Working Paper 92-25
May 1992

División de Economía
Universidad Carlos III de Madrid
Calle Madrid, 126
28903 Getafe (Spain)
Fax (341) 624-9757

EXPORTS AND ECONOMIC GROWTH. THE GAINS FROM REALLOCATION IN KOREA.

Juan R. España*

Abstract

This paper presents some empirical evidence suggesting that promotion of manufactured exports can lead to accelerated rates of growth in a developing economy. Based on a two-sectoral model involving exports and non-exports, a method is developed to measure the gains obtained through a reallocation of resources from the domestic to the external sector. The benefits from continued export expansion are found to decline over time. Cointegration tests confirm the long-run character of the estimated relationships. A simulation based on a dynamic, optimal control model illustrates the growth effects of different shocks and policies affecting the Korean export sector.

Key words:
Export expansion, economic growth, reallocation gains, Korea.

*Economics Department, Universidad Carlos III de Madrid.

1. INTRODUCTION

The main contributions of exports to economic growth in LDCs fall into two categories: First, the contribution of exports to structural change (defined as the increase in the share of manufacturing in GDP); and second, the contribution of exports income to the supply of productive inputs, i.e., intermediate goods (raw materials and oil) and capital, especially capital imports.

The relation between exports and economic growth has recently received much attention in the economic development literature, particularly due to the successful growth record of outward-oriented economies in East Asia.

Earlier works on the subject of exports and growth were mainly cross-country studies using correlation or regression analysis linking aggregate output and exports growth. In many cases other variables were also included, such as foreign investment and foreign savings. Among these studies one can mention Michaely (1977), Balassa (1978), Williamson (1978) and Tyler (1981). More recently, some studies have been carried out using time series of single countries, such as the works by Rana (1985) and Ram (1987) or pooled data such as in Fosu (1990). The vast majority of these studies have found a positive and significant relationship between output and exports growth.

Other studies worth mentioning are those of Michalopoulos and Jay (1973), who introduced a variable to test the impact of exports diversification on exports growth, finding a positive and significant relationship. Bradford (1987) analysed the relation between exports and structural change, detecting "a strong association between rapid change in the sectoral composition of output and exports (structural change) and rapid exports growth in the newly industrializing countries".

Feder (1982) provided a major advance in the formalization of the structural link between the two variables. In his study, the link between exports and output growth is based on the asymmetric relationship between the exports sector and the rest of the economy. Even though his model postulates this kind of asymmetric relation between sectors, the analysis takes place at the aggregate and not the sectoral level. Riedel (1983) found that it is supply rather than demand factors that determine LDCs exports performance in manufactures. Tests of demand dominance performed in España (1990) and Sengupta and España (1991) seem to indicate that supply constraints have been more important than demand constraints in determining exports and income growth in LDCs. Chen and Tang (1987) found that exports-oriented firms in Taiwan were between 6% and 11% more efficient than import-substitution-oriented ones.

Maizel (1968) and Fajana (1979) hypothesised that the link between exports and output growth was the more than proportional contribution of exports to savings formation. Kavoussi (1984) suggested that part of the effect of exports on growth is due to an acceleration of the rate of capital formation caused by exports growth.

The analysis of the role of exports in the supply of capital and intermediate inputs was formalized by several authors in the two-gap model. A novel approach to this problem was adopted by Bacha (1984), who recast the two-gap model into an analytical framework consisting of internal and external imbalances in the Meade-Swan tradition.

A shortcoming in almost all the studies of the link between exports and growth is the lack of a structural approach to the problem. Taking an aggregate approach, they fail to provide insights into the asymmetrical relation between the exports sector and the rest of the economy in LDCs. Also, previous works focus on one of the main effects of exports on growth, either the contribution to structural change or the contribution to the supply of inputs, completely ignoring the other. Another major omission is the lack of attention to the econometric problems involved in the actual estimations such as the question of cointegration or the treatment of autocorrelated residuals.

This study takes a different approach, analyzing the problem at both the aggregate and sectoral levels in order to determine the nature and extent of intersectoral relationships. These results are then used to estimate the gains from the factor reallocation implied by a policy of export promotion. Cointegration tests are performed on the aggregate and sectoral models in order to explore the structural, i.e. long-run character of the estimated relationships. Turning to the other major contribution of exports to growth in LDCs, the role of exports in the alleviation of internal and external disequilibria is analyzed as well as the relative importance of each type of imbalance for the evolution of output in Korea. The dynamic effects of different shocks and policies affecting the external sector of the economy are simulated using an optimal control approach.

2. EXPORTS AND STRUCTURAL CHANGE

One of the main effects of exports on economic growth in an industrializing economy is the contribution of exports to economy-wide structural change. The empirical evidence suggests that structural change has been one of the main links between exports and economic growth in outward-oriented LDCs. The dynamic expansion of the exports sector, largely based on specialization in manufactured exports, has been the driving force behind the modernization of the economy. Export growth itself has been promoted by diversifying the exports base, away from primary exports, in response to changing world demand.

In Korea, structural change has been very rapid since the adoption of the export-oriented growth strategy in the early 1960's. For the period 1961-86, the compounded annual growth rate of exports volume was 21.1%, almost three times the 8.5% rate of growth of output. Manufacturing output grew at a rate of 16.1%, more than twice the 7.3% growth rate of non-manufacturing. Over the period, manufacturing's share of GDP rose from 5.6% to 29.8%. The structural change implied by a larger share of manufacturing in aggregate output raised the overall efficiency of the economy as aggregate productivity moved closer to the higher productivity level prevailing in manufacturing. The increase in overall productivity was the result of two effects: first, the direct effect on total productivity of a relatively larger manufacturing sector; and second, the indirect effect resulting from linkages between manufacturing and the rest of the economy.

In order to put Korean results into perspective, we look at the pace of transformation in five East Asian economies, namely Korea, Taiwan, Thailand, The Philippines, and Japan. The evolution is shown in table 2.1 below.

Table 2.1 Evolution of the Share of Manufacturing in GDP in East Asia

	Rate of Exports Growth	Gain in (Mfg/Y)*	Degree of Structural Change**	Rate of Economic Growth
	%	%	%	%
KOREA	30.9	18.2	0.7	8.7
TAIWAN	23.0	22.8	0.8	9.1
THAILAND	14.1	11.6	0.4	6.8
PHILIPP.	9.0	5.9	0.2	4.3
JAPAN	14.3	1.8	0.1	7.3

* Mfg/Y = Manufacturing's share in GDP, based on the current market value of both variables.
** Equal to average annual change in Mfg/Y
The growth rate of exports is computed using the current value of exports.
The growth rate of real output is computed using constant 1980 (for Taiwan 1981) prices.
The periods covered are: Korea 1960-86; Taiwan 1961-87; Japan 1960-85, Thailand and The Philippines 1960-87.
Sources: Bank of Korea, National Bureau of Statistics of Korea, Directorate General of Budget of the Republic of China, Economic Commission for Asia and the Far East, Statistics Bureau of Japan.

As table 2.1 reveals, there is a high degree of positive correlation between export growth, structural change and economic growth in these Asian NICs, with Korea and Taiwan leading the group in all three categories. The dynamic pattern in the evolution of exports and structural change is less visible in the cases of Thailand and The Philippines, countries experiencing the lowest rates of economic growth in the sample. Japan, as a mature exporter, experienced less structural change during this period, and it is conceivable that the role of exports in such a mature economy is less essential than in the exports-oriented NICs.

Diversification of the exports base, away from primary exports, was an essential element in Korean export expansion. A measure of the gains from export diversification can be obtained by computing the hypothetical growth rate of exports, B, that would have prevailed if the composition of exports had remained unchanged, and then comparing this with the actual, observed, growth rate of exports, g_X. The difference, $(g_X - B)$, can be regarded as the gain resulting from exports diversification.

As proposed by Michalopoulos and Jay (1973), B can be computed as

(2.1) $$B = \Sigma w_i g^i$$

where w_i = base year share of export i, equal to the value of exports of commodity i divided by the value of total exports; and g^i = growth rate of world exports of commodity i. Diversification of exports results in a gain of $(g_X - B)$ in the exports growth rate. As a percentage of the actual growth rate of exports, g_X, the gain is,

(2.2) $$S = \frac{g_X - B}{g_X} 100\%$$

The gains, S, over different periods in Korea are shown in table 2.2 below.

Table 2.2 Gains from Exports Diversification in Korea

Period	S
1960-80	69%
1965-80	59%
1970-80	49%
1975-80	37%

Sources: Bank of Korea, National Bureau of Statistics of Korea, United Nations.

As table 2.2 shows, over the period 1960-80, exports diversification was responsible for 69% of the growth rate of Korean exports. The gains from export diversification declined towards the end of the period, as the composition of Korean exports more closely matched the pattern of world demand for LDC exports, thus exhausting the gains from further adjustment.

3. SPECIFICATION OF THE MODELS

The models used in this study to analyse the relationship between exports and growth represent an extension of the aggregate model used by Feder (1982). In Feder's formulation there are two sectors in the economy, the exports, X, and the non-exports sector, N, and aggregate output is equal to Y= N + X. Sectoral outputs are produced according to the following production functions,

(3.1) $$N = N(K_N, L_N, X)$$

(3.2) $$X = X(K_X, L_X)$$

Differentiating with respect to time gives,

(3.3) $\dot{N} = F_K I_N + F_L \dot{L}_N + F_X \dot{X}$

(3.4) $\dot{X} = G_K I_X + G_L \dot{L}_X$

where F_K, F_L = Marginal productivity of capital and labor, respectively, in non-exports

F_X = Externality effects from the exports on the non-exports sector

G_K, G_L = Marginal productivity of capital and labor, respectively, in exports

I_N, I_X = Investment in the non-exports and the exports sector, respectively

Primary factors are assumed to be more productive in exports than in non-exports,

$$(G_K/F_K) = (G_L/F_L) = 1 + \delta$$

where $\delta>0$ is the marginal productivity differential, and there are externalities from exports on the rest of the economy as represented by the term F_X in (3.3).

Noting that $\dot{Y} = \dot{N} + \dot{X}$ and after some transformations and assumptions discussed below, the specification used by Feder becomes,

$$(3.5) \qquad \frac{\dot{Y}}{Y} = \alpha \frac{I}{Y} + \beta \frac{\dot{L}}{L} + \left(F_X + \frac{\delta}{1+\delta}\right) \frac{\dot{X}}{X}\frac{X}{Y}$$

Some elements in Feder's analysis are questionable, and objections can be raised regarding three areas: First, the data and assumptions; second, the economic implications of the model; and third, econometric aspects. Concerning the data and variables used, Feder uses population as a proxy for labor. Then, he assumes a linear relationship between marginal and average labor productivity, i.e., $F_L = \beta(Y/L)$, which leads to the equality $F_L(\dot{L}/Y) = \beta(\dot{L}/L)$. Regarding capital, he uses the share of investment in output, I/Y, as a proxy for the growth rate of capital, $\dot{I}/K$. Implicit in this practice is the assumption that the capital output ratio, K/Y, is constant over time.

Another questionable aspect of Feder's analysis is the assumption that productivity differentials between sectors are the same for both labor and capital, i.e., $\delta_K = \delta_L$. He also assumes that the externalities are unidirectional, i.e. from exports to non-exports but, a priori, there seems to be little reason to exclude a bidirectional, mutual conditioning between the sectors.

From an econometric point of view, the question of cointegration must be posed. The variables used in the estimation must be cointegrated of the same order for the estimated relationship to be a long-run, structural one.

A major omission in Feder's economic analysis is the failure to investigate the impact of exports on the supply of inputs, a link repeatedly stressed in the development literature, and formalized in the two-gap model.

The present analysis attempts to generalize and expand Feder's approach, dealing as well with the data and econometric limitations mentioned above. The link between exports and growth is analyzed not only at the aggregate but also at the sectoral level in order to highlight the asymmetrical relation between exports and the rest of the economy. A method is then developed to estimate the gains from reallocating resources into the exports sector.

This study also looks into the role played by export revenues in the relaxation of internal and external growth constraints. The empirical analysis is applied to the case of Korea, and includes comparisons with other East Asian NICs as well as a simulation of the effects of different shocks and policies affecting the export sector. The question of cointegration of the variables used in the models is explored in detail in the appendix.

3.1 <u>The Aggregate Model</u>

It is postulated that exports play a significant role for economic growth. This hypothesis is tested using an extended production function including exports as an additional argument,

(3.6) $$Y = Y(K, L, X)$$

Given the lack of reliable data on capital stock, the specification used is based on first differences of the variables, denoted by a dot, for instance $\dot{Y} = \Delta Y$,

(3.7) $$\dot{Y} = \alpha I + \beta \dot{L} + \gamma \dot{X}$$

$$\hat{\dot{Y}} = C + \hat{\alpha} I + \hat{\beta} \dot{L} + \gamma \dot{X}$$

$$=-208.9 + 0.151I + 0.024\dot{L} + 0.401\dot{X} \qquad R^2=0.641 \quad DW=1.965$$
$$(-0.372) \quad (2.875) \quad (1.921) \quad (1.805) \qquad \hat{\rho}=0.016$$

In this specification, the constant term, C, might be interpreted as the coefficient of time, but it turns out to be statistically insignificant. A decomposition of the sources of change in Korea, based on the estimation of equation (3.7), gives

Table 3.1 Sources of Change. Extended Production Function (1967-86)

Variable	(1) Mean	(2) Coefficient	(3) Contribution to Change (1)x(2)	(4) As % of Total Growth a)	b)*	(5) Feder's Results
$\dot{Y}$	2,175	1.000	2,175	100	100	100
C	-209	1.000	-209	-9	-	7
I	8,945	0.151	1,351	62	56	44
$\dot{L}$	22,317	0.024	535	24	22	17
$\dot{X}$	1,251	0.401	503	24	22	32

* The contribution of the constant term, C, was found to be statistically insignificant. In column 4b) this term has been left out and the figures have been rescaled so as to add up to 100%.
The dependent variable, Y, representing GDP as well as fixed investment, I, and total exports, X, are measured in Billions of constant 1980 Korean Won. Labor is expressed as the yearly flow of man-hours.
Sources: Bank of Korea, National Bureau of Statistics of Korea.

As can be seen from table 3.1, exports explain 22% of Korean growth over the period 1967-86, a figure roughly comparable with the 32% obtained by Feder (1982) for a cross-country sample of 19 semi-industrialized countries. Eventhough these figures seem to confirm the significance of the exports term in the extended production function, it is difficult to assess how these results are affected by existing collinearity between exports and the primary inputs, especially capital. It is therefore convenient to carry out a similar estimation using a different approach based on a disaggregated framework, and this is done next.

3.2 The Two-Sector Model

While the aggregate model is useful in analysing the impact of exports on aggregate output, it does not provide insights into the asymmetric relationship between exports and the rest of the economy. For this reason, a two-sector model comprising exports and non-exports is used.

In Korea, during the period in consideration, increases in manufacturing output were almost exclusively earmarked for export. Given the lack of data on factor inputs used for the production of exports, manufacturing is used as a proxy for the exports sector. The two-sector model is specified in a general form as,

$$N = F(K_N, L_N, X) \qquad (3.8)$$

$$X = G(K_X, L_X, N) \qquad (3.9)$$

where the additional arguments, N and X, are included to allow for linkages between the sectors. Differentiating (3.8) and (3.9) with respect to time gives

$$\dot{N} = F_K I_N + F_L \dot{L}_N + F_X \dot{X} \qquad (3.10)$$

$$\dot{X} = G_K I_X + G_L \dot{L}_X + G_N \dot{N} \qquad (3.11)$$

In this formulation no restrictions are imposed on the direction of externalities, represented here by F_X and G_N, or on the magnitude of the differentials in marginal productivities between sectors, represented by δ_K and δ_L in the ratios $(G_K/F_K)=1+\delta_K$ and $(G_L/F_L)=1+\delta_L$. These parameters can be directly estimated from the model and they can be used to compute the gains from the reallocation of factors between sectors, as done below.

4. GROWTH EFFECTS OF STRUCTURAL CHANGE

If the exports sector is indeed the leading sector in the economy, it can be expected to be more productive. In its role as initiator of technical and managerial innovations, the exports sector promotes economy-wide modernization. Therefore one can expect to find beneficial externality effects originating in the external sector and affecting the rest of the economy. In this chapter, we determine the extent of differentials in factor productivities between the two sectors as well as the magnitudes and directions of intersectoral linkages (externalities).

4.1. Marginal Productivity Differentials Between Sectors

The estimation of intersectoral productivity differentials is based on the sectoral models of equations (3.10) and (3.11), assuming at this point that $F_X, G_N = 0$, i.e., leaving out externality effects,

(4.1) $\dot{N} = F_K I_N + F_L \dot{L}_N$

(4.2) $\dot{X} = G_K I_X + F_L \dot{L}_X$

Based on the results on sectoral factor productivities, one can test the hypothesis that both capital and labor are more productive in the exports sector, i.e., $G_K/F_K = 1+\delta_K$ and $G_L/F_L = 1+\delta_L$ where $\delta_K, \delta_L > 0$. Estimation of (3.7), leaving out the exports term $\dot{X}$, as well as (4.1) and (4.2) for different periods gives the evolution of aggregate and sectoral marginal productivities over time as shown in table 4.1 below.

Table 4.1 Marginal Factor Productivities and Intersectoral Differentials in Korea

		Period				
		1964-83	1967-84	1964-86	1967-86	1969-86
Parameter	Sector					
	Aggregate					
Y_K		0.165	0.220	0.191	0.206	0.203
Y_L		0.030	0.031	0.023	0.029	0.029
	Exports					
G_K		0.398	0.456	0.337	0.331	0.317
G_L		0.023	0.022	0.026	0.026	0.027
	Non-Exports					
F_K		0.103	0.123	0.127	0.137	0.131
F_L		-	-	0.021	-	-
$1 + \delta_K$		3.86	3.70	2.65	2.42	2.42
$1 + \delta_L$		-	-	1.24	-	-

All estimated coefficients are statistically significant at the α=5% level, two-tailed, unless otherwise specified.

Consistent with the situation of labor surplus in Korea found by España (1990), all labor coefficients in the non-exports sector were statitiscally insignificant and are not reported here. The labor coefficient, F_L, for the period 1964-86 was computed indirectly, using the highly significant coefficients of the labor term in the aggregate and export specifications, Y_L, and G_L, respectively, as well as the sectoral output shares ΔN and ΔX:

$Y_L = (\Delta X/\Delta Y)G_L + (\Delta N/\Delta Y)F_L$ to give $F_L = [Y_L - (\Delta X/\Delta Y)G_L]\Delta N/\Delta Y$.

Aggregate as well as sectoral output and investment figures used for these estimations represent Billions of constant 1980 Korean Won.

Sources: Bank of Korea, National Bureau of Statistics of Korea.

These results provide evidence of substantial differentials in the marginal productivity of the primary factors between sectors, and these differentials are larger for capital than for labor. The estimates also reveal that the gap in factor productivity between the sectors has continuously narrowed in the case of capital while remaining relatively constant, but small, in the case of labor.

4.2. Intersectoral Externality Effects

In this section, we estimate the extent and direction of intersectoral externality effects. No restrictions are imposed on the direction(s) and magnitude(s) of externalities. Two types of approaches are taken: a direct and an indirect one, as explained below.

The direct approach consists of estimating F_X and G_N from (3.10) and (3.11), and the results indicate that the externality effects from exports on non-exports are between 7 and 3 times larger than in the opposite direction. This ratio is found to decline over time. However, there is a problem with this direct approach to the estimation of externalities. Even though the externality term itself turns out to be highly significant, its inclusion in the non-exports equation renders the factor input variables, capital and labor, statistically insignificant. For this reason, a two-step, indirect approach is adopted next. In the first stage, both sectoral equations (4.1) and (4.2) are estimated. Then, in a second stage, the residuals from (4.1) and (4.2) are regressed on the externality terms, $\dot{X}$ and $\dot{N}$,

(4.3) $e_N = C_N + F_X'\dot{X}$

(4.4) $e_X = C_X + G_N'\dot{N}$

The results are shown in table 4.2 below.

Table 4.2 Intersectoral Externalities. Two-Step Estimation

	Period				
Parameter	1964-80	1964-83	1967-84	1970-84	1972-86
F_X'	1.13	0.66	0.66	0.77	0.65
G_N'	0.10	0.17	0.20	0.20	0.17*
F_X'/G_X'	11.20	3.80	3.20	3.70	3.90

* Statistically not significant (α=5%, two-tailed).

The results of the two-step, indirect estimation confirm the results obtained through the direct procedure in terms of order of magnitude, evolution and relative importance of externalities between the sectors. Externalities from exports are found to be between 11 and 3 times larger than non-exports externalities, and this ratio is also found to decline over time.

Thus, the asymmetric relationship between the sectors consists of a faster growing, more productive and modem sector exerting a positive externality effect on the rest of the economy. These results suggest that there are gains to be made from expanding the external sector by reallocating resources from domestic to export production. These benefits, however, tend to decline over time. The gains from such a reallocation of resources are estimated below.

4.3 <u>Gains from Factor Reallocation</u>

The estimation of the static gains implied by a shift of resources between sectors is based on the previously estimated values of the productivity differentials (δ_K and δ_L), and linkage effects (F_X).

In our two-sector economy, Y = N + X, and differentiating with respect to time gives

(4.5) $$\dot{Y} = \dot{N} + \dot{X}$$

Substitution of (3.10) and (3.11) into (4.5) gives

(4.6) $$\dot{Y} = F_K I_N + F_L \dot{L}_N + (1+F_X)[G_K I_X + G_L \dot{L}_X + G_N \dot{N}]$$

Since $F_X > 3G_N$, and G_N is relatively small, for the remainder G_N is left out, i.e., set $G_N=0$.

Incorporating intersectoral productivity differentials, (4.6) can be written as

(4.7) $$\dot{Y} = F_K I_N + F_L \dot{L}_N + (1 + F_X)[(1+\delta_K)F_K I_X + (1+\delta_L)F_L \dot{L}_X]$$

Equation (4.7) can be reformulated into an expression that allows for the measurement of the effects on output of a reallocation of resources between sectors. Let $\lambda_K = I_X/I$ and $\lambda_L = \dot{L}_X/L$ denote the share of total investment and the share of the aggregate employment increase allocated to the exports sector, respectively. Then, (4.7) can be written as

(4.8) $$\dot{Y} = F_K(1-\lambda_K)I + F_L(1-\lambda_L)\dot{L} + (1+F_X)[(1+\delta_K)F_K\lambda_K I + (1+\delta_L)F_L\lambda_L\dot{L}]$$

Using (4.8), the impact of resource reallocation, represented here by changes in the sectoral factor shares, λ_K and λ_L, is obtained as

$$\frac{\partial \dot{Y}}{\partial \lambda_K} = F_K I\ [\delta_K + F_X(1+\delta_K)] \text{ and } \qquad \frac{\partial \dot{Y}}{\partial \lambda_L} = F_L \dot{L}\ [\delta_L + F_X(1+\delta_L)]$$

The gains from different types of resource reallocation for the period 1967-86 are estimated below.

a) Total Reallocation Gains.

Suppose all resources were allocated to the non-exports sector, i.e., $\lambda_K = \lambda_L = 0$. Then, in the absence of exports, the change in output would be given by (4.8), $\dot{Y}_1 = F_K I + F_L \dot{L} = 1694.11$. Contrasting this figure with the output change obtained by using in (4.8) the actual average shares of capital and labor over the period, $\lambda_K = 0.217$ and $\lambda_L = 0.356$ respectively, one can see that 33.9%, or roughly one third of the total increase in output over the period, $\dot{Y}_T = 2{,}563.35$, was due to the contribution of exports to structural change in the economy.

Next, we break down the total reallocation gains into the partial contributions of differentials in factor productivity and externality effects.

b) Reallocation Gains due to Productivity Differentials.

Using (4.7), the reallocation gains due to the intersectoral productivity differentials, δ_K and δ_L, are given by $\Delta\dot{Y}_\delta = [\delta_K F_K I + \delta_L F_L \dot{L}] = 378.29 + 40.00 = 418.29$.

As a percentage of the total output change,

$$\frac{\Delta\dot{Y}_\delta}{\dot{Y}_T} = 0.163 \mathrel{\hat{=}} 16.3\%$$

The contribution by factor inputs is given by

$$\Delta\dot{Y}_\delta^K = \frac{378.29}{418.29} \mathrel{\hat{=}} 14.8\% \quad \text{for capital}$$

$$\Delta\dot{Y}_\delta^L = \frac{40.00}{418.29} \mathrel{\hat{=}} 1.5\% \quad \text{for labor}$$

As can be seen from these figures, the reallocation gains due to productivity differentials originate almost exclusively in the higher productivity of capital in the exports sector.

c) Reallocation Gains due to Externality Effects.

These gains are given, using (4.7), by

$$\Delta\dot{Y}_{Ext} = F_X[(1+\delta_X)F_K I_X + (1+\delta_L)F_L \dot{L}_X] = 451.34, \qquad \text{and}$$

$$\frac{\Delta \dot{Y}Ext}{\dot{Y}T} = 0.1761 \hat{=} 17.61\%$$

Thus, roughly half the total reallocation gains of 33.9% is attributable to each productivity differentials and externality effects. The gains estimated above provide a rationale for a policy of exports promotion involving a massive reallocation of resources from domestic to export production in order to achieve higher rates of economic growth.

5. EXPORTS AND THE SUPPLY OF INPUTS

Besides contributing to economy-wide structural change, exports also play a crucial role in the provision of productive inputs. Some authors have also reported a special role of exports income in savings formation in LDCs. Thus, exports seem to play a crucial role in the alleviation of both internal and external disequilibria. In this chapter, we attempt to assess the role of exports in savings formation and in the provision of foreign exchange. We also try to determine the relative importance of internal and external imbalances for the evolution of output in Korea.

5.1 The Role of Exports in Savings Formation

A possible link between exports and growth might be the existence of a more than proportional contribution of exports income to savings formation as proposed by Maizel (1968) and Fajana (1979). España (1990) summarizes previous results and provides empirical evidence supporting this hypothesis in the Korean case.

In Korea, the increases in savings and investment rates, both measured as percentages of GDP, have been especially rapid, rising, from 11.7% to 44.1% and from 20.2% to 37.5%, respectively, over the period 1967-86, an evolution matched only by Taiwan in the developing world.

5.2 Impact of Internal and External Disequilibria on Growth

In this context it is of interest to determine whether Korean growth was savings- or foreign-exchange-constrained. The following analysis of the impact of internal and external disequilibria on growth is based on Bacha's (1984) reformulation of the conventional two-gap model. The notation used is as follows: u is the degree of capital utilization; b is the balance of payments as a proportion of potential output; a is the capital-output ratio; m_j is the intermediate goods coefficient; m_K is the capital goods import coefficient; s is the average propensity to save; f is the capital transfers to output ratio; e is the ratio of net exports to potential output; and g is the growth rate of potential output.

In the Meade-Swan tradition, equations can be derived to describe the internal and external balances. The economy is said to be in internal balance if actual output is equal to potential output, i.e. if u = 1. The external balance is defined by the condition of zero international reserves change, or b = 0. Under these equilibrium conditions, the growth rates that would have been achieved in the absence of internal or external disequilibrium are, respectively,

$$(5.3) \quad u = 1 \quad g_u = \frac{a}{1 - m_k}(m_j + s) - \frac{a}{1 - m_k}e$$

$$(5.4) \quad b = 0 \quad g_b = \frac{a \cdot s}{m_k \cdot s + m_j}e + \frac{a(m_j + s)}{m_k \cdot s + m_j}f$$

For given values of all right-hand variables in (5.3) and (5.4), growth is said to be savings constrained if $g_u \leq g_b$ and foreign exchange constrained if $g_b \leq g_u$.

Also, solving (5.3) for e (given that, in equilibrium, $g_u = g_b$) and substituting in (5.4) gives a Harrod-Domar expression for the equilibrium growth rate of potential output

$$(5.5) \qquad g_{equil} = a(s + f)$$

Equation (5.5) gives the equilibrium growth rate, i.e., the growth rate that would obtain if the economy were simultaneously constrained by savings and foreign exchange. It is the highest feasible growth rate given the constraints in the economy, assuming that exports are flexible so as to close to zero the difference between the gaps[1].

One can also obtain the equilibrium value of the exports share in GDP, e_{equil}, by equating (5.3) and (5.4) and solving for e,

[1] Three ways of closing the ex ante gap between g_u and g_b are mentioned by Bacha (1984): In the programming view, net exports are treated as a flexible policy intrument; in the structuralist view, exports are rigidly bound from above; finally, in the cost-of-adjustment view, exports are treated as a slowly adjusting variable, adapting themselves in the long run to the domestic capacity constraint.

(5.6) $e_{equil} = m_K s + m_j - f(1 - m_K)$

Applying equations (5.3) and (5.4) to the period 1967-86 in Korea[2], gives

$g_u = 10.7\%$ $g_b = 9.3\%$ $g_{equil} = 9.9\%$

Since $g_b \leq g_u$, one can conclude that growth in Korea was foreign-exchange constrained over the period. The equilibrium growth rate, g_{equil}, estimated above was 9.9%, whereas the actual compounded growth rate between 1967 and 1986 in Korea was 8.98%. Thus, the actual growth rate of output was relatively close to the rate that would have obtained if exports had been flexibly used as an instrument of growth policy.

Solving (5.6) for Korea, period 1967-86, gives $e_{equil} = 18.5\%$, while the actual value of e was e = 16.7%. Thus, the actual ratio of net exports to GDP, e, was close to the equilibrium value, e_{equil}. This evolution of exports seems to conform very closely to the programming view of the effectiveness of exports as a policy instrument.

In order to determine the dominant constraint at different points in time, (5.3) and (5.4) were computed for different subperiods. The results are shown in Table 5.1 and Figure 5.1, below.

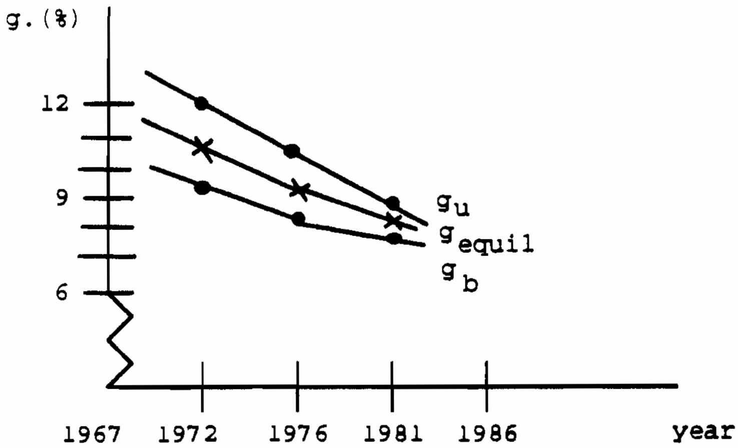
Table 5.1 Growth Constraints in Korea

Period	gu %	gb %	gequil %	(gu - gb) %	Binding Constraint
1967-76	12.1	9.3	10.5	2.8	Foreign Exch.
1972-81	10.9	8.5	9.5	2.3	Foreign Exch.
1977-86	8.8	8.2	8.4	0.6	Foreign Exch.

The values used here are Korean average ratios over the corresponding subperiods. These average ratios are calculated using actual instead of potential output data as the latter ones are not available.
Sources: Bank of Korea, National Bureau of Statistics of Korea.

[2] The values used in these calculations represent Korean averages over the period 1967-86. Actual instead of potential output data are used as the latter ones are not available. Sources: Korea Statistical Yearbook, Economic Statistics Yearbook of Korea.

Figure 5.1 Evolution of The Equilibrium Growth Rates in Korea



Clearly, the gap between the two gaps has been closing over time and the equilibrium growth rate has steadily declined. Referring to equation (5.5), $g_{equil} = a(s + f)$, the secular decline in the equilibrium growth rate is due to a decreasing output-capital ratio, a, and a diminishing ratio of foreign savings inflows, f. Undoubtedly, high levels of the equilibrium growth rate could not have been mantained in Korea had it not been for the rapid increase in the savings ratio.

Korean planners seem to have been successful in achieving close to optimal growth rates of output, apparently utilizing exports as a flexible instrument of economic policy. However, the secular decline in the equilibrium growth rate suggests that export-led growth is becoming less of a plausible route for the Korean economy in the future, thus confirming similar results obtained in chapters 2 and 4, above.

6. DYNAMIC SIMULATIONS

In order to predict the evolution of the economy over time we introduce dynamic models. Investment reacts swiftly to changes in the economic environment and for this reason accelerator features are introduced into the models to show how the effects of a shock to the system propagate over time. Two types of dynamic simulations are performed, on Korean data: the first one is based on the aggregate model and uses an optimal control approach to simulate the dynamic investment and output effects of an external shock. The second one is based on the two-sector model, and simulates the evolution of both sectoral and aggregate investment and output given different sectoral investment scenarios.

6.1 An Optimal Control Simulation of the Effects of an External Shock

This simulation is based on the aggregate model, and it makes use of an optimal control approach to the formulation of economic policy. The use of optimal control theory allows for the integration of econometric relations that have been estimated elsewhere with a policy optimizing framework that explicitly identifies some of the choices available to policy makers, see Klein and Su (1980) and Sengupta (1985).

This exercise simulates the effects on Korean growth of the second oil shock of 1979-1980. This external shock can best be appreciated in terms of the evolution of the internal and external gaps[3]. The investment-savings gap increased from 4.4% to 10.8% between 1978 and 1979, reaching the highest value since 1972. The foreign exchange gap had reached, by 1979, the highest level ever at roughly 6.6%. The volume of imports declined, for the first time since 1967, by 5.3%. GDP in 1980 showed the only ever documented decline, a contraction of 4.1%.

The econometric model used here has the following general form,

$$(6.1) \qquad f_i(Y'_t, Y'_{t-1}, Y'_{t-k}, \ldots, X'_t, Z'_t) = e_{it} \quad i=1,2,\ldots n$$

where Y'_t is a row vector with n target (i.e., endogeneous) variables, X'_t contains m exogeneous control (policy) variables, Z'_t denotes other non-control exogeneous variables, and e_{it} are

---

[3] Figures are given as percentages of GDP. The data used in these simulations are taken from Bank of Korea and National Bureau of Statistics of Korea.

random errors. The policy maker is assumed to minimize a loss function over the planning horizon, h, and the loss function, L, is assumed to be a quadratic function of the deviations of the endogeneous variables from their targeted levels, Y^*_t, and from the values of the control (policy) variables, X^*_t, that are used to steer the system towards the desired goals.

The loss function can be written in matrix notation as

(6.2) $$L = -[Y'WY + X'PX]$$

where W represents the weight attached to each objective, Y', and P are the penalties attached to the use of the control X'. Minimization of the loss function is achieved by differentiating with respect to the control variables to give

(6.3) $$X = -P^{-1}U'WY$$

where X is the set of optimal control variables and U' denotes the partial derivatives of each element of Y with respect ot each element of X.

The specific formulation used in our case is as follows

(6.4) $$\text{Min } L = E\{W(\dot{Y}_t - \dot{Y}^*_t)^2 + P(\dot{X}_t - \dot{X}^*_t)^2\}$$

(6.5) $$\text{s.t} \quad \dot{Y}_t = c + \hat{\alpha} I_t + \hat{\beta}\dot{L}_t + \hat{\gamma}\dot{X}_t + e_t$$

Substituting (6.5) into (6.4)

(6.6) $$\text{Min } L = E\{W(c + \hat{\alpha} I_t + \hat{\beta}\dot{L}_t + \hat{\gamma}\dot{X}_t + e_t - \dot{Y}^*_t)^2 + P(\dot{X}_t - \dot{X}^*_t)^2\}$$

Taking the expected value in (6.6), differentiating with respect to $\dot{X}_t$, and setting the derivatives equal to zero gives the optimal control policy

(6.7) $$\dot{X}'_t = \frac{1}{P + W\hat{\gamma}^2}[P\dot{X}^*_t + W\hat{\gamma}\dot{Y}^*_t - W\hat{\gamma}(c + \hat{\alpha} I + \hat{\beta}\dot{L}_t)]$$

The optimal path of $\dot{Y}_t$, $\dot{Y}'_t$, is obtained by substituting (6.7) into (6.5) to give

(6.8) $$\dot{Y}'_t = \frac{1}{P + W\hat{\gamma}^2}[W\hat{\gamma}^2\dot{Y}^*_t + P\hat{\gamma}\dot{X}^*_t + P(c + \hat{\alpha} I + \hat{\beta}\dot{L}_t)]$$

In this model, the dynamic effects of an external shock can be simulated by constraining the policy variables to reflect the more limited range of policy alternatives available as a result of the shock[4]. During the oil shock export expansion was bounded from above as proposed by the structuralist view. The parameters used in this simulation are those estimated for the aggregate model for the period 1964-86.

It is found that, in the case of Korea, the second oil shock led to a reduction of 3.2 percentage points in the annual growth rate during the post-shock period, 1980-86. The level of output and investment at the end of the period, i.e. in 1986, were, respectively, 21.0% and 23.2% lower than they would have been in the absence of external shocks.

6.2 A Dynamic Simulation of the Effects of Sectoral Investment Policy

As shown above, there are gains from reallocating resources across sectors. In this section, we estimate the growth differential associated with two different sectoral investment scenarios. The model used is a dynamic, sequential one, and it is based on the two-sector model previously developed and estimated for Korea. Accelerator features are incorporated, this time at the sectoral level[5].

The comparison is based on the effects of increasing investment in each sector by a fixed annual amount of 100 Billion of constant 1980 Korean Won. This corresponds to approximately 15% of the investment level in the non-exports sector in 1964. It is found that the exports promotion alternative results in a 36.7% higher level of output at the end of the period 1964-1986. On an annual basis, this amounts to an addition of 1.6 percentage points to the compounded growth rate of output over those years. These results seem to confirm our earlier finding indicating that export promotion leads to higher rates of economic growth than import substitution.

---

[4] The goodness-of fit of the model is assessed using Theil's (1966) inequality coefficient U. The computed values of U for the endogeneous variables are U_Y = 0.082 and U_I = 0.138.

[5] The computed values of U for the endogeneous variables are U_Y = 0.036, U_I =0.102, $U(I_N)$ =0.143, $U(I_X)$ = 0.303.

8. CONCLUSIONS

This paper analyzed the structural relation between exports and growth in a rapidly industrializing, developing economy. The general economic analysis was empirically applied to the case of South Korea.

The main contributions of exports to economic growth in LCDs fall into two categories:

1. The contribution of exports to economy-wide structural change. Growing faster than output, and specializing in manufactures, export expansion leads to a larger share of manufacturing in GDP. Given the higher productivity and more advanced technology level prevailing in manufacturing, aggregate productivity rises while at the same time externality effects from the exports/manufacturing sector on the rest of the economy increase.

The pace of change in the Korean economy has been very rapid since the adoption of the exports-oriented growth strategy in the early 1960's. For the period 1961-86, the growth rate of exports was 21.1%, almost three times the 8.5% growth rate of output. Manufacturing grew at a rate of 16.1%, more than twice the 7.3% growth rate of non-manufacturing. Over the period manufacturing's share in GDP increased fivefold from 5.6% to 29.8%, leading to an increase in the overall efficiency of the economy as aggregate productivity moved closer to the higher productivity levels prevailing in manufacturing. It is found that structural change, and the associated reallocation of resources between sectors, was responsible for one third of the growth rate of output in Korea over the period 1967-86. Higher marginal productivity and externality effects each accounted for about half the total gains obtained from reallocating resources to the exports sector. Capital was almost exclusively responsible for the reallocation gains associated with intersectoral productivity differentials. Different types of cointegration tests performed on the sectoral models confirm that these results indeed reflect structural (i.e. long-run) relationships. Over time, however, the benefits of continued resource reallocation decline as aggregate productivity rises and factor returns are equalized across sectors.

2. The contribution of exports income to the supply of productive inputs. Exports income seems to have a special impact on investment due to its higher than proportional contribution to

savings formation. Exports also provide foreign exchange needed for the purchase of non-competitive imports used as productive inputs. Evidence shows that, for the period 1967-86, Korean growth was foreign-exchange constrained. Receipts from exports became the most important source of foreign exchange during these years, and their contribution to Korean economic growth was significant. Korean planners seem to have adopted a "programming view" of export promotion, succesfully using exports as a flexible instrument of growth policy.

A dynamic simulation based on an optimal control approach is used to demonstrate the output effects of a foreign exchange shortage caused by a simultaneous fall in exports revenue and an increase in the price of non-competitive imports. It is found that, in the case of Korea, the second oil shock led to a reduction of 3.2 percentage points in the annual growth rate during the post-shock period, 1980-86. The level of output and investment at the end of the period, i.e. in 1986, were, respectively, 21.0% and 23.2% lower as a result of the shock. In another dynamic simulation, the two-sector model is applied to the Korean economy for the period 1964-1986, to show that a permanent reallocation of capital equivalent to 15% of the 1964 level of non-exports investment would result in a gain of 1.6 percentage points in the annual growth rate of output, and a 36.7% higher output level at the end of the period. These reallocation gains seem to provide a rationale for preferential treatment of investment in exports-oriented industries.

The empirical evidence provided in different parts of this study seems to indicate that policies aimed at the promotion of manufactured exports can lead to higher rates of economic growth in a developing economy. As could be expected, the results also show that the returns from this type of policies tend to decline over time as the asymmetries between sectors become less pronounced.

REFERENCES

Bacha, E.L. (1984), "Growth with Limited Supplies of Foreign Exchange: A Reapraisal of the Two-Gap Model," in M. Syrquin, L. Taylor, and L. Westphal, eds, "Economic Structure and Performance," pp.263-280.

Balassa, B. (1978), "Exports and Economic Growth. Further Evidence," *Journal of Development Economics*, 5, pp. 181-189.

Bank of Korea, several editions, *Economic Statistics Yearbook*, Seoul, Korea.

Bradford Jr., C.I. (1987), "Trade and Structural Change: NICs and Next-Tier NICs as Transitional Economies," *World Development*, vol.15, No.3, pp.299-316.

Chen, T.J. and D.P. Tang, (1987), "Comparing Technical Efficiency Between Import-Substitution-Oriented and Export-Oriented Foreign Firms in a Developing Country," *Journal of Development Economics*, 26, pp.277-289.

Directorate General of Budget of the Republic of China, several editions, *Statistical Yearbook of the Republic of China*, Accounting and Statistics, Executive Yuan, The Republic of China.

Economic Commission for Asia and the Far East, several editions, *Statistical Yearbook for Asia and the Far East*, United Nations, Bangkok, Thailand.

España, J.R. (1990), "Exports, Structural Change and Economic Growth. An Empirical Analysis with Applications to Korea. Unpublished Ph.D. Dissertation, University of California, Santa Barbara.

Fajana, O. (1979), "Trade and Growth: The Nigerian Experience," *World Development*, vol.7, No.1, pp.73-78.

Feder, G. (1982), "On Exports and Economic Growth," *Journal of Development Economics*, 12, pp.59-73.

Fosu, A.K. (1990), "Exports and Economic Growth: The African Case," *World Development*, vol. 18, No. 6, pp.831-835.

Granger, C.W.J. and R.F. Engle (1987), "Co-Integration and Error Correction: Representation, Estimation, and Testing," *Econometrica*, vol.55, No. 2, pp.251-276.

Kavoussi, R.M. (1984), "Export Expansion and Economic Growth. Further Empirical Evidence," *Journal of Development Economics*, 14, pp.241-250.

Klein, L.R. and V. Su (1980), "Recent Economic Fluctuations and Stabilization Policies: An Optimal Control Approach," in Klein, L.R. Nerlove, M., and S.C. Tsiang, eds., "Quantitative Economics and Development." New York: Academic Press, pp.225-254.

Maizels, A. (1968), "Exports and Economic Growth in Developing Countries." Cambridge: Harvard University Press.

Michaely, M. (1977), "Exports and Growth. An Empirical Investigation," *Journal of Development Economics*, 4, pp.49-53.

Michalopoulos, C., and K. Jay, (1973), "Growth of Exports and Income in the Developing World: A Neoclassical View," A.I.D., Discussion Paper No.28, Nov.

National Bureau of Statistics of Korea, several editions, *Korea Statistical Yearbook*, Economic Planning Board, Republic of Korea.

Ram, R. (1987), "Exports and Economic Growth in Developing Countries: Evidence from Time-Series and Cross-Section Data," *Economic Development and Cultural Change*, vol.36, No.1.

Rana, P.B. (1985), "Exports and Economic Growth in the Asian Region," Asian Development Bank Economic Staff Paper No.25, Febr.

Riedel, J. (1983), "Trade as the Engine of Growth in Developing Countries," World Bank Staff Working Papers, No.555.

Sengupta, J.K. (1985), "Information and Efficiency in Economic Decision." Boston: Martinus Nijhof Publishers.

Sengupta, J.K. and J.R. España (1991), Exports and Economic Growth in Asian NICs: an Econometric Analysis for Korea," *Economic Modelling*, forthcoming.

Statistics Bureau of Japan, several editions, *Japan Statistical Yearbook*, Management and Coordination, Tokyo, Japan.

Theil, H. (1966), "Applied Economic Forecasting." Chicago: Rand McNally and Company.

Tyler, W.G. (1981), "Growth and Export Expansion in Developing Countries," *Journal of Development Economics*, 9, pp.121-130.

United Nations, several editions, International Trade Statistics Yearbook, New York.

Whitmore, G.E. and M.C. Findley (1978), "Stochastic Dominance." Lexington, MA, Lexington Books.

Williamson, R.B. (1978), "The Role of Exports and Foreign Capital in Latin American Economic Growth," *Southern Economic Journal*, 45, No.2, 410-420, July.

APPENDIX: COINTEGRATION TESTS

Most econometric studies are based on the assumption of stationarity of the data processes involved despite the obvious non-stationarity of many of the series used. If a series is non-stationary, then its first and second moments are not time invariant. Regression involving such type of variables are likely to produce spurious results, in which case the co-movement of the variables does not reflect a structural or long-term relationship.

Consider two series X_t, Y_t each of which is I(1). In general, any linear combination of these two variables is also I(1). However, if there exists a constant A such that

$$Z_t = Y_t - AX_t$$

is I(0), then X_t, Y_t are said to be cointegrated with A called the cointegration parameter, reflecting a long-run or structural relationship. In other words, cointegration is a necessary condition for a pair of I(1) series to be linked by a structural or long-run relationship.

This appendix describes the different cointegration tests performed on both the aggregate and two-sector models, using different statistics. Granger and Engle (1987) suggested seven possible cointegration tests, among them the Co-integrating Regression Durbin Watson (CRDW) and the Dickey Fuller (DF) tests. In the case of the CRDW, after running the co-integrating regression, the Durbin Watson statistic is tested to see if the residuals appear stationary. If they are non-stationary, the Durbin Watson will approach zero and thus the test rejects non-cointegration (finds cointegration) if the DW is too big.

The DF tests the residuals of the co-integrating regression by running the following auxiliary regression,

$$\Delta e_t = de_{t-1} + u_t$$

Then the DF uses a test to determine whether or not d is zero or negative. The t statistic for d is then the DF statistic. If d is found statistically to be equal to zero or negative then the null hypothesis of non-cointegration is rejected.

The results of the cointegration tests performed on the aggregate and sectoral models for the period 1964-86 indicate that the estimated parameters do, indeed, reflect a long-term or structural relationship between the variables involved[6].

[6] The specific figures from the individual cointegration tests are available from the author upon request.