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Korean Exports Economic Growth: An Econometric Reassessment*

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Controversy has surrounded the role exports play in stimulating GNP growth. Some authors find causation from exports to GNP, while other have concluded that exports retard GNP growth. Still others find no causation or find bidirectional causation with the Sims' test but not with the Granger test. We employ annual data for a long time span (1953 to 1990) for Korea, enhancing the power of unit root tests. With these data we consistently find two-way exogeneity with the Sim's test under progressively longer lead and lag assumptions. Moreover, Granger causality tests also indicate two-way causation. Therefore, at least for institutional settings similar to Korea, considerable confidence can be placed in the hypothesis that export promoting policies will enhance growth prospects.

I. Introduction

One of the most controversial and longstanding topics in development economics has been the choice of a regime to promote and accompany rapid economic growth. Export promotion policies are employed as a central part of many development strategies. Recent literature raises questions about the potential of export promotion policies to stimulate growth. The issue is whether export growth leads to output growth, whether exports merely accompany growth (growth causing exports), whether no causal relation exists. A more complex model might posit additional channels of influence that cause both exports and output to be causally releated. As many developing countries have adopted export promotion, it is of interest to determine the existence and (if we can establish existence) the direction of causation between export and output growth. We

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address these issues for South Korea (hereafter Korea), although the techniques used to conduct our analysis are applicable in many other institutional settings.

Korea is argued to have made the transition from import substitution to export promotion following the Korean War (see Bhagwati (1978) and Krueger (1978) for a discussion of the Korean development phases, and see Holman and Graves (1992) for an alternative interpretation). Korea's growth rates reached their highest levels after the adoption of export promotion policies, and thus many authors have attributed Korea's success to its export policies (see Frank, Kim, and Westphal (1978) for a discussion of the dramatic growth in exports beginning in the early 1960s, changes in commodity composition-from primary to manufactured goods-of exports, and the pronounced growth of the Korean economy in the two post-Korean War decades).

The early approaches used in exploring the relationship between exports and output took the issue of causation for granted. Empirical analyses of export-led growth have ranged from non-parametric tests to cross-sectional regression analysis (see Balassa (1978), Balassa (1985), Heller and Porter (1978), Kavoussi (1984), Michaely (1977), and Tyler (1981)). More recently, time series studies of one or more specific countries have used progressively more sophisticated techiniques to address causation issues (see, for example, Chow (1987), Hsiao (1987), Jung and Marshall (1985), and Sung-Shen, Biswas, and Tribedy (1990)). As discussed in Sung-Shen, Biswas, and Tribedy (1990), hereafter SBT, technical weaknesses have flawed most analyses of the role of exports in stimulating growth. Partly as a consequence, various authours have concluded differently regarding the causative role of export promotion policies, a topic we will return to in our closing Section Ⅲ.

Section Ⅱ expands the seminal contribution of SBT for the case of Korea. This section begins with a subsection that discusses potential data sources and our reason for selecting a longer time span of annual observations rather than a shorter period of quarterly observations. We then empirically analyze the data selected employing a modification of the approach employed by SBT. Cointegration tests are applied and both Sim's exogeneity and Granger causality are examined without the use of arbitrary lag structures, as urged by SBT. Section Ⅲ concludes, offers caveats, and notes how the results compare with those of Chow (1987), Hsiao (1987), Jung and Marshall (1985), and SBT. In particular for the data and techniques employed here, the Sim's and Granger tests result in consistent conclusions, in contrast to Hsaio (1987). The

Hsiao study is the sole prior study to employ both tests in an analysis akin to that advocated here.

Ⅱ. Data and Empirical Evidence

Data

SBT employ Korean quarterly data form 1960:1 to 1984:4 obtained from the database of the International Monetary Fund, deseasonalizing with TSP-computer software. We have chosen to use annual data for exports and GNP from 1953 to 1990 (available for all years in hard-copy form from various issues of the International Monetary Fund's *International Financial Statistics*). We feel that these data are preferred, despite the possibility of poor quality early observations and the potential for structural change, for reasons well described by Campbell and Perron (1991, pp. 153):

> It turns out that for tests of the unit root hypothesis versus stationary alternatives the power depends very little on the number of observations per se but is rather influenced in an important way by the span of the data. For a given number of observations, the power is largest when the span is longest. For a given span, additional observations obtained using data sampled more frequently leads to only a marginal increase in power, the increase becoming negligible as the sampling interval is decreased... In most applications of interest, a data set containing fewer annual data over a long time period will lead to tests having higher power than if use was made of a data set containing more observations over a short time period. These results show that, whenever possible, tests of the unit root hypothesis shoud be performed using annual data over a long time period. This conclusion is reinforced by the fact that seasonal adjustment procedures often create a bias toward nonrejection of the unit root hypothesis...

The analysis is conducted with GNP rather than the more typically examined GDP due to data limitations, but these variables are effectively the same over the sample period (simple correlation = 0.99987). As most macroeconomic time series contain unit roots (see Neloson and Plosser (1982)), which make standard hypothesis testing of dubious value, Dickey-Fuller (1979) tests were performed on the log-transformed raw data. These tests suggest, not surprisingly, that nei-

Table 1

Nonstationary Trends of GNP and Exports
1953-1990

Equations	Dickey-Fuller t-statistics	Critical Values[a]
(1) $\Delta \ln Y_t = m + \gamma \ln Y_{t-1} + u_t$	-2.2818	-4.2324
(2) $\Delta \ln X_t = m + \gamma \ln X_{t-1} + v_t$	-0.0851	-4.2324
(1a) first difference of (1)	-4.5707	-4.2412
(2a) first difference of (2)	-3.3939[b]	-4.2412

[a] Critical values given are for the 1 percent level of significance.
[b] Dickey-Fuller t-statistic is significant at the 10 percent level.

ther exports nor GNP was trend stationary [see Table 1, equations (1) and (2)]. However, in eauations (1a) and (2a), both series were stationary in first-differences. Thus, all subsequent analysis was conducted on the first differenced series to eliminate spurious inferences.

In the empirical analysis that follows, we implicitly use a vector-

Table 2

Engle-Granger Cointergration Tests
Formulation of the Test Equation:[a]

$$\Delta u_t = \delta u_{t-1} + \sum_{j=1}^{m} \gamma_j \Delta u_{t-j} + \epsilon_t$$

Equations	Test Statistic (δ)	Critical Value [b]	Conclusion	Q-Stat[c]
$GNP_t = \beta_0 + \beta_1 Exports_t + u_t$	-1.1841	-3.29	not cointegrated	12.90
$Exports_t = \beta_0 + \beta_1 GNP_t + u_t$	-1.5378	-3.29	not cointegrated	12.23

[a] The lagged first-differences of the dependent varible are called augmented Dickey-Fuller terms. The number of these terms is chosen so that the residuals of the equation (ϵ) are not autocorrelated. One augmented Dickey-Fuller term was required in each of the tests conducted.
[b] This is Engle-Yoo (1991) critical value for 50 observation at the 5 percent significant level allowing for augemented Dickey-Fuller terms.
[c] The criticla value for the Q-test at the 10 percent significance level with 10 degrees of freedom is 15.59. Thus, in both cases, we can accpet the null hypothesis that the residuals of the test equation are not autocorrelated.

autoregression (VAR). If exports and GNP are not cointegrated, a VAR is appropriate. However, if exports and GNP are cointegrated, a VAR is misspecified and an error-correction model should be used instead. To guard against specification error, Engle-Granger (1991) cointegration tests were conducted, and the results are presented in Table 2.

First, GNP is regressed on a constant and exports. Ths residuals of this regression are then examined for stationarity. As can be seen in Table 2, the test indicates that GNP and exports are not cointegrated. A Q - test indicates that the residuals of the test equation do not exhibit autocorrelation as is required. Because the results of the Engle-Granger test often are sensitive to the normalization of the test equation, the results are verified by conducting the test under an alternative normalization. That is, exports are also regressed on a constant and GNP, and the residuals are examined for stationarity. The results in this case also indicate that exports and GNP are not cointegrated. Therfore, it is appropriate to use a VAR specification rather than an error-correction model in the subsequent empirical work.

Empirical Analysis

The central issue of causality between exports and GNP, despite the test chosen, is known (see, for example, Hsiao (1987)) to hinge critically on the data (as noted above), the functional form chosen, and on the econometric techniques applied. We have employed both the Sim's (1972) exogeneity test and the Granger (1969) causality test in an attempt to detect the existence and direction of causation between Korean exports and GNP. The Sims' test provides a practical method for determining unidirectional causation in a bivariate model. The functional forms used to conduct the Sim's test were:

$$(3) \qquad y_t = a + \sum_{i=-k}^{l} b_i x_{t-i} + e_t,$$

$$(4) \qquad x_t = c + \sum_{i=-k}^{l} d_i y_{t-i} + w_t,$$

where y_t denotes the first difference of the log of GNP, x_t denotes the first difference of the log of exports, i is the lagged period, l is the length of the lag variables -k is the length of the lead variables, a and c are constants, b_i and d_i are coefficients, and e_t and w_t are series of disturbances that follow all classical, normal assumptions. Sim's would argue that x is exogenous to (or causes) y, if the coeffients of the lead values of x in equation (3) are not jointly significantly different from zero. Similarly, y is exogenous to x, if the coefficients on the lead

Table 3

Results of Sims' Test
Dependent Variable = GNP Growth (Eq. 3)
(t-statistics in parentheses)

b(-5)	b(-4)	b(-3)	b(-2)	b(-1)	b(0)	b(1)	b(2)	b(3)	b(4)	b(5)	C	n	F*	R^2	Conclusion
				-.0644	.0709	.0075					.0904	34	1.134	.1270	X is exogenous to Y.
				(-1.07)	(1.14)	(.128)					(4.26)				
			.0159	-.1088	.1291	-.0473	.1039				.0783	32	1.155	.2239	X is exogenous to Y.
			(.232)	(-1.37)	(1.63)	(-.657)	(.060)				(3.01)				
		-.0801	0.576	-.1445	.1475	-.0300	.0844	.0462			.0805	30	.8838	.2738	X is exogenous to Y.
		(-.815)	(.581)	(-1.46)	(1.37)	(-.345)	(1.08)	(.671)			(2.24)				
	.1171	-.1174	0.532	-1.572	.1107	-.0189	.0657	.0776	-.0693		.0903	28	.6078	.3391	X is exogenous to Y.
	(.947)	(-.879)	(.428)	(-1.22)	(.938)	(-1.63)	(.631)	(.863)	(-924)		(1.99)				
-.384	.1265	-.0543	0.447	-.1525	.1026	-.0124	.0801	.1137	-0.723	.0377	.0541	26	.3145	.4101	X is exogenous to Y.
(-.283)	(.914)	(-.363)	(.279)	(-1.04)	(.741)	(-.093)	(.604)	(1.03)	(-.789)	(.477)	(.946)				

Table 4

Results of Sims' Test
Dependent Variable = Export Growth (Eq. 4)
(t-statistics in parentheses)

b(-5)	b(-4)	b(-3)	b(-2)	b(-1)	b(0)	b(1)	b(2)	b(3)	b(4)	b(5)	C	n	F*	R^2	Conclusion
				.1575	.4565	-.5932					.1900	34	.0631	.2885	X is exogenous to X.
				(.248)	(.747)	(-.964)					(1.29)				
			.7779	.3797	.6806	-.4267	.1227				.0606	32	.0170	.3166	X is exogenous to X.
			(1.12)	(.570)	(1.00)	(-.646)	(.186)				(.274)				
		.8967	.5452	.4821	.5412	-.3422	-.2132	.0762			.0468	30	.7073	.3854	X is exogenous to X.
		(1.25)	(.797)	(.718)	(.833)	(-.519)	(-.300)	(.097)			(.173)				
	-.1909	.7877	.3988	.3597	.4236	.3597	.3988	.7877	-.1909		.1581	28	.3629	.3201	X is exogenous to X.
	(-.237)	(.979)	(.455)	(.444)	(.544)	(.444)	(.455)	(.979)	(-.237)		(.432)				
.5384	.1363	.5844	.5267	-.0176	1.120	-1.026	.0926	-.2206	.2088	-1.153	.1769	26	.2255	.3604	X is exogenous to X.
(609)	(.149)	(.598)	(.555)	(-.017)	(1.00)	(-.913)	(.084)	(-.204)	(.199)	(-1.06)	(.487)				

values of y in equation (4) are jointly insignificant. A bidirectional relationship is said to exist between x and y, if it found that x is exogenous to y and y is exogenous to x. There is no causal relation between x and y, if the lead values in both equations (3) and (4) are significantly differnet from zero.

Initailly, OLS was used to estimate equations (3) and (4). The Durbin-watson statistics for these regressions showed substantial autocorrelation among the disturbance terms. Thus, the Cochrane -Orcutt iterative procedure was employed. The results of the Sims' test for exogeneity are presented in Tables 3 and 4. We have attempted to address SBT's criticism of previous work with the Sim's test in which the number of leads and lags was arbitrarity specified. As is apparent in Tables 3 and 4, the results of the Sims' text do not, in this case, depend on the (arbitrary) lead/lag structure. For all leads and lags, exports are exogenous to GNP, since future values of exports are not jointly significant in explaining changes in GNP, with F-statistics well below the critical values for typical levels of confidence. Additionally, the Sims' test indicated that GNP is exogenous to exports. Thus, according to the Sims' test, there is feedback or bidirectional causality between Korean exports and GNP, a result consistent with Hsiao (1987).

The Granger test provides an alternative method for detecting statistical causality. The functional forms employed in the Granger test were.:

$$(5) \qquad y_t = a + \sum_{j=1}^{J^*} b_j y_{t-j} + \sum_{i=1}^{I^*} d_i x_{t-i} + e_t,$$

$$(6) \qquad x_t = c + \sum_{j=1}^{J^{**}} b_j y_{t-j} + \sum_{i=1}^{I^{**}} d_i y_{t-i} + w_t,$$

where y_t, x_t, a, c, e_t, and w_t are as defined in equations (3) and (4). Following SBT, we have used Hsiao's (1979 and 1981) method for determining the otimal lag structure in the above equations using the minimum final prediction error (FPE) criterion. J* and I* indicate the otimal lags of y and x respectively in equation (5). Similarly, J** and I** denote the optimal lags on x and y in equation (6). The appropraite null hypotheses for the Granger test are (a) $d_i = 0$ for all $i = 1, 2, \ldots, I^*$ and (b) $d_i = 0$ for all $i = 1, 2, \ldots, I^{**}$. Instead of employing the conventional F-tests to test hypotheses (a) and (b), we have followed SBT in adopting the F-test implied in Hsiao's minimum FPE criterion (see SBT pp. 51-3 for a discussion of how FPEs are calculated and how hypothesis testing was conducted.)

As seen in Table 5, with GNP as the dependent variable, the FPE_y is minimized when only one lag of GNP is employed; using that lag

for GNP, the otimal lag for exports was also found to be one. With exports on the left hand side, three lags of exports minimized the FPE_x in the first stage -- using these lags, the FPE_x was minimized with only one lag of GNP. These results differ a bit from SBT who find a shorter lag structure, although their use of quarterly data renders comparison difficult.

Table 5

Final Prediction Errors

Lag of y (I=0)	$FPE_y \cdot 10^2$	Lag of x (J* = 1)	$FPE_y \cdot 10^2$
1	.3810[a]	1	.3796[a]
2	.3957	2	.4027
3	.4329	3	.4174
4	.4663	4	.4421
5	.4683	5	.4395
Lag of x (I=0)	**$FPE_y \cdot 10^2$**	**Lag of y (J* = 3)**	**$FPE_y \cdot 10^2$**
1	5.063	1	3.264[n]
2	4.461	2	3.362
3	3.398[n]	3	3.278
4	3.574	4	3.556
5	3.890	5	3.882

[a]Minimum FPE.

A Granger causality test was then conducted on the equations incorporating the optimal lag structure as described above. The results are shown in Table 6 where it is seen that there is two-way causation, a conclusion consistent with both the Sims' test conducted by Chow (1987) and with the tests of SBT. Confidence in two-way causation is blostered by the results of Engle-Granger cointegration tests which showed that both specifications used in the Granger causality test were cointegrated at the 1 percent level of significance. This is an important finding, novel in the present context, in that conventional inference procedures are valid in this case.

The finding of two-way causation is, however, counter to both Jung and Marshall (1985) and Hsiao (1987), the latter noting (p. 143) that the "Sims' test indicates a feedback relationship while Granger's

test indicates no causal relation between exports and GDP… " Hence, while we find that past values of exports do appear to cause current GNP, Hsiao (p. 150) concludes that "the hypothesis of export oriented growth policy in the Asian NICs is not supported by the empirical results from Granger's test." This important difference in finding could stem, in part, from the smaller span of the data and/or the smaller sample size (n = 36 here versus Hsiao's 20) or from Hsiao's use of an arbitary lag structure rather than choosing the lag structure according to the minimum FPE criterion, the latter two possibilities suggested by SBT (p.58).

Table 6

Estimated Coefficients of Equations (5) and (6)
(t-statistics in parentheses)

Dep. Var.	y_{t-1}	x_{t-1}	x_{t-2}	x_{t-3}	C	n	R^2	D-W	Direction of Causality
y	.1836	.0509			.0690	36	.1205	1.99	x causes y.
	(1.11)	(1.42)			(3.88)				
x	-.8787	.8256	-.5510	.3834	.0578	34	.5546	2.06	y causes x.
	(-1.74)	(5.56)	(-3.42)	(3.44)	(2.81)				

Ⅲ. Conclusions

We have empirically analyzed with modern time series techniques a substantially longer span of time (1953-1990) than have prior contributions, adding to the power of unit root tests. The Sims' test of exogeneity was found, under progressively longer lead and lag assumptions, to show consistently a feedback relationship between Korean exports and GNP. That is, while Korean GNP growth causes exports to increase, it also appears that policies that increase exports will also cause GNP to increase, at least in the Korean setting. The optimal lag structure was determined by minimizing the FPE. Using this lag structure, a Granger causality test also indicated two-way causation.

It is, of course, possible that Korean export promotion policies were not responsible for much of the observed changes in exports and it remains possible that observed changes in exports were not responsible for GNP growth, since other influences in a more complicated model might be causing both export growth and GNP

growth. Any such influences might not be present in other such institutional settings. Therefore, attempts to draw parallells between the Korean experience and that of other developing countries, say those of Eastern Europe, must be conducted with great caution.

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