$	$r=4$	3.89	15.87	$r \leq 3$	$r \geq 4$	4.63	20.18
$r \leq 4$	$r=5$	0.74	9.16	$r \leq 4$	$r=5$	0.74	9.16
B. Reduction of Cointegration Space							
$r=2$ , cointegration space is unrestricted:							
LR Test for Exogeneity of $p^w$ & $y^w$ ,				$\chi^2_{(4)} = 6.48$ (pval>0.10)			
LR Test for Exogeneity of $c, p^w$ & $y^w$ ,				$\chi^2_{(6)} = 45.27$ (pval<0.01)			

**Notes to table (Panel I):** The list of variables entering each VAR and their status is reported case by case within the table. The maximal lag order choice for all the estimated VAR's was  $s=4$ . Critical values for Johansen's (1988) maximal eigenvalue and trace statistics of Panel A.I are obtained from "Microfit." The switching algorithm employed for the estimation of the cointegration space under general over-identifying restrictions (whose results are presented in Panel II.A) is described in Doornik and Hendry (1994).



**Table A.1 (Continued) Specification Process of the System of Demand and Supply of Exports: Vector Error Correction Model (4) with Quarterly Data 1971:1 - 1995:4**

Panel II.								
A. Testing about the Cointegration Space, r=2								
Modeled Variables of the System (endogenous):						$x, p^*$		
Non-Modeled Variables (restricted in the cointegrating space):						$c, p^w, y^w$ and intercept		
Other Non-Modeled Variables (unrestricted):						$\Delta c, \Delta p^w, \Delta y^w$ , Oil and seasonal dummies		
Cointegrating Vectors: Over-identifying Restrictions - (1) (S.E. in parenthesis)						Loading Coefficients (S.E. in parenthesis)		LR Test $\chi^2_{(q)}$
$x$	$p^*$	$c$	$p^w$	$y^w$	intercept	1st C.V.	2nd C.V.	
1.000	1.728 (0.429)	-	-1.728	-3.186 (0.141)	9.829 (0.652)	-0.220 (0.040)	-0.181 (0.174)	$q=2$ 1.292 pval>0.10
-0.139 (0.043)	1.000	-0.599 (0.118)	-	-	-4.002 (0.196)	0.014 (0.016)	-0.134 (0.071)	
Cointegrating Vectors: Over-identifying Restrictions - (2) (S.E. in parenthesis)						Loading Coefficients (S.E. in parenthesis)		LR Test Chi-sq.(q)
$x$	$p^*$	$c$	$p^w$	$y^w$	intercept	1st C.V.	2nd C.V.	
1.000	1.972 (0.450)	-	-1.972	-3.156 (0.140)	9.682 (0.646)	-0.205 (0.037)	-	$q=4$ 2.393 pval>0.10
-0.135 (0.045)	1.000	-0.640 (0.127)	-	-	-4.004 (0.206)	-	-0.148 (0.059)	
B. Testing about the Cointegration Space, r=2								
Modeled Variables of the System (endogenous):						$x, p^*, c$		
Non-Modeled Variables (restricted in the cointegrating space):						$p^w, y^w$ and intercept		
Other Non-Modeled Variables (unrestricted):						$\Delta c, \Delta p^w, \Delta y^w$ , Oil and seasonal dummies		
LR Joint Test of the Long-run Over-identifying Restrictions (2) plus Weak Exogeneity of c: $\chi^2_{(10)} = 13.6$ (pval>0.10)								

**Notes to table (Panel II).**  $ec_d$  and  $ec_s$  denote, respectively, the demand and supply error correction terms obtained from Panel I.A. In the same panel, AR(1-5) is a Lagrange Multiplier test for the presence of residuals autocorrelation up to the fifth order (p-values for the F-type test are reported); ARCH is a Lagrange Multiplier test for Autoregressive Conditional Heteroskedasticity of the estimated residuals, while Heteroskedasticity is a general test for residuals heteroskedasticity (p-values for both F-type tests are reported); Normality is a test for the presence of deviation from Gaussianity of the residuals (p-values for the F-type test are reported).

To begin with, the unrestricted version of the above VECM, augmented by a set of seasonal dummies and one oil shock dummy (for the first quarter of 1974), was estimated in order to select the lag-order,  $s$ , using standard information criteria. For a given choice of the lag order, Panel I.A of Table A.1 contains the results of the test for the number of cointegrating relationships present in the system. Using both the maximal and trace eigenvalue statistics of Johansen (1988), the hypothesis that two cointegrating vectors were present among the five variables  $\{x_t, p_t^x, c_t, p_t^w, y_t^w\}$  could not be rejected at the 95% significance level.<sup>24</sup> The presence of two cointegrating relations is consistent with the long-run demand and supply system of equations. The next step was the determination of the exogeneity status of some of the variables appearing in the system. It was found, for example, that inference about the long-run parameters was not affected by treating the world variables  $\{p_t^w, y_t^w\}$  as exogenous, i.e., these variables were weakly exogenous for the cointegrating parameters of interest (see the likelihood ratio tests presented in Table A.1, Panel I.B). In contrast, this hypothesis was rejected for the cost variable. To simplify further the system, the world variables and the cost variable were treated in the remainder of the analysis as non-modeled, or exogenous variables. For reasons which will become clearer shortly, the choice of exogenizing domestic costs with respect to exports and domestic prices, even in presence of a rejection of the exogeneity tests, will not invalidate the results that follow.

Within Pesaran and Shin's (1994) identification and estimation approach, we tested different relevant long-run hypotheses. In Panel II.A of Table A.1, we present results of two sets of over-identifying restrictions. The first, labeled (1) in the table, consists in the exclusion of the cost variable from the demand equation (i.e., the first cointegrating vector, with  $x_t$  normalized to have unitary coefficient) and of the world price and expenditure variables from the supply equation (i.e., the second cointegrating vector, with  $p_t^x$  normalized to have unitary coefficient), as well as the imposition of the price homogeneity restriction in the demand equation. For the constrained model, all the estimated coefficients (the  $\alpha$ 's and  $\beta$ 's) take on the expected signs and are significant at conventional significance levels, and all the restrictions are comfortably accepted by the likelihood ratio test. Under the additional "symmetry" restriction, denoted by the specification (2) in Table A.1, of zero cross-equation loading coefficients ( $\alpha_{12}=\alpha_{21}=0$ , i.e., the export demand adjusts in the short-run only with respect to deviations from the long-run demand equilibrium, while the export supply adjusts in the short-run only with respect to deviations from the long-run supply equilibrium), the estimated long-run elasticities are unchanged, with the exception of a slightly higher relative price demand elasticity.

For the congruency of the results just discussed, it is crucial that the estimates of  $\alpha$  and  $\beta$  obtained from the over-identified cases illustrated above and for the two-endogenous-variable system not be rejected within the three variable system that treats endogenously the cost variable, together with domestic export prices and quantities. Indeed, the test results presented in the Panel II.B of Table A.1 suggest that the structure of demand and supply equations derived from the two-variable system is also coherent with the three variable model.

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<sup>24</sup>The constant term was restricted on the cointegration space in all the estimated specifications presented in Table 4 and Table A.1.

Earlier, the rejection of the exogeneity of  $c_t$  was obtained in presence of an unrestricted long-run parameter space. Evidently, it is the imposition of more economic structure on the system, that makes the exogeneity status of  $c_t$  consistent with the data.

Once the long-run structure of the system has been identified, the final step, described in Section V.C, where the reader is referred, consists in the joint estimation of the model's short-run parameters and the testing of possible (short-run) over-identifying restrictions.

**DATA SOURCES AND DEFINITIONS**

Volume of Imports ( $M$ ): value of imports deflated by import unit value. Source: IFS.  
Gross domestic product at constant prices ( $Y$ ). Source: IFS  
Real Aggregate Consumption ( $CONS$ ). Source: Bank of Korea  
Net Real Fixed Investment ( $INV$ ). Source: Bank of Korea  
Real Absorption ( $ABSO$ ). Source: Bank of Korea  
Unit Value of Imports in US \$ terms ( $P^M$ ). Source: IFS  
Wholesale Price Index (WPI). Source: IFS  
Consumer Price Index (CPI). Source: IFS  
Real Effective Exchange Rate, CPI-based ( $RER^{CPI}$ ). Source: IFS  
Real Effective Exchange Rate, WPI-based ( $RER^{WPI}$ ). Source: author's calculations.  
Volume of Exports ( $X$ ): value of exports deflated by export unit value. Source: IFS.  
Volume of Exports to Industrial Countries ( $X^{IN}$ ). Source: DOTS.  
Volume of Exports to Asian developing countries ( $X^{AS}$ ). Source: DOTS.  
Real World GDP ( $Y^W$ ). Source: World Economic Outlook.  
Real GDP in Industrialized countries ( $Y^{IN}$ ). Source: World Economic Outlook.  
Real GDP in Asian developing countries ( $Y^{AS}$ ). Source: World Economic Outlook.  
Real Capital Stock ( $K$ ): Measure of the real capital stock calculated with a perpetual inventory method using fixed investment at 1990 prices and a fixed depreciation rate. Source: staff calculations.  
Unit Value of Exports in dollar terms ( $P^X$ ). Source: IFS  
World Export Price Index ( $P^W$ ): trade-weighted index of world export prices. Source: IFS.  
Asian Export Price Index ( $P^{AS}$ ): trade-weighted index of Asian export prices. Source: IFS.  
Industrial Export Price Index ( $P^{IN}$ ): trade-weighted index of industrial countries' export prices. Source: IFS.  
Relative Export Prices vis-à-vis the world ( $RX^W$ ):  $P^X / P^W$ .  
Relative Export Prices vis-à-vis Asian developing countries ( $RX^{AS}$ ):  $P^X / P^{AS}$ .  
Relative Export Prices vis-à-vis industrial countries ( $RX^{IN}$ ):  $P^X / P^{IN}$ .  
Wages ( $WG$ ): index of monthly earnings, converted in dollars. Source: IFS

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