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# OUTPUT GROWTH AND VARIABILITY OF EXPORT AND IMPORT GROWTH: INTERNATIONAL EVIDENCE FROM GRANGER CAUSALITY TESTS

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## INTRODUCTION

Economic development was from the very beginning the focus of classical political economy and presently retains its original human welfare mission and intellectual attraction through insightful anthropological, sociological, and historical investigations.[1] Within the context of complex and constantly evolving sociospheres, the objective of a sustained better life for the masses is enhanced, according to Nobel Prize winner Amartya K. Sen (1983, 1988), by functionings and entitlements which cannot be implemented without a public commitment and a deep government involvement.

Notwithstanding the inevitability of semantical differences, the real challenge of development does not lie in eliminating definitional disputes pertaining to the objective of development but in illuminating those pertinent instrumental relations which are relevant in each social milieu, and which, when properly activated, generate an internal development dynamic. Such a dynamic would exhibit characteristics of uniformity in countries with high degrees of similarity in human and natural resources, in institutions and in individual preferences. If advanced industrial countries converge toward similar patterns, the same cannot be observed in developing countries whose differences are more pronounced than their similarities. The task of establishing meaningful patterns of uniformity in the highly differentiated developing world is not easy, but if accomplished, it would guarantee substantial benefits in the formulation of effective strategies and policies.

An area in which the search for such patterns goes on unabated is that of international trade and openness. Forces of dependence, autarky, balance of payments, international competition, vulnerability to external shocks affect the objective of

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[1] See Lewis (1984).

developing countries to achieve some degree of balanced growth,[2] and most certainly influence their patterns of trade. Although these forces are important, they are beyond the scope of this paper, which focuses on the investigation of possible trade patterns and their impact on growth.

In the course of this investigation the paper is organized as follows. In the next section the role of openness is examined along with citations of empirical studies that analyze the impact of export growth and export growth volatility on the growth of GNP. In the third section the rationale of Granger causality, which constitutes the core of the paper, is presented, followed by short sections on unit root tests, cointegration tests, and volatility tests that are accompanied by a brief analysis of the respective statistical results. In the final section the conclusions of the paper are summarized.

## I. OPENNESS AND DEVELOPMENT

The degree of openness varies among countries depending on such factors as economic size, resource endowments, access to modern technology, and balance of payments policies. The large demand for imports in developing countries does not become satisfied fully due to limited export growth, and because foreign exchange earnings from merchandise exports are used to finance both merchandise imports and international services. Therefore the statistical relationship between merchandise exports and imports may not be very close, and may be further influenced by international loans, credit, and grants which often translate into imports of raw materials and machinery that are needed for development purposes. These facts may be significant in showing whether economic development is affected by openness as measured by exports or imports.

For causality analysis it is necessary to investigate the cointegration properties of exports and imports, but for less demanding approaches, under the implicit assumption that imports depend on exports, the empirical studies concentrate on exports and quantify the productivity benefits derived from their growth.[3] Keesing (1967), Bhagwati (1978), Krueger (1978), Chenery and Strout (1966), and Scitovsky (1954) have pointed out with different degrees of emphasis that these benefits from exports are derived (a) from the necessity of adopting the most advanced new concepts and methods of production as a means of surviving in the harsh international competitive environment, (b) from economies of scale that overcome the small size of domestic markets, (c) from the removal of foreign exchange constraints through which imports essential to development are financed, and (d) from positive externalities, mainly pecuniary, that promote industrialization.

[2] See Hirschman (1958) for the rationale of unbalanced growth, and Scitovsky (1959) for an analysis of the trend toward balanced growth.

[3] Kaldor (1967) suggested that causality runs from GDP growth to exports, rather than vice versa, due to the positive impact of GDP productivity growth on per unit cost reduction of tradables whose international competitiveness is thus improved.

Studies of the impact of export growth on GDP growth cover a wide spectrum, ranging from ordinary regression analyses to Granger causality tests. As more data became available more countries were sampled and the tests extended over longer periods of time. A chronological anthology of research in this area includes works by Jung and Marshall (1985), Chow (1987), Kunst and Marin (1989), Sharma, Norris, and Cheung (1991), Bahamni-Oskooee, Mohtadi, and Shebsigh (1991), Afxentiou and Serletis (1992), Sharma and Dhakal (1992). Departing somewhat from the conceptual framework of these works, Dollar (1992) observed that per capita GDP growth was enhanced by outward-orientation represented by an index based on real exchange distortion and variability; his conclusion is in essence neoclassical and points toward the benefits derived from trade liberalization, devaluation of the real exchange rate, and the maintenance of stable real exchange rates. Concentrating on industrialization, instead of GDP, and letting prices reflect true scarcities, Clark (1997) also found that developing countries were more successful when they adopted free outward-oriented trade policies compared with price-distorting import-substitution policies.

In contrast to the probable long-term relation derived from regressing export trends on GDP trends, interest in the rather short-term impact of export instability on GDP growth led to a different type of empirical studies. In principle export instability, represented by instability of export earnings, that results from either volume or price volatility, can have negative or positive repercussions on GDP growth. On the negative side, it is hypothesized that export instability increases uncertainty, exerts a detrimental impact on private investment decisions, and adversely affects the efficiency of capital. Due to the close dependence of imports on export earnings, instability in the latter causes instability in the former which amounts to disruptions in both private development expenditure and in public investment owing to the government tax revenue and export-import nexus.[4] On the positive side, the beneficial effects[5] are based on Friedman's permanent income hypothesis or the precautionary motive for saving, whereby in the first case, deviations of export revenues from their trend lead to savings in the form of transitory income, while in the second case, saving rates increase in response to increased uncertainty, so that both cases lead to higher investment rates, which in turn promote GDP growth.[6] When both negative and positive repercussions are scrutinized under the

[4] Export instability may also deprive developing countries of valuable imports by forcing them to hold excessive foreign exchange reserves as they cope with risk management operations. See Lim (1976).

[5] See MacBean (1966).

[6] Little credence should be given to the positive relation between export instability and increased investment in developing countries. Instability in these countries is likely to induce hoarding or capital flight rather than investment, and to cause price confusion that undermines the rates of return to capital. See Dawe (1996).

prevalent structural and institutional realities of underdevelopment, the beneficial effects appear to be rather insignificant or unlikely due to the adverse effects of export earnings shocks.

In principle, then, the expected negative impact of export instability on GDP growth becomes an issue of determining how developing countries faced with numerous rigidities deal with shocks, whether external or internal.[7] Prima facie evidence since the 1970s suggests that the more flexible NICs (newly industrializing countries) were more successful than other developing countries in extricating themselves from the external oil shocks. Even though these are open economies, the flexibility they acquired in their industrialization process rather than their export orientation per se enabled them to overcome the external shocks.[8] If developing countries are shaken by shocks, the reason must be rather sought in the rigidity of their economic structure that is riddled with bottlenecks, slow transmission of information, high risks, and traditionally low resource mobility than in their openness and the volatility of their exports. The matter is not settled when export volatility is considered to exert an impact on GDP growth, until a definitive measure of volatility itself is adopted. Which volatility index captures the totality of export fluctuations remains a controversial issue. Variability in the indices used may be another reason for the ambiguity of statistical results in addition to the ambiguity that originates in the basic weakness of the assumption that export growth is a reliable indicator of GDP growth.[9]

By and large there is stronger evidence for a negative than a positive relationship between export instability and GDP growth. Some of the contradictory results can be attributed to sample differences, while others arise from differences in econometric modeling. For example, the difference between the results of Gyimah-Brempong (1991), who found that export variability exerted a significant and negative impact on the growth of twenty-three sub-Saharan African countries, and those of Fosu (1992) who found that the same negative relation was statistically not significant for thirty-five African countries and much weaker for a subsample of thirty sub-Saharan countries is due to modeling differences. An example of contradictory results due to sample coverage is provided by Moran (1983) who found that the growth of countries sampled from 1954 to 1975 was not affected by export instabil-

7 Internal shocks, in the case of export instability, result from lower export volumes largely due to poor domestic harvests, whereas external shocks result, to a greater extent, from declines in export international prices, and to a lesser extent from decreases in the demand volume of exports.

8 Flexibility as a qualitative characterization defies accurate measurement, and in its place such proxy variables as export ratios are employed in empirical work. As indicated earlier, however, export ratios are not necessarily representative of development which in large and resource-rich countries may depend mostly on domestic rather than on external forces.

9 For an early development of a volatility index see Glezakos (1973); for a list of the most commonly used indices in empirical studies see Moran (1983).

ity. Although for the subperiod 1954–65 he observed a statistically significant negative relation, he found no relation for the subperiod 1966–75. Dawe (1996) reported that (a) export instability exerted a negative impact on the growth of eighty-five countries, and (b) export instability and investment were positively related; the latter relation did not affect his overall results probably because of the low correlation between investment and growth or because investment is primarily determined by factors other than export revenue volatility. Love (1992) also found a negative relation between export instability and income instability in a causality analysis of twenty developing countries.

Researchers investigated another aspect of instability manifested by changes in the terms of trade and their influence on GDP. Using squared deviations from a time trend as a proxy for terms of trade, Basu and McLeod (1991) showed that terms of trade shocks and variability reduced economic growth in eleven Latin American countries and the Philippines and explained up to 50 per cent of the long-term variation in GDP levels in ten of the twelve sampled countries. Similarly, using standard deviations of first differences as a proxy for terms of trade instability, Van Wincoop (1992) found that in a multi-varied cross-country regression analysis of eighty-one countries from 1968 to 1988, the increased uncertainty in the terms of trade caused significant withdrawals of labor from risky tradable sectors and thus affected negatively output growth.

An inference derived from theoretical reasoning and empirical findings is that shocks—whether external or internal—are more likely than not to exert a negative than positive impact on GDP growth. Understanding the mechanisms of causality in any relation is a prerequisite to minimizing the risks inherent to these shocks which are liable to hinder the development process. Countries are at different development stages and have different structural and institutional characteristics resulting in different degrees of flexibility that enable them to cope in their own individual manner with the different kinds of shocks to which they are exposed. In such a variable environment, common patterns of economic behavior may to be highly predictable, but cannot be excluded in advance. If the relation between export growth and GDP growth were to be statistically verified, economic problems could be more readily addressed by policy makers. This study was undertaken to examine these aspects.

## II. STATISTICAL APPROACH OF STUDY

A time-series analysis was employed in this study covering a sample of fifty developing countries over the period 1970 to 1993, namely, fifteen countries from sub-Saharan Africa, three from South Asia, six from East Asia and the Pacific, nineteen from Latin America and Caribbean, and seven from the Middle East and North Africa. All the countries with continuous annual data pertaining to GNP, merchandise exports and imports were included in the sample. Data were extracted from various World Bank World Tables, especially from World Tables 1994, which incorporate and update several revisions of earlier years. All the data expressed in U.S. dollars represent as far as possible constant rather than nominal values, and owing to the development nature of the paper they were converted to per capita terms when needed.

Our objective was to examine possible causality relations between the growth of GNP and exports, as well as between that of GNP and imports. In the latter case, imports were considered to take into account private foreign inflows of direct or portfolio investment and commercial bank lending as well as foreign official assistance from governments or international institutions, which together enhance development efforts in addition to the contribution made by foreign exchange earnings from exports.[10] The statistical properties of data pertaining to the three variables must be checked for stationarity through unit root tests, and for cointegration in order to examine long-term equilibrium relations and ensure that the causality tests do not produce spurious results. When the series are cointegrated, the causality tests must be carried out in first differences with an error correction term included, in contrast to non-cointegrated series which require that causality tests be conducted in first differences without the error correction term. In addition to causality tests, volatility models that display the impact of fluctuations in the variables were used to shed some light on the importance of variability of the time series.

A description and a justification of these statistical procedures are briefly provided.

## III. UNIT ROOT TESTS

Whether economic time series have a unit root or not has important implications in empirical work, for estimation and hypothesis testing, both of which rely on asymptotic distribution theory. It has been recognized, for example, that inappropriate detrending of integrated processes produces spurious variation in the detrending series (at low frequencies), while inappropriate differencing of trending processes produces spurious variation in the differenced series (at high frequencies). Hence, in order to determine the appropriate form in which the Granger causality tests will be carried out, the time series properties of the data must first be investigated.

[10] The unwillingness of commercial banks and multinationals to invest or lend funds to developing countries after the early 1980s debt crisis was gradually overcome by the improvement of world economic conditions. Foreign indebtedness problems, especially of low-income countries, still remain, and are periodically aggravated by crises. The impact of these crises has been until now restricted to one region or another with less severe repercussions on the rest of the world. The original pessimism from the recent Asian crisis appears to have been exaggerated, and there is no reason to believe that another crisis is likely to engulf the entire world.

The literature on unit root testing is vast.[11] Here we tested for unit roots using three alternative procedures to deal with anomalies that arise when the data do not provide information about the existence of a unit root. In particular in Table I, we report *p*-values for the augmented "weighted symmetric" (WS) unit root test,[12] the augmented Dickey-Fuller (ADF) test,[13] and the nonparametric, $Z(t_{\hat{\alpha}})$, test of Phillips (1987) and Phillips and Perron (1988). These *p*-values (calculated using TSP 4.3) are based on the response surface estimates given by MacKinnon (1994). For the WS and ADF tests, the optimal lag length was adopted in the order selected by the Akaike information criterion (AIC) plus 2.[14] The $Z(t_{\hat{\alpha}})$ test was performed with the same Dickey-Fuller regression variables, without the use of augmenting lags. Based on the *p*-values for the WS, ADF, and $Z(t_{\hat{\alpha}})$ test statistics reported in Table I, the null hypothesis of a unit root in logged per capita levels cannot in general be rejected. This is consistent with the Nelson and Plosser (1982) argument that most of the macroeconomic time series have a stochastic trend. Since the series are integrated of order one or $I(1)$ in the terminology of Engle and Granger (1987), and their first differences are stationary, we proceeded to the next step and tested for cointegration in order to determine the form in which causality tests will be carried out.

## IV. COINTEGRATION TESTS

Cointegration aims at dealing explicitly with the analysis of the relationship between nonstationary time series. In particular, it allows individual time series to be integrated of order one or $I(1)$ in the terminology of Engle and Granger (1987), but requires that a linear combination of these series be $I(0)$. Therefore, the basic concept of cointegration is to search for linear combinations of individually nonstationary time series that are themselves stationary.

Several methods have been proposed in the literature for testing for cointegration.[15] In Table II, we list the *p*-values of the most frequently used Engle and Granger (1987) cointegration test, for two systems—(GNP, exports) and (GNP, imports). The test involves regressing one variable on the other to obtain the ordinary least squares (OLS) residuals $\hat{e}$. A test of the null hypothesis of no cointegration is based on testing for a unit root in the regression residuals $\hat{e}$ using the ADF test and simulated critical values which correctly take into account the number of variables in the cointegrating regression.

11 See Campbell and Perron (1991) and Stock (1994) for selective surveys, and Enders (1995, Chap. 4) for a textbook treatment.

12 See Pantula et al. (1994).

13 See Dickey and Fuller (1981).

14 See Pantula et al. (1994) for details regarding the advantages of this rule for choosing the number of augmenting lags.

15 See, for example Gonzalo (1994).

TABLE I

UNIT ROOT TEST RESULTS IN LOGGED PER CAPITA LEVELS

| Country | GNP | | | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|---|---|
| | WS | ADF | $Z(t_{\hat{\alpha}})$ | WS | ADF | $Z(t_{\hat{\alpha}})$ | WS | ADF | $Z(t_{\hat{\alpha}})$ |
| Sub-Saharan Africa | | | | | | | | | |
| Cameroon | .999 | .598 | .999 | .996 | .192 | .997 | .932 | .904 | .997 |
| Congo | .650 | .984 | .439 | .564 | .999 | .437 | .983 | .596 | .946 |
| Côte d'Ivoire | .980 | .032 | .987 | .890 | .029 | .981 | .826 | .000 | .978 |
| Ghana | .579 | .000 | .926 | .311 | .879 | .943 | .723 | .971 | .864 |
| Kenya | .999 | .326 | .992 | .862 | .000 | .934 | .901 | .000 | .973 |
| Madagascar | .920 | .003 | .969 | .902 | .000 | .968 | .758 | .003 | .924 |
| Malawi | .982 | .075 | .853 | .998 | .703 | .534 | .569 | .767 | .277 |
| Mali | .850 | .157 | .972 | .914 | .926 | .832 | .962 | .966 | .866 |
| Mauritius | .984 | .169 | .912 | .389 | .798 | .899 | .515 | .810 | .914 |
| Nigeria | .857 | .665 | .971 | .962 | .155 | .902 | .305 | .916 | .946 |
| Senegal | .771 | .001 | .956 | .866 | .041 | .648 | .944 | .923 | .925 |
| South Africa | .948 | .319 | .950 | .977 | .000 | .962 | .900 | .744 | .935 |
| Tanzania | .382 | .665 | .997 | .926 | .031 | .847 | .938 | .379 | .880 |
| Zambia | .623 | .007 | .942 | .071 | .955 | .711 | .059 | .539 | .801 |
| Zimbabwe | .993 | .000 | .987 | .952 | .000 | .936 | .861 | .000 | .930 |
| South Asia | | | | | | | | | |
| India | .991 | .982 | .999 | .956 | .019 | .870 | .960 | .118 | .991 |
| Pakistan | .986 | .921 | .797 | .267 | .953 | .225 | .960 | .271 | .797 |
| Sri Lanka | .749 | .912 | .883 | .655 | .658 | .704 | .700 | .034 | .875 |
| East Asia and Pacific | | | | | | | | | |
| China | .688 | .397 | .863 | .723 | .568 | .891 | .827 | .040 | .877 |
| Indonesia | .996 | .608 | .975 | .962 | .201 | .923 | .991 | .000 | .943 |
| Korea, Rep. | .910 | .000 | .979 | .997 | .000 | .926 | .977 | .044 | .983 |
| Malaysia | .997 | .034 | .965 | .825 | .445 | .924 | .848 | .469 | .951 |
| Philippines | .981 | .042 | .971 | .339 | .000 | .770 | .802 | .523 | .928 |
| Thailand | .981 | .015 | .941 | .762 | .972 | .884 | .432 | .309 | .879 |
| Latin America and Caribbean | | | | | | | | | |
| Argentina | .689 | .023 | .797 | .893 | .840 | .934 | .625 | .008 | .881 |
| Barbados | .999 | .388 | .999 | .779 | .742 | .396 | .969 | .999 | .997 |
| Bolivia | .985 | .225 | .938 | .869 | .659 | .970 | .669 | .307 | .912 |
| Brazil | .994 | .281 | .946 | .997 | .233 | .964 | .928 | .476 | .856 |
| Chile | .213 | .000 | .968 | .312 | .000 | .666 | .307 | .566 | .944 |
| Colombia | .995 | .193 | .989 | .861 | .816 | .973 | .626 | .670 | .927 |
| Costa Rica | .898 | .000 | .937 | .675 | .000 | .941 | .774 | .673 | .897 |
| Ecuador | .974 | .696 | .978 | .975 | .018 | .930 | .944 | .738 | .952 |
| El Salvador | .994 | .431 | .864 | .689 | .107 | .946 | .661 | .110 | .851 |
| Guatemala | .939 | .006 | .976 | .939 | .000 | .966 | .855 | .026 | .911 |
| Honduras | .993 | .999 | .999 | .948 | .134 | .992 | .869 | .000 | .974 |
| Jamaica | .536 | .690 | .862 | .653 | .583 | .929 | .158 | .940 | .868 |
| Mexico | .941 | .493 | .917 | .984 | .897 | .973 | .575 | .000 | .912 |
| Nicaragua | .907 | .999 | .986 | .939 | .115 | .926 | .989 | .081 | .852 |
| Paraguay | .962 | .008 | .969 | .946 | .576 | .983 | .848 | .189 | .968 |
| Peru | .851 | .669 | .838 | .523 | .003 | .217 | .225 | .195 | .151 |

TABLE I (Continued)

| Country | GNP | | | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|---|---|
| | WS | ADF | $Z(t_{\hat{\alpha}})$ | WS | ADF | $Z(t_{\hat{\alpha}})$ | WS | ADF | $Z(t_{\hat{\alpha}})$ |
| Trinidad & Tobago | .969 | .988 | .989 | .936 | .896 | .955 | .870 | .535 | .898 |
| Uruguay | .936 | .701 | .941 | .887 | .796 | .973 | .766 | .516 | .946 |
| Venezuela | .922 | .003 | .984 | .847 | .348 | .948 | .933 | .829 | .945 |
| Middle East and North Africa | | | | | | | | | |
| Algeria | .998 | .000 | .999 | .904 | .491 | .982 | .917 | .133 | .959 |
| Egypt | .995 | .999 | .999 | .929 | .479 | .939 | .983 | .072 | .977 |
| Morocco | .972 | .000 | .960 | .799 | .000 | .930 | .950 | .696 | .955 |
| Oman | .993 | .377 | .994 | .907 | .686 | .962 | .976 | .531 | .894 |
| Saudi Arabia | .987 | .946 | .948 | .771 | .000 | .914 | .984 | .000 | .970 |
| Tunisia | .994 | .000 | .935 | .964 | .089 | .935 | .987 | .559 | .935 |
| Turkey | .986 | .422 | .926 | .829 | .995 | .769 | .895 | .994 | .056 |

Note: Numbers in the WS, ADF, and $Z(t_{\hat{\alpha}})$ columns are tail areas of unit root tests. Low *p*-values reject the null hypothesis of a unit root.

TABLE II

ENGLE-GRANGER COINTEGRATION TEST RESULTS

| Country | System | | | |
|---|---|---|---|---|
| | (GNP, Exports) Dependent Variable | | (GNP, Imports) Dependent Variable | |
| | GNP | Exports | GNP | Imports |
| Sub-Saharan Africa | | | | |
| Cameroon | .467 | .651 | .828 | .781 |
| Congo | .960 | .320 | .937 | .958 |
| Côte d'Ivoire | .292 | .307 | .804 | .866 |
| Ghana | .212 | .786 | .966 | .713 |
| Kenya | .382 | .936 | .775 | .675 |
| Madagascar | .504 | .664 | .871 | .646 |
| Malawi | .777 | .699 | .920 | .716 |
| Mali | .911 | .908 | .614 | .846 |
| Mauritius | .713 | .628 | .778 | .782 |
| Nigeria | .977 | .840 | .916 | .376 |
| Senegal | .427 | .362 | .537 | .824 |
| South Africa | .763 | .983 | .934 | .883 |
| Tanzania | .911 | .859 | .601 | .462 |
| Zambia | .798 | .849 | .764 | .269 |
| Zimbabwe | .716 | .691 | .894 | .883 |
| South Asia | | | | |
| India | .908 | .478 | .090 | .720 |
| Pakistan | .009 | .932 | .851 | .146 |
| Sri Lanka | .066 | .829 | .936 | .784 |
| East Asia and Pacific | | | | |
| China | .874 | .339 | .548 | .615 |

TABLE II (Continued)

| Country | System (GNP, Exports) Dependent Variable | | (GNP, Imports) Dependent Variable | |
|---|---|---|---|---|
| | GNP | Exports | GNP | Imports |
| Indonesia | .678 | .365 | .742 | .854 |
| Korea, Rep. | .426 | .811 | .393 | .389 |
| Malaysia | .936 | .825 | .863 | .420 |
| Philippines | .596 | .152 | .984 | .967 |
| Thailand | .782 | .530 | .886 | .899 |
| Latin America and Caribbean | | | | |
| Argentina | .915 | .818 | .900 | .459 |
| Barbados | .343 | .102 | .691 | .639 |
| Bolivia | .631 | .968 | .893 | .267 |
| Brazil | .774 | .852 | .114 | .032 |
| Chile | .466 | .991 | .834 | .392 |
| Colombia | .787 | .456 | .990 | .000 |
| Costa Rica | .669 | .488 | .208 | .713 |
| Ecuador | .799 | .477 | .961 | .879 |
| El Salvador | .547 | .669 | .075 | .841 |
| Guatemala | .822 | .707 | .047 | .002 |
| Honduras | .380 | .730 | .907 | .950 |
| Jamaica | .981 | .991 | .092 | .469 |
| Mexico | .843 | .812 | .774 | .641 |
| Nicaragua | .565 | .627 | .509 | .625 |
| Paraguay | .630 | .906 | .591 | .234 |
| Peru | .804 | .613 | .494 | .185 |
| Trinidad & Tobago | .879 | .204 | .093 | .053 |
| Uruguay | .631 | .943 | .041 | .115 |
| Venezuela | .803 | .190 | .942 | .861 |
| Middle East and North Africa | | | | |
| Algeria | .640 | .450 | .847 | .559 |
| Egypt | .951 | .488 | .932 | .625 |
| Morocco | .988 | .415 | .407 | .658 |
| Oman | .529 | .093 | .784 | .018 |
| Saudi Arabia | .947 | .870 | .413 | .571 |
| Tunisia | .532 | .002 | .372 | .332 |
| Turkey | .507 | .817 | .947 | .653 |

Note: All the tests use a constant and trend variable. Asymmetric *p*-values are computed using the coefficients in MacKinnon (1994). The numbers of augmenting logs are determined using the AIC + 2 rule. Low *p*-values reject the null hypothesis of no cointegration.

The Engle and Granger (1987) cointegration test was performed using the logarithms of the per capita series and in each system the test was first conducted with GNP as the dependent variable in the cointegrating regression and then repeated with the other variable as the dependent variable. We used a constant and a trend variable and selected the number of augmenting lags based on the AIC + 2 rule.[16] Asymptotic *p*-values were computed using the coefficients in MacKinnon (1994). The results suggest that the null hypothesis of no cointegration between GNP and each of "exports" and "imports" cannot in general be rejected (at the 5 per cent level).

In Table III, we present the results in the same way as those in Table II, for cointegration between "exports" and "imports." Clearly, the null hypothesis of no cointegration cannot be rejected here as well. Because of the cointegration properties of the series in what follows, the causality tests were conducted in growth rates.

## V. VOLATILITY MODELING

The conventional approach to modeling volatility in macroeconomic variables uses moving standard deviations of growth rates as measures of variability. Such measures, however, are inappropriate since they are ad hoc, non-parametric estimates. In this paper, we used autoregressive conditional heteroscedasticity (ARCH)–type models to capture the time-varying conditional variance as a parameter generated from a time-series model of the conditional mean and variance of the growth rate.

Let $\mu_t$ be the growth rate of a series with conditional forecast $E(\mu_t|\Omega_{t-1})$ as indicated in the following equation

$$\mu_t = E(\mu_t \,|\, \Omega_{t-1}) + \varepsilon_t, \tag{1}$$

where $\Omega_{t-1}$ is the conditioning information set on which forecasts are based and the forecast error $\varepsilon_t$ has zero mean and conditional variance given by

$$E(\varepsilon_t^2 \,|\, \Omega_{t-1}) = \sigma_t^2. \tag{2}$$

Our objective is to use conditional volatility models to capture the time-dependent heteroscedastic distribution of $\varepsilon_t$. By capturing this feature of the data, we can produce a forecasted variance $\hat{\sigma}_t^2$, along with a growth forecast error $\hat{\varepsilon}_t$, such that the standardized residuals $\hat{\varepsilon}_t/\hat{\sigma}_t$ are homoscedastic and independent.

Among the several conditional volatility models that have been proposed for capturing time-dependent heteroscedastic distributions, the most popular are members of Engle's (1982) autoregressive conditional heteroscedastic (ARCH) family. One such model, widely used in the literature, is Bollerslev's (1986) generalized ARCH(1, 1), or GARCH(1, 1) symmetric volatility model,

$$\sigma_t^2 = w_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2, \tag{3}$$

with $w_0 > 0$, $\alpha_1 \geq 0$, and $\beta_1 \geq 0$. This model allows the conditional variance of $\varepsilon_t$ to be an autoregressive moving average, ARMA (1, 1) process, and harbors as special

[16] See Pantula et al. (1994) for more details.

TABLE III

ENGLE-GRANGER COINTEGRATION TEST RESULTS BETWEEN EXPORTS AND IMPORTS

| Country | Dependent Variable | |
|---|---|---|
| | Exports | Imports |
| Sub-Saharan Africa | | |
| Cameroon | .388 | .023 |
| Congo | .780 | .894 |
| Côte d'Ivoire | .422 | .515 |
| Ghana | .693 | .901 |
| Kenya | .991 | .465 |
| Madagascar | .377 | .585 |
| Malawi | .916 | .391 |
| Mali | .982 | .165 |
| Mauritius | .384 | .611 |
| Nigeria | .121 | .614 |
| Senegal | .717 | .269 |
| South Africa | .309 | .687 |
| Tanzania | .398 | .063 |
| Zambia | .423 | .444 |
| Zimbabwe | .238 | .212 |
| South Asia | | |
| India | .097 | .957 |
| Pakistan | .333 | .629 |
| Sri Lanka | .683 | .608 |
| East Asia and Pacific | | |
| China | .107 | .293 |
| Indonesia | .124 | .173 |
| Korea, Rep. | .558 | .434 |
| Malaysia | .416 | .119 |
| Philippines | .022 | .424 |
| Thailand | .538 | .305 |
| Latin America and Caribbean | | |
| Argentina | .609 | .602 |
| Barbados | .587 | .723 |
| Bolivia | .789 | .737 |
| Brazil | .830 | .106 |
| Chile | .702 | .353 |
| Colombia | .502 | .511 |
| Costa Rica | .924 | .904 |
| Ecuador | .143 | .409 |
| El Salvador | .982 | .961 |
| Guatemala | .878 | .750 |
| Honduras | .989 | .596 |
| Jamaica | .597 | .476 |
| Mexico | .976 | .723 |
| Nicaragua | .730 | .558 |
| Paraguay | .947 | .864 |
| Peru | .963 | .681 |
| Trinidad & Tobago | .239 | .658 |

TABLE III (Continued)

| Country | Dependent Variable | |
|---|---|---|
| | Exports | Imports |
| Uruguay | .931 | .735 |
| Venezuela | .382 | .987 |
| Middle East and North Africa | | |
| Algeria | .216 | .419 |
| Egypt | .730 | .381 |
| Morocco | .017 | .364 |
| Oman | .461 | .149 |
| Saudi Arabia | .402 | .772 |
| Tunisia | .828 | .886 |
| Turkey | .870 | .721 |

Note: All the tests use a constant and trend variable. Asymmetric *p*-values are computed using the coefficients in MacKinnon (1994). The numbers of augmenting logs are determined using the AIC + 2 rule. Low *p*-values reject the null hypothesis of no cointegration.

cases a variety of other models, including the Engle (1982) ARCH ($\beta_1 = 0$) and Bollerslev (1986) integrated GARCH ($\alpha_1 + \beta_1 = 1$) models.

Within the context of this model, the estimated $\sigma_t^2$ is the conditional variance of the growth rate of the series—that is, the variability of the growth rate expected to prevail (next period) given currently available information. The unexpected component of growth is given by $\hat{\varepsilon}_t = \mu_t - \hat{\mu}_t$, where $\hat{\mu}_t = E(\mu_t | \Omega_{t-1})$ is the conditional expectation of $\mu_t$. In this expression $\hat{\varepsilon}_t$ does not reflect changes in conditional variability over time. A measure of unanticipated volatility that reflects both the unanticipated component of growth and the (time-varying) conditional variance of growth forecasts is given by $\hat{\varepsilon}_t / \hat{\sigma}_t$. This variable can be conceived as a measure determining how different a given growth rate change is from the historical pattern.

## VI. GRANGER CAUSALITY TEST RESULTS

The causality models and results will be presented. In the case of causality from export growth to GNP growth, the results given in Table IV are based on the following model:

$$g_t = \alpha_0 + \sum_{j=1}^{r} \alpha_j g_{t-j} + \sum_{j=1}^{s} \beta_j \Delta \log Exports_{t-j} + \varepsilon_t, \tag{4}$$

where $g_t$ is the per capita GNP growth, $\alpha_0$ is a constant, $\alpha_j$ and $\beta_j$ are parameters, and $\varepsilon_t$ is the disturbance term. Common lags of two (i.e., $r = s = 2$) were chosen throughout this investigation and for all the models employed. In these tests causality is validated in the sense that predictive power is enhanced if the $\beta_j$ coefficients

TABLE IV

TAIL AREAS OF TESTS OF GRANGER CAUSALITY FROM EXPORT AND IMPORT GROWTH TO GNP GROWTH

| Country | From Exports to GNP | From Imports to GNP |
|---|---|---|
| Sub-Saharan Africa | | |
| Cameroon | .545 | .205 |
| Congo | .262 | .122 |
| Côte d'Ivoire | .173 | .228 |
| Ghana | .146 | .664 |
| Kenya | .735 | .999 |
| Madagascar | .318 | .638 |
| Malawi | .680 | .980 |
| Mali | .424 | .383 |
| Mauritius | .321 | .164 |
| Nigeria | .446 | .343 |
| Senegal | .977 | .463 |
| South Africa | .137 | .237 |
| Tanzania | .419 | .595 |
| Zambia | .446 | .998 |
| Zimbabwe | .296 | .864 |
| South Asia | | |
| India | .353 | .623 |
| Pakistan | .533 | .100 |
| Sri Lanka | .723 | .998 |
| East Asia and Pacific | | |
| China | .506 | .265 |
| Indonesia | .097 | .144 |
| Korea, Rep. | .492 | .443 |
| Malaysia | .881 | .998 |
| Philippines | .927 | .601 |
| Thailand | .160 | .848 |
| Latin America and Caribbean | | |
| Argentina | .915 | .497 |
| Barbados | .389 | .570 |
| Bolivia | .864 | .765 |
| Brazil | .848 | .998 |
| Chile | .953 | .901 |
| Colombia | .526 | .440 |
| Costa Rica | .948 | .931 |
| Ecuador | .263 | .323 |
| El Salvador | .126 | .246 |
| Guatemala | .575 | .998 |
| Honduras | .643 | .890 |
| Jamaica | .821 | .940 |
| Mexico | .926 | .646 |
| Nicaragua | .953 | .883 |
| Paraguay | .999 | .998 |
| Peru | .774 | .516 |
| Trinidad & Tobago | .980 | .779 |
| Uruguay | .938 | .497 |
| Venezuela | .499 | .987 |

TABLE IV (Continued)

| Country | From Exports to GNP | From Imports to GNP |
|---|---|---|
| Middle East and North Africa | | |
| Algeria | .974 | .994 |
| Egypt | .641 | .469 |
| Morocco | .648 | .863 |
| Oman | .066 | .121 |
| Saudi Arabia | .701 | .741 |
| Tunisia | .422 | .853 |
| Turkey | .952 | .559 |

Note: Low *p*-values imply strong marginal predictive power.

are significantly different from zero so that $g_t$ in addition to its dependence on lagged $g_t$ is also dependent on lagged values of export growth rates. In none of the fifty sampled countries did we obtain such a causality at the 5 per cent level (at the 10 per cent level Indonesia and Oman, both oil exporters were the only countries with causality from export growth to GNP growth).

Causality tests from import growth to GNP growth were derived from a model with parallel interpretations as above, i.e.,

$$g_t = \alpha_0 + \sum_{j=1}^{r} \alpha_j g_{t-j} + \sum_{j=1}^{s} \beta_j \Delta \log Imports_{t-j} + \varepsilon_t. \tag{5}$$

Again no causality whatsoever was detectable at the 5 per cent level (at the 10 per cent level, import growth in Pakistan was found to cause per capita GNP growth).

To test if export growth volatility is related to GNP growth in the Granger sense, the following regression equation was employed:

$$g_t = \alpha_0 + \sum_{j=1}^{r} \alpha_j g_{t-j} + \sum_{j=1}^{s} \beta_j \hat{\sigma}^2_{t-j} + \sum_{j=1}^{k} \gamma_j (\hat{\varepsilon}_{t-j} / \hat{\sigma}_{t-j}) + \varepsilon_t, \tag{6}$$

where $g_t$ is the (per capita) GNP growth rate, $\hat{\sigma}^2_t$ is the GARCH (1, 1) anticipated volatility of export growth, and $\hat{\varepsilon}_t / \hat{\sigma}_t$ the unanticipated volatility of export growth. We selected common lags of two and reported the results in Table V.

In Table V, $F_1$ is the test of the null hypothesis in which in a regression of $g_t$ on lagged values of itself and anticipated export growth volatility, the coefficients of anticipated export growth volatility are zero. $F_2$ is the test of the null hypothesis in which in a regression of $g_t$ on lagged valued of itself and unanticipated export growth volatility, the coefficients of unanticipated export growth volatility are zero. $F_3$ is the test of the null hypothesis in which in a regression of $g_t$ on lagged values of itself and anticipated and unanticipated export growth volatility, the coefficients of both anticipated and unanticipated export growth volatility are zero.

TABLE V

TAIL AREAS OF TESTS OF GRANGER CAUSALITY FROM GARCH(1, 1) ANTICIPATED AND UNANTICIPATED EXPORT GROWTH VOLATILITY TO PER CAPITA GNP GROWTH

| Country | $F_1$ | $F_2$ | $F_3$ |
|---|---|---|---|
| Sub-Saharan Africa | | | |
| Cameroon | .217 | .740 | .414 |
| Congo | .418 | .355 | .216 |
| Côte d'Ivoire | .449 | .192 | .177 |
| Ghana | .436 | .160 | .108 |
| Kenya | .258 | .839 | .406 |
| Madagascar | .402 | .251 | .357 |
| Malawi | .372 | .912 | .693 |
| Mali | .433 | .277 | .283 |
| Mauritius | .480 | .687 | .680 |
| Nigeria | .695 | .585 | .378 |
| Senegal | .533 | .968 | .916 |
| South Africa | .428 | .089 | .012 |
| Tanzania | .911 | .330 | .306 |
| Zambia | .672 | .320 | .461 |
| Zimbabwe | .148 | .602 | .073 |
| South Asia | | | |
| India | .322 | .333 | .365 |
| Pakistan | .993 | .356 | .104 |
| Sri Lanka | .999 | .774 | .998 |
| East Asia and Pacific | | | |
| China | .324 | .271 | .196 |
| Indonesia | .053 | .326 | .096 |
| Korea, Rep. | .592 | .607 | .661 |
| Malaysia | .168 | .769 | .453 |
| Philippines | .403 | .947 | .126 |
| Thailand | .800 | .144 | .199 |
| Latin America and Carbbean | | | |
| Argentina | .993 | .576 | .060 |
| Barbados | .576 | .402 | .386 |
| Bolivia | .598 | .741 | .872 |
| Brazil | .463 | .916 | .993 |
| Chile | .999 | .997 | .985 |
| Colombia | .995 | .503 | .632 |
| Costa Rica | .459 | .933 | .523 |
| Ecuador | .339 | .378 | .326 |
| El Salvador | .521 | .128 | .056 |
| Guatemala | .250 | .561 | .334 |
| Honduras | .305 | .619 | .314 |
| Jamaica | .889 | .845 | .992 |
| Mexico | .676 | .998 | .987 |
| Nicaragua | .336 | .977 | .692 |
| Paraguay | .358 | .999 | .819 |
| Peru | .999 | .691 | .786 |
| Trinidad & Tobago | .973 | .998 | .900 |

TABLE V (Continued)

| Country | $F_1$ | $F_2$ | $F_3$ |
|---|---|---|---|
| Uruguay | .927 | .930 | .962 |
| Venezuela | .329 | .485 | .239 |
| Middle East and North Africa | | | |
| Algeria | .362 | .670 | .388 |
| Egypt | .452 | .626 | .279 |
| Morocco | .938 | .376 | .788 |
| Oman | .156 | .513 | .047 |
| Saudi Arabia | .167 | .748 | .180 |
| Tunisia | .151 | .624 | .299 |
| Turkey | .975 | .651 | .341 |

Note: Low *p*-values imply strong marginal predictive power.

The results indicate that with very few exceptions neither anticipated nor unanticipated export growth volatility improved significantly the predictive path of per capita GNP growth. Indonesia shows that its anticipated export growth volatility caused GNP growth per capita at the 5 per cent level; it appears that the strength of this relationship led to the combined anticipated and unanticipated export growth volatility at the 10 per cent level as a predictive factor of the country's per capita GNP growth. When unanticipated export growth volatility was considered, only South Africa's per capita GNP growth prediction was improved by it at the 10 per cent level.

The combination of anticipated and unanticipated export growth volatility was causally significant at the 5 per cent level for South Africa and Oman, whereas at the 10 per cent level this causality relation was significant for Zimbabwe, Indonesia, Argentina, and El Salvador.

To test the hypothesis that import growth volatility is related to GNP growth in the Granger sense, we presented the results in Table VI, in the same way as those in Table V, based on equation (7) with $\hat{\sigma}_t^2$ now being the GARCH(1, 1) anticipated volatility of import growth and $\hat{\varepsilon}_t/\hat{\sigma}_t$ the unanticipated volatility of import growth. The $F_1$, $F_2$, and $F_3$ tests represent the null hypothesis in which in a regression of per capita GNP growth on lagged values of itself and correspondingly on (1) anticipated, (2) unanticipated, and (3) anticipated and unanticipated import growth volatility the relevant coefficients are zero. The results indicate that with the exception of $F_1$ for Indonesia which was significant at the 5 per cent level, in none of the other countries was either anticipated or unanticipated import growth volatility causally related to per capita GNP growth at either the 5 per cent or the 10 per cent level. When $F_3$ was considered, no causality was detected at the 5 per cent level, but at the 10 per cent level causality was traced in South Africa, Tanzania, Pakistan, and Venezuela.

TABLE VI

TAIL AREAS OF TESTS OF GRANGER CAUSALITY FROM GARCH(1, 1) ANTICIPATED AND UNANTICIPATED IMPORT GROWTH VOLATILITY TO PER CAPITA GNP GROWTH

| Country | $F_1$ | $F_2$ | $F_3$ |
|---|---|---|---|
| Sub-Saharan Africa | | | |
| Cameroon | .216 | .233 | .102 |
| Congo | .479 | .108 | .293 |
| Côte d'Ivoire | .337 | .314 | .510 |
| Ghana | .999 | .817 | .519 |
| Kenya | .412 | .994 | .434 |
| Madagascar | .703 | .647 | .842 |
| Malawi | .482 | .946 | .984 |
| Mali | .602 | .361 | .187 |
| Mauritius | .417 | .301 | .146 |
| Nigeria | .925 | .519 | .673 |
| Senegal | .974 | .637 | .932 |
| South Africa | .237 | .367 | .082 |
| Tanzania | .149 | .619 | .083 |
| Zambia | .999 | .976 | .974 |
| Zimbabwe | .317 | .991 | .430 |
| South Asia | | | |
| India | .224 | .870 | .738 |
| Pakistan | .551 | .496 | .061 |
| Sri Lanka | .626 | .999 | .272 |
| East Asia and Pacific | | | |
| China | .266 | .394 | .127 |
| Indonesia | .041 | .444 | .234 |
| Korea, Rep. | .842 | .778 | .711 |
| Malaysia | .999 | .961 | .916 |
| Philippines | .679 | .666 | .995 |
| Thailand | .773 | .980 | .785 |
| Latin America and Caribbean | | | |
| Argentina | .481 | .648 | .250 |
| Barbados | .185 | .812 | .296 |
| Bolivia | .959 | .545 | .548 |
| Brazil | .588 | .713 | .593 |
| Chile | .993 | .833 | .973 |
| Colombia | .980 | .674 | .921 |
| Costa Rica | .999 | .731 | .843 |
| Ecuador | .598 | .324 | .195 |
| El Salvador | .492 | .460 | .505 |
| Guatemala | .999 | .998 | .998 |
| Honduras | .639 | .959 | .808 |
| Jamaica | .231 | .839 | .199 |
| Mexico | .323 | .734 | .551 |
| Nicaragua | .986 | .838 | .986 |
| Paraguay | .192 | .965 | .197 |
| Peru | .997 | .498 | .624 |
| Trinidad & Tobago | .442 | .493 | .112 |

TABLE VI (Continued)

| Country | $F_1$ | $F_2$ | $F_3$ |
|---|---|---|---|
| Uruguay | .630 | .802 | .384 |
| Venezuela | .448 | .958 | .097 |
| Middle East and North Africa | | | |
| Algeria | .427 | .998 | .545 |
| Egypt | .979 | .367 | .549 |
| Morocco | .777 | .725 | .961 |
| Oman | .209 | .335 | .137 |
| Saudi Arabia | .426 | .517 | .960 |
| Tunisia | .161 | .967 | .364 |
| Turkey | .267 | .284 | .105 |

Note: Low *p*-values imply strong marginal predictive power.

## CONCLUSIONS

Exports as vehicles, if not as engines of growth, are important to developing countries by improving their factor utilization, expanding factor endowments, generating a multiplicity of forward and backward linkages, earning valuable foreign exchange, and forcing them to keep up with technological changes and protecting their international competitiveness.[17] The extent to which these benefits are disseminated depends on such factors as country size, the diversity of resource endowments, state of technology applied, and the degree of openness. If there were uniform patterns of export benefits, despite the striking heterogeneity of developing countries, they would be revealed by statistical tests and most certainly by causality analysis.

Our investigation which covered all the fifty countries with continuous data from 1970 to 1993 shows that export growth has not been an engine of growth, not even in the cases of the Asian tigers, which are used as the phenomenal paradigms of export-led growth by neoclassical scholars. Our tests in general did not support the hypothesis that export growth led to GNP growth in a Granger sense. Only in two oil-exporting countries (Indonesia and Oman) was such a causality demonstrated,

[17] Under ceteris paribus conditions the long-run implications of export growth lead to transfer of valuable resources abroad that damages domestic future growth potential. This inference is reminiscent of Adam Smith's devastating criticisms of the extreme version of mercantilism which elevated the import of gold as the primary goal of economic policy in general, and export growth in particular (a more accurate interpretation of mercantilism considers growth through export growth and import substitution as its policy objective). The ceteris paribus conditions involved in this inference are not realistic for developing countries, which face chronic balance of payments problems and depend heavily on imports of capital, technology, and know-how. For them the growth of exports is not an end in itself, but a means toward modernization and sustained growth.

and only at the 10 per cent level. When volatility was introduced in our causality analysis, anticipated export growth volatility was found to be associated with GNP growth in only the case of Indonesia at the 5 per cent level; unanticipated export growth volatility was found to be causally related to GNP growth in the single case of South Africa at the 10 per cent level; whereas for anticipated and unanticipated export growth volatility causality was marginally more evident in six cases (South Africa, Oman, Zimbabwe, Indonesia, Argentina, and El Salvador) mainly at the 10 per cent level. From the entire sample only Indonesia and Oman appeared to exhibit reliable causality from export growth to GNP growth, and in both countries it is likely that their dependence on oil exports produced the obtained outcome.

The search for causality from import growth to GNP growth was motivated by the large foreign indebtedness which might enable developing countries to harmonize their capital imports and thus reduce drastic internal dislocations. It appears that foreign indebtedness has not contributed to industrial or export restructuring[18] and may have provided only a temporary relief from the external oil shock which was attenuated over time, as shown by the cointegration between exports and imports. But since cointegration was not perfect, and for purposes of analytical completeness, causality tests from import growth to GNP growth were conducted. As sparse was the evidence in the export growth causality tests, so equally sparse it was here as well. Only Pakistan was found to exhibit causality from import growth to GNP growth. When tests of import growth volatility were carried out, anticipated import growth volatility was found at the 5 per cent level to lead to GNP growth in a Granger sense in Indonesia, whereas at the 10 per cent level anticipated and nonanticipated import growth volatility was leading to growth again in Pakistan in a Granger sense, but also in South Africa, Tanzania, and Venezuela.

Based on the evidence collected from a highly comprehensive sample of developing countries, an overall conclusion emerges, namely, that irrespective of the geographical location or level of development, export growth and much less import growth do not causally affect per capita GNP growth. In stating our conclusion we do not by any means suggest that the sampled countries would be equally well-off without as with international trade. This study does not imply that international trade plays a minor role in the process of development, but rather that the main development forces are derived from domestic sources. The gains from trade are well documented by the theory of comparative advantage. But this theory does not qualify as a theory of growth. Beyond its gains that energize domestic resources, development as a process of radical institutional and structural transformations depends more on the domestic development dynamic than on trade with other countries. International trade can contribute to development but is not strategically indispensable.

18 See Afxentiou and Serletis (1995).

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