# The Relation between Openness And Economic Growth: Postwar Evidence From 124 Countries

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Conventional wisdom suggests that openness of an economy promotes economic growth. Romer (1989) posits the positive relationship between openness and economic growth as a stylized fact. He uses only ex-post industrialized countries to "prove" his stylized fact thereby introducing a sample selection bias. We correct for this sample selection bias by analyzing the biggest available sample of countries using the Penn World Table 5.6. We also correct for the fact that trade does not mean export only. We obtain quantitative estimates of the impact of trade on growth. In doing so, we use modern time series techniques instead of relying on simple scatter diagrams. Results show that growth in openness is indeed significantly positively related to the growth in real GDP for 94 out of 124 countries. (JEL Classification: F14)

## I. Introduction

In a pathbreaking paper Romer (1989) asserts that growth in the volume of trade is positively correlated with the growth of output for a country. To prove his point Romer (1989, p.67) plots annual growth

rate of GDP and annual growth rate of export for (now) indus-
trialized countries over 1870-1913, 1913-50, and 1950-70 using
Maddison (1982) datasets. All of them show very tight positive
correlation between the variables. This is a classic sample selection
trap that Romer falls into. He looks at how the countries that are
now industrialized had behaved in the past.

Consider the following example. In 1900, Argentina had a per
capita income higher than most European countries. But because
Argentina has not become one of the industrialized countries today,
it is not in the sample considered by Romer (a similar argument
was used against the convergence hypothesis by De Long (1988)).
Thus, inclusion of all countries without regard to their industrial
development is necessary to test the robustness of Romer's stylized
fact. In this paper, we set out to do exactly that: we do not choose
any specific group of countries — we include *all countries* in the
world for which data are available for at least 30 years during the
post-war period. Therefore, our data span the entire range of
countries classified by the World Bank (1992).

Does the relationship hold for import and export together rather
than for export only? Romer (and others) have used growth rate of
exports rather than the growth rate of openness. We argue that
openness is a better measure than export alone. If we use export
alone, it implicitly acknowledges that import contributes nothing to
growth. This clearly misses out on a number of channels through
which import can contribute to economic growth (see, for example,
Clerides *et al.* 1996).

The only studies to our knowledge that explicitly looks at import
at all was that of Ram (1990) and Liu, Song and Romilly (1997).
Ram, however, considers only import (rather than import and
export together). He finds that import growth is positively correlated
with GDP growth for most countries. Liu, Song and Romilly do
measure openness the way we do it (see below). However, their
study is limited to only one country: China. They find bi-directional
causality between GNP and openness.

Leamer (1988) provides a number of measures of openness. The
only measure of openness with a quantitative basis is export and
import put together. All other measures require some implicit
theorizing (for example, one measure looks at the number of
restrictions a country puts on capital flow and declares it as a
measure of openness). Our method of calculating openness is

closely related to the measure used by Summers and Heston (1991) in the widely used Penn World Table. Specifically, we term openness for a country for year $t$ as

$$o_t = (im_t + ex_t),$$

where as Summers and Heston use a ratio form $(im_t + ex_t)/y_t$ where $im_t$ is the import for year $t$, $ex_t$ is the export for year $t$ and $y_t$ is the GDP in year $t$. Note that we use import and export in real terms (this distinction does not arise in the definition of Summers and Heston because they take the ratio with the GDP for year $t$).

We explicitly consider the important issue of causality. Does the openness of the economy cause the growth in real GDP or does the growth itself brings about an associated increase in openness? In our study, we explicitly address this issue.

## II. Existing Literature

Previous literature has looked solely at the relationship between export and economic growth. Early efforts investigating the relationship between export and economic growth include Emery (1967), Michaely (1977), Balassa (1978), Krueger (1978) and Feder (1982). Numerous other studies also appeared on the subject. Some of these are multi-country studies while others concentrated on a single country. Recent papers have included Ahmed and Harnhirun (1995), Dollar (1992), Harrison (1995), Frankel, Romer and Cyrus (1995), Krueger (1990), Sengupta (1994) and van den Berg and Schmidt (1994). Edwards (1993) provided an excellent review of the many previous studies.

*In References, "Harnihuran". Which one is correct?*

One problem with the earlier studies using time series data is that the studies might have estimated spurious regressions as Granger and Newbold (1974) and Phillips (1986) have shown. In some studies, causality between export and economic growth is explored. But studies prior to 1990 typically suffered from a methodological problem as they studied causal relationship between the two variables without addressing the issue of stationarity of the variables. If the variables do not have unit roots, then the causality tests are valid (Sims, Stock and Watson 1990). Causality tests are also valid if the variables are cointegrated (Granger 1988).

We fit the following model for our data. First we define openness

at time $t$ $o_t$ as $o_t = (im_t + ex_t)$ where $im_t$ is the import at time $t$ and $ex_t$ is the export at time $t$. Since we are interested in the contribution of growth rate of openness on the growth rate of real GDP, we define $GOP_t = (o_t - o_{t-1})/o_{t-1}$ and

$$GRGDP_t = \frac{(GDP_t - GDP_{t-1})}{GDP_{t-1}}$$

Thus, our model for empirically testing the relationship between trade and growth takes the following form:

$$GOP_t = a + b \ GRGDP_t + error_t. \tag{1}$$

## III. Causality Relation

The results from most previous cross section analyses strongly suggest that there is a relation between openness and economic growth. Unfortunately, there is no theoretical way of resolving the direction of causality. Does the rate of change of openness cause economic growth? We can argue that export promotion certainly can improve domestic production technology. Growth in export can cause improvement in living standards by increasing profits and income within the country. Similarly, we can also argue that the threat of import can improve domestically sold products for consumption and thereby raise export further. Similarly, if income within a country increases, domestic demand for foreign made goods will rise. Therefore, *a priori*, we cannot determine the direction of causality between growth in real GDP and the rate of growth in openness. One way of dealing with such an issue is to study the direction of causality using Granger (1969) method. But before causality can be studied, we need to check for unit roots in our series.

We use the Phillips-Perron (1988) unit root test. The test is well suited for analyzing time series whose differences may follow mixed *ARMA* $(p, q)$ processes of unknown order in that the test statistic incorporates a nonparametric allowance for serial correlation. Consider the following equation:

$$y_t = \tilde{c}_0 + \tilde{c}_1 y_{t-1} + \tilde{c}_2 \ (t - \frac{T}{2}) \ v_t, \tag{2}$$

where $\{y_t\}$ is the relevant time series in equation (2), $T$ is the number of observations and $v_t$ is the error term. The null hypothesis

**TABLE 1**

RESULTS OF NON-PARAMETRIC PHILLIPS-PERRON UNIT ROOT TESTS FOR GROWTH
RATE IN REAL GDP (GRGDP) AND FOR GROWTH RATE IN OPENNESS (GOP)

| Country | Obs | variable: GRGDP | | variable: GOP | |
| | | without trend | with trend | without trend | with trend |
|---|---|---|---|---|---|
| Algeria | 33 | -5.59 | -5.55 | -3.85 | -3.77 |
| Angola | 30 | -4.06 | -4.11 | -3.52 | -4.04 |
| Argentina | 41 | -6.14 | -6.82 | -6.12 | -6.09 |
| Australia | 43 | -5.96 | -6.03 | -6.67 | -7 |
| Austria | 43 | -5.28 | -6.24 | -6.96 | -8.2 |
| Bangladesh | 34 | -7.04 | -6.94 | -7.3 | -7.19 |
| Barbados | 30 | -5.66 | -5.70 | -4.56 | -4.89 |
| Belgium | 43 | -5.11 | -5.18 | -6.88 | -7.13 |
| Benin | 33 | -5.75 | -5.82 | -6.67 | -8.74 |
| Bolivia | 43 | -6.11 | -6.08 | -4.3 | -4.3 |
| Botswana | 30 | -5.72 | -5.54 | -6.6 | -6.6 |
| Brazil | 43 | -4.10 | -4.58 | -8.15 | -8.15 |
| Burkina Faso | 34 | -4.77 | -5.22 | -7.04 | -7.28 |
| Burundi | 33 | -6.71 | -7.57 | -6.78 | -7.18 |
| Cameroon | 33 | -3.01 | -3.29 | -4.68 | -4.69 |
| Canada | 43 | -5.63 | -5.72 | -5.6 | -5.54 |
| Cape Verde | 33 | -4.78 | -4.70 | -3.51 | -3.48 |
| Central African Republic | 33 | -5.80 | -5.80 | -6.53 | -7.83 |
| Chad | 33 | -5.61 | -5.51 | -5.64 | -5.55 |
| Chile | 43 | -4.98 | -4.92 | -5.41 | -5.32 |
| China | 33 | -3.72 | -3.70 | -3.19 | (-3.38) |
| Colombia | 43 | -4.99 | -5.03 | -8.55 | -8.53 |
| Comoros | 33 | -4.50 | -4.79 | -6.65 | -6.82 |
| Congo | 33 | -5.11 | -5.04 | -5.8 | -5.74 |
| Costa Rica | 43 | -4.29 | -4.85 | -7.07 | -7.19 |
| Cyprus | 43 | -5.92 | -5.85 | -7.89 | -7.84 |
| Czechoslovakia | 31 | -4.26 | -4.87 | -5.43 | -5.53 |
| Denmark | 43 | -5.16 | -5.34 | -8.18 | -9.02 |
| Dominican Republic | 43 | -7.11 | -7.40 | -7.12 | -7.01 |
| Ecuador | 43 | -4.33 | -4.43 | -6.05 | -5.99 |
| Egypt | 43 | -4.44 | -4.33 | -5.63 | -5.63 |
| El Salvador | 43 | -3.54 | -3.95 | -4.6 | -4.84 |
| Ethiopia | 37 | -7.02 | -7.48 | -5.83 | -6.58 |
| Fiji | 31 | -5.00 | -4.95 | -3.77 | -3.69 |
| Finland | 43 | -4.70 | -5.34 | -6.76 | -7.42 |
| France | 43 | -3.91 | -4.98 | -7.24 | -7.21 |
| Gabon | 33 | -4.59 | -4.79 | -4.26 | -4.68 |
| Gambia | 31 | -6.37 | -6.36 | -8.32 | -8.17 |
| Ghana | 38 | -5.63 | -5.55 | -4.12 | -4.23 |
| Greece | 42 | -5.48 | -6.10 | -5.02 | -5.14 |

TABLE 1 (Continued)

| Country | Obs | variable: GRGDP | | variable: GOP | |
|---|---|---|---|---|---|
| | | without trend | with trend | without trend | with trend |
| Guatemala | 43 | -3.79 | -3.78 | -4.84 | -4.77 |
| Guinea | 34 | -6.06 | -6.25 | -4.93 | -5.3 |
| Guinea-Bissau | 33 | -6.58 | -6.50 | -7.89 | -7.89 |
| Guyana | 41 | -5.63 | -6.04 | -4.19 | -4.36 |
| Haiti | 30 | -5.70 | -5.60 | -3.47 | -3.42 |
| Honduras | 43 | -4.77 | -4.78 | -5.01 | -4.94 |
| Hong Kong | 33 | -4.68 | -5.05 | -6.07 | -6.2 |
| Iceland | 43 | -4.18 | -4.27 | -7.69 | -8.04 |
| India | 43 | -5.77 | -5.73 | -6.44 | -6.65 |
| Indonesia | 33 | -3.53 | -3.50 | -8.49 | -8.82 |
| Iran | 38 | -4.58 | -4.65 | -3.42 | -3.39 |
| Iraq | 35 | -4.80 | -5.12 | -4.72 | -4.86 |
| Ireland | 43 | -4.42 | -4.37 | -6.53 | -6.54 |
| Israel | 40 | -4.43 | -5.48 | -5.65 | -6.35 |
| Italy | 43 | -5.23 | -6.80 | -7.23 | -8.61 |
| Ivory Coast | 33 | -3.76 | -4.63 | -5.22 | -6.28 |
| Jamaica | 39 | -4.97 | -6.02 | -7.34 | -7.48 |
| Japan | 43 | -3.96 | -5.40 | -6.6 | -7.45 |
| Jordan | 37 | -5.54 | -5.77 | -6.99 | -6.96 |
| Kenya | 43 | -8.15 | -8.04 | -8.48 | -8.36 |
| Kuwait | 30 | -5.77 | -6.92 | -4.77 | -6.2 |
| Lesotho | 33 | -3.95 | -4.21 | -5.02 | -5.18 |
| Luxemburg | 43 | -6.13 | -6.04 | -5.4 | -5.51 |
| Madagascar | 33 | -5.31 | -5.55 | -5.56 | -5.5 |
| Malawi | 39 | -6.84 | -7.24 | -6.85 | -7.01 |
| Malaysia | 38 | -4.90 | -4.84 | -4.97 | -5.07 |
| Mali | 32 | -6.15 | -6.18 | -5.82 | -5.68 |
| Malta | 36 | -3.82 | -3.78 | -4.88 | -4.84 |
| Mauritania | 33 | -6.31 | -6.24 | -7.89 | -8.22 |
| Mauritius | 43 | -5.85 | -5.88 | -6.73 | -6.71 |
| Mexico | 43 | -4.71 | -4.87 | -4.58 | -4.64 |
| Morocco | 43 | -5.12 | -5.06 | -5.58 | -5.51 |
| Mozambique | 33 | -4.45 | -4.70 | -4.75 | -4.78 |
| Myanmar | 40 | -6.45 | -6.30 | -4.86 | -4.8 |
| Namibia | 33 | -6.39 | -7.07 | -3.96 | -3.9 |
| Netherlands | 43 | -3.91 | -4.01 | -6.95 | -7.34 |
| New Zealand | 43 | -5.21 | -5.28 | -8.23 | -8.15 |
| Nicaragua | 41 | -5.50 | -6.46 | -6.4 | -6.33 |
| Niger | 30 | -7.34 | -7.71 | -6.56 | -7.21 |

**TABLE 1** (Continued)

| Country | Obs | variable: GRGDP | | variable: GOP | |
|---|---|---|---|---|---|
| | | without trend | with trend | without trend | with trend |
| Nigeria | 43 | -4.39 | -4.43 | -5.5 | -5.43 |
| Norway | 43 | -3.95 | -4.39 | -5.66 | -5.88 |
| Pakistan | 43 | -5.82 | -5.92 | -6.31 | -6.47 |
| Panama | 43 | -5.06 | -5.17 | -5 | -4.98 |
| Papua New Guinea | 33 | -3.77 | -4.32 | -4.19 | -4.87 |
| Paraguay | 43 | -6.65 | -6.61 | -7.1 | -7.14 |
| Peru | 43 | -4.43 | -4.99 | -6.99 | -8.29 |
| Philippines | 43 | -3.53 | -4.03 | -6.3 | -6.26 |
| Portugal | 41 | -4.88 | -4.82 | -6.06 | -6 |
| Puerto Rico | 35 | -4.41 | -5.22 | -3.99 | -4.02 |
| Reunion | 30 | -5.15 | -6.48 | -5.59 | -5.36 |
| Romania | 30 | -5.12 | -5.38 | -5.01 | -5.05 |
| Rwanda | 33 | -4.19 | -4.12 | -6.25 | -6.2 |
| Saudi Arabia | 30 | -3.60 | -3.76 | -3.57 | -3.94 |
| Senegal | 32 | -8.06 | -7.95 | -6.95 | -6.9 |
| Seychelles | 31 | -4.40 | -4.36 | -4.45 | -4.41 |
| Sierra Leone | 32 | -5.43 | -6.21 | -3.59 | -3.5 |
| Singapore | 33 | -4.02 | -4.01 | -4.22 | -4.13 |
| Somalia | 30 | -8.59 | -8.48 | -6.01 | -5.92 |
| South Africa | 43 | -5.06 | -5.44 | -6.37 | -6.53 |
| South Korea | 39 | -4.50 | -4.76 | -5.36 | -5.49 |
| Soviet Union | 30 | -5.12 | -7.59 | -9.36 | -9.32 |
| Spain | 43 | -5.34 | -6.06 | -4.94 | -5.73 |
| Sri Lanka | 43 | -8.59 | -8.54 | -5.76 | -5.75 |
| Surinam | 30 | -3.77 | -4.66 | -4.05 | -4.72 |
| Swaziland | 30 | -5.84 | -6.22 | -5.54 | -5.83 |
| Sweden | 43 | -3.90 | -4.80 | -7.01 | -7.4 |
| Switzerland | 43 | -3.91 | -4.40 | -6.75 | -7.56 |
| Syria | 32 | -8.15 | -9.18 | -7.14 | -7.04 |
| Taiwan | 40 | -6.49 | -6.34 | -5.8 | -5.81 |
| Thailand | 43 | -5.48 | -5.74 | -5.57 | -5.62 |
| Togo | 33 | -6.44 | -7.15 | -6.67 | -7.34 |
| Trinidad and Tobago | 42 | -6.13 | -6.98 | -6.67 | -6.47 |
| Tunisia | 33 | -5.27 | -5.30 | -4.13 | -4.05 |
| Turkey | 43 | -7.15 | -7.48 | -4.73 | -4.67 |
| Uganda | 43 | -8.77 | -8.65 | -6.83 | -6.8 |
| United Kingdom | 43 | -4.89 | -4.96 | -7.05 | -6.97 |
| United States | 43 | -6.59 | -6.87 | -6.04 | -5.96 |
| Uruguay | 43 | -6.25 | -6.18 | -9.63 | -9.52 |
| Venezuela | 43 | -5.52 | -5.87 | -7.23 | -7.15 |
| West Germany | 43 | -3.85 | -1.13 | -5.5 | -7.05 |
| Yugoslavia | 31 | -4.70 | -5.94 | -6.94 | -8.49 |
| Zaire | 40 | -6.51 | -7.61 | -7.23 | -7.12 |
| Zambia | 37 | -5.23 | -5.37 | -6.26 | -6.41 |
| Zimbabwe | 39 | -5.62 | -5.56 | -6.52 | -6.73 |

of a unit root is $H_0 : \tilde{c}_1 = 1$. We can drop the trend term to test the stationarity of a variable without the trend. The results reported in Table 1. Results indicate that for both the variables for almost all countries listed below do not exhibit unit roots at the conventional level of significance.

We proceed with the Granger causality tests as follows. Let $\{x_t\}$ and $\{y_t\}$ be two time series. Suppose we regress $y_t$ on past values of $y$ and past values of $x$:

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + \cdots + b_1 x_{t-1} + b_2 x_{t-2} + \cdots + u_t. \qquad (3)$$

We first run this unrestricted regression and then we add conditions that $b_1 = b_2 = \cdots = 0$. Let the error sum of squares for the restricted and unrestricted equations be $E(r)$ and $E(u)$. Then

$$F(r, \; n-k-1) = \frac{[E(r) - E(u)/r]}{[E(u)/(n-k-1)]} \qquad (4)$$

will have a $F$ distribution with $r$ and $n-k-1$ degrees of freedom where $r$ is the number of restrictions and $n-k-1$ is the degrees of freedom in equation (3). In our model, we first take the rate of change of real GDP (called GRGDP) as the $x$ variable in equation (3) and the rate of change of openness (called GOP) as the $y$ variable. If past values of growth in openness do not affect the current value of GRGDP, then the corresponding $F$ ratios will be insignificant. Similarly, if we reverse the roles of the two variables, and run a similar test, we can conclude about causality in the opposite direction.

One problem of Granger causality test is that there is no *a priori* theory which tells us what lag length to use. One convenient way is to choose a lag length that minimizes prediction error. In our test, we used Akaikes Final Prediction Error (FPE) criterion in deciding the number of lags in equation (3).

Results of $F$ statistics using (4) are reported in Table 2. These are reported as $F_1$ and $F_2$ values. $F_1$ is the $F$ statistic in (4) where the null we are testing is $H_0$: GRGDP does not Granger cause GOP. $F_2$ is the $F$ statistic in (4) where the null we are testing is $H_0$: GOP does not Granger cause GRGDP. There are 13 countries for which $F_1$ is rejected. These include the following developed countries: Australia, Finland, Sweden and the UK. The rest of these 13 countries are the following developing countries: Bangladesh, Barbados, Colombia, Gambia, Kuwait, Mauritius, Somalia, Uganda

**TABLE 2**

REGRESSION RESULTS FROM FITTING REGRESSION EQUATION (1) AND FROM
GRANGER CAUSALITY TESTS (OF EQUATION (3))

| Country | Obs | $R^2$ | $b$ | $a$ | DW | Model | $F_1$ | $F_2$ | $t_b$ | $t_a$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Algeria | 33 | 0.309 | 0.357 | 0.003 | 2.1 | OLS | 0.1 | 0.58 | 3.94* | 1.79 |
| Angola | 30 | 0.4096 | 0.532 | -0.001 | 1.8 | OLS | 1.89 | 0.24 | 4.52* | -0.008 |
| Argentina | 41 | 0.0066 | -0.04 | 0.21 | 1.91 | OLS | 2.64 | 0.38 | -0.05 | 2.41* |
| Australia | 43 | 0.5101 | 0.311 | 0.25 | 1.79 | OLS | 10.2* | 0.87 | 6.45* | 5.86* |
| Austria | 43 | 0.4404 | 0.24 | 0.025 | 1.86 | OLS | 1.54 | 1.03 | 5.61* | 5.62* |
| Bangladesh | 34 | 0.1083 | 0.122 | 0.03 | 2.07 | AR1 | 6.41* | 1.1 | 1.91 | 2.65* |
| Barbados | 30 | 0.1691 | 0.23 | 0.003 | 1.96 | OLS | 3.9* | 0.94 | 2.58* | 3.73* |
| Belgium | 43 | 0.5086 | 0.202 | 0.02 | 2.15 | AR1 | 0.6 | 5.61* | 6.09* | 4.32* |
| Benin | 33 | 0.4429 | 0.157 | 0.012 | 1.99 | OLS | 0.71 | 0.27 | 5.06 | 1.96 |
| Bolivia | 43 | 0.0051 | 0.111 | 0.031 | 1.76 | OLS | 0.17 | 0.26 | 0.45 | 3.79* |
| Botswana | 30 | 0.572 | 0.572 | 0.017 | 2.1 | AR1 | 1.03 | 0.25 | 6.16* | 1.13 |
| Brazil | 43 | 0.1868 | 0.027 | 0.05 | 2.19 | AR1 | 1.98 | 0.34 | 0.96 | 4.94* |
| Burkina Faso | 34 | 0.0971 | 0.096 | 0.02 | 1.97 | AR1 | 1.17 | 0.15 | 1.99* | 2.19* |
| Burundi | 33 | 0.621 | 0.476 | -0.008 | 2.19 | AR1 | 0.47 | 0.96 | 7.79* | -0.11 |
| Cameroon | 33 | 0.525 | 0.262 | 0.027 | 2.08 | AR1 | 1.37 | 0.2 | 4.39* | 2.11* |
| Canada | 43 | 0.5618 | 0.352 | 0.023 | 1.87 | AR1 | 0.15 | 0.18 | 7.12* | 5.12* |
| Cape Verde | 33 | 0.2281 | 0.287 | 0.045 | 2.02 | OLS | 1.11 | 1.21 | 3.19* | 2.86* |
| Central African Republic | 33 | 0.2823 | 0.275 | 0.012 | 1.92 | AR1 | 1.59 | 0.02 | 3.82* | 1.96 |
| Chad | 33 | 0.1103 | 0.226 | -0.004 | 2.09 | AR1 | 1.66 | 9.6* | 2.29* | -0.028 |
| Chile | 43 | 0.0906 | 0.115 | 0.031 | 1.93 | AR1 | 0.36 | 0.36 | 1.72 | 2.26* |
| China | 33 | 0.2832 | 0.196 | 0.028 | 1.63 | AR1 | 0.28 | 1 | 3.08* | 1.67 |
| Colombia | 43 | 0.2245 | 0.098 | 0.038 | 1.81 | AR1 | 3.35* | 1.11 | 3.22* | 6.21* |
| Comoros | 33 | 0.4262 | 0.268 | 0.021 | 1.85 | AR1 | 0.32 | 0.57 | 4.73* | 1.63 |
| Congo | 33 | 0.4236 | 0.346 | 0.035 | 2.04 | OLS | 0.88 | 0.84 | 4.87* | 2.51* |
| Costa Rica | 43 | 0.2471 | 0.136 | 0.046 | 1.57 | AR1 | 1.58 | 2.85 | 2.23* | 3.83* |
| Cyprus | 43 | 0.5668 | 0.444 | 0.021 | 1.85 | AR1 | 0.93 | 0.87 | 7.4* | 2.01* |
| Czechoslovakia | 31 | 0.1759 | 0.179 | 0.023 | 1.71 | AR1 | 2.17 | 0.27 | 2.36* | 2.07* |
| Denmark | 43 | 0.0752 | 0.169 | 0.023 | 1.78 | AR1 | 0.85 | 3.69* | 1.76 | 3.18* |
| Dominican Republic | 43 | 0.3217 | 0.193 | 0.034 | 2.04 | OLS | 0.08 | 0.04 | 4.52* | 3.52* |
| Ecuador | 43 | 0.6061 | 0.211 | 0.033 | 2.19 | AR1 | 0.53 | 0.25 | 6.95* | 3.69* |
| Egypt | 43 | 0.125 | 0.05 | 0.042 | 1.9 | AR1 | 2.05 | 1.62 | 1.46 | 4.93* |
| El Salvador | 43 | 0.5964 | 0.271 | 0.023 | 1.91 | AR1 | 1.41 | 0.19 | 2.42* | 4.2* |
| Ethiopia | 37 | 0.1226 | 0.116 | 0.028 | 2.1 | OLS | 1.49 | 0.19 | 2.42* | 4.2* |
| Fiji | 31 | 0.4321 | 0.301 | 0.011 | 1.98 | OLS | 0.24 | 0.66 | 4.01* | 0.002 |
| Finland | 43 | 0.6517 | 0.274 | 0.028 | 1.8 | AR1 | 7.43* | 0.61 | 8.33* | 2.3* |
| France | 43 | 0.3145 | 0.664 | 0.034 | 2.02 | AR1 | 2.9 | 2.11 | 1.88 | 5.38* |
| Gabon | 33 | 0.3466 | 0.512 | 0.038 | 1.93 | AR1 | 0.96 | 1.56 | 3.97* | 1.34 |
| Gambia | 31 | 0.4127 | 0.401 | 0.011 | 1.99 | AR1 | 3.78* | 0.81 | 4.42* | 0.82 |
| Ghana | 38 | 0.1572 | 0.113 | 0.025 | 1.94 | AR1 | 0.78 | 0.44 | 2.76* | 2.17* |

TABLE 2 (Continued)

| Country | Obs | $R^2$ | $b$ | $a$ | DW | Model | $F_1$ | $F_2$ | $t_b$ | $t_a$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Greece | 42 | 0.3458 | 0.236 | 0.029 | 1.98 | AR1 | 2.43 | 1.12 | 4.92* | 3.93* |
| Guatemala | 43 | 0.5825 | 0.169 | 0.028 | 1.95 | AR1 | 0.15 | 0.28 | 6.14* | 5.05* |
| Guinea | 34 | 0.606 | 0.317 | -0.001 | 2.16 | OLS | 0.23 | 1.23 | 7.09* | -0.17 |
| Guinea-Bissau | 33 | 0.1804 | 0.182 | 0.017 | 2.04 | AR1 | 0.7 | 0.27 | 2.06* | 1.2 |
| Guyana | 41 | 0.6004 | 0.439 | 0.001 | 1.94 | AR1 | 3.12 | 7.66* | 10.94* | 0.1 |
| Haiti | 30 | 0.2822 | 0.187 | 0.012 | 1.94 | AR1 | 1.59 | 3.35* | 3.49* | 2.47* |
| Honduras | 43 | 0.3458 | 0.193 | 0.031 | 1.85 | AR1 | 2.61 | 2.36 | 4.22* | 4.73* |
| Hong Kong | 33 | 0.279 | 0.297 | 0.058 | 2.04 | AR1 | 2.32 | 0.38 | 3.24* | 4.41* |
| Iceland | 43 | 0.0808 | 0.027 | 0.043 | 1.09 | AR1 | 0.12 | 0.59 | 0.61 | 3.33* |
| India | 43 | 0.0368 | 0.086 | 0.036 | 1.95 | AR1 | 0.56 | 0.66 | 1.45 | 4.27* |
| Indonesia | 33 | 0.1673 | 0.002 | 0.062 | 2.09 | AR1 | 0.76 | 0.08 | 0.15 | 4.31* |
| Iran | 38 | 0.4161 | 0.253 | 0.029 | 1.89 | AR1 | 1.52 | 2.08 | 4.75* | 1.67 |
| Iraq | 35 | 0.5613 | 0.497 | 0.024 | 1.87 | OLS | 0.28 | 1.37 | 6.57* | 1.4 |
| Ireland | 43 | 0.229 | 0.145 | 0.027 | 1.86 | AR1 | 2.8 | 0.12 | 2.85* | 4.78* |
| Israel | 40 | 0.3109 | 0.091 | 0.064 | 1.81 | AR1 | 0.91 | 1.68 | 2.13* | 5.8* |
| Italy | 43 | 0.3776 | 0.157 | 0.032 | 1.93 | AR1 | 1.73 | 0.53 | 4.5* | 6.43* |
| Ivory Coast | 33 | 0.5626 | 0.45 | 0.019 | 1.89 | AR1 | 0.1 | 2.69 | 5.41* | 1.4 |
| Jamaica | 39 | 0.137 | 0.142 | 0.024 | 1.9 | AR1 | 2.46 | 0.95 | 2.27* | 1.85 |
| Japan | 43 | 0.3661 | 0.179 | 0.067 | 1.98 | AR1 | 2.04 | 0.86 | 0.54 | 5.64* |
| Jordan | 37 | 0.0162 | 0.112 | 0.054 | 1.91 | OLS | 0.59 | 0.65 | 1.25 | 2.82* |
| Kenya | 43 | 0.4565 | 0.371 | 0.027 | 2.13 | OLS | 1.28 | 0.31 | 5.95* | 3.23* |
| Kuwait | 30 | 0.941 | 1.089 | 0.008 | 1.92 | AR1 | 6.49* | 3.13 | 24.47* | 1.25 |
| Lesotho | 33 | 0.3335 | 0.248 | 0.036 | 1.91 | AR1 | 0.67 | 3.15 | 3.54* | 2.42* |
| Luxemburg | 43 | 0.4022 | 0.317 | 0.018 | 2.02 | OLS | 0.05 | 0.48 | 5.34* | 2.57* |
| Madagascar | 33 | 0.228 | 0.167 | 0.011 | 1.97 | AR1 | 0.32 | 0.78 | 3.24* | 0.19 |
| Malawi | 39 | 0.4679 | 0.297 | 0.027 | 1.96 | AR1 | 0.53 | 1.32 | 5.86* | 4.93* |
| Malaysia | 38 | 0.7612 | 0.434 | 0.028 | 1.98 | AR1 | 2.91 | 5.05* | 10.62* | 3.65* |
| Mali | 32 | 0.0052 | 0.032 | 0.021 | 1.95 | AR1 | 0.12 | 1.94 | 0.56 | 2.41* |
| Malta | 36 | 0.256 | 0.179 | 0.041 | 1.92 | AR1 | 0.31 | 6.19* | 2.49* | 3.96* |
| Mauritania | 33 | 0.2748 | 0.213 | 0.017 | 2.02 | OLS | 0.17 | 2.71 | 3.57* | 1.41 |
| Mauritius | 43 | 0.521 | 0.521 | 0.007 | 1.98 | OLS | 10.5* | 1.04 | 1.32 | 1.34 |
| Mexico | 43 | 0.2149 | 0.199 | 0.042 | 1.82 | AR1 | 0.07 | 0.51 | 2.5* | 4.23* |
| Morocco | 43 | 0.0861 | 0.144 | 0.043 | 1.98 | AR1 | 0.37 | 5.17* | 1.78 | 4.2* |
| Mozambique | 33 | 0.0274 | 0.017 | 0.009 | 2.05 | AR1 | 1.57 | 0.35 | 0.68 | 0.67 |
| Myanmar | 40 | 0.4411 | 0.293 | 0.043 | 1.83 | AR1 | 1.74 | 0.17 | 5.56* | 4.15* |
| Namibia | 33 | 0.2509 | -0.25 | 0.052 | 1.92 | OLS | 1.54 | 0.07 | 3.37* | 4* |
| Netherlands | 43 | 0.3652 | 0.194 | 0.027 | 1.78 | AR1 | 0.89 | 1.27 | 3.55* | 3.75* |
| New Zealand | 43 | 0.2808 | 0.218 | 0.019 | 1.71 | AR1 | 0.56 | 1.44 | 3.97* | 2.35* |
| Nicaragua | 41 | 0.0008 | 0.009 | 0.031 | 1.75 | OLS | 0.75 | 0.25 | 0.17 | 2.13* |
| Niger | 30 | 0.5372 | 0.453 | 0.005 | 2.05 | AR1 | 0.25 | 0.15 | 5.41* | 0.39 |
| Nigeria | 43 | 0.4861 | 0.337 | 0.017 | 1.88 | AR1 | 0.22 | 0.35 | 5.61* | 0.99 |

**TABLE 2** (Continued)

| Country | Obs | $R^2$ | $b$ | $a$ | $DW$ | Model | $F_1$ | $F_2$ | $t_b$ | $t_a$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Norway | 43 | 0.5841 | 0.264 | 0.025 | 1.96 | AR1 | 2.62 | 1.74 | 6.2* | 5.28* |
| Pakistan | 43 | 0.1657 | 0.145 | 0.037 | 2.08 | AR1 | 2.74 | 1.69 | 3.36* | 4.55* |
| Panama | 43 | 0.4439 | 0.402 | 0.027 | 1.8 | OLS | 0.27 | 0.49 | 5.8* | 3.76* |
| Papua New Guinea | 33 | 0.6466 | 0.447 | 0.047 | 1.8 | OLS | 2.21 | 0.71 | 7.59* | 0.74 |
| Paraguay | 43 | 0.4782 | 0.297 | 0.02 | 1.93 | AR1 | 2.63 | 0.39 | 6.93* | 1.61 |
| Peru | 43 | 0.1883 | 0.13 | 0.03 | 1.72 | AR1 | 1.62 | 3.29 | 1.9 | 2.37* |
| Philippines | 43 | 0.3582 | 0.057 | 0.039 | 1.72 | AR1 | 2.46 | 0.07 | 1.63 | 3.95* |
| Portugal | 41 | 0.2412 | 0.152 | 0.041 | 0.18 | AR1 | 1.31 | 1.66 | 3.24* | 5.28* |
| Puerto Rico | 35 | 0.6441 | 0.192 | 0.043 | 1.99 | OLS | 0.45 | 1.99 | 2.25* | 3.81* |
| Reunion | 30 | 0.0005 | -0.19 | 0.071 | 1.94 | OLS | 0.02 | 1.08 | -0.11 | 3.97* |
| Romania | 30 | 0.2101 | 0.125 | 0.056 | 2.03 | OLS | 0.02 | 0.45 | 0.99 | 1 |
| Rwanda | 33 | 0.1488 | 0.22 | 0.031 | 1.87 | OLS | 1.98 | 2.51 | 2.53* | 2.03* |
| Saudi Arabia | 30 | 0.9191 | 0.804 | 0.012 | 1.86 | AR1 | 0.14 | 0.25 | 17.13* | 1.2 |
| Senegal | 32 | 0.0971 | 0 | 0.029 | 2 | AR1 | 1.93 | 0.4 | -0.03 | 5.63* |
| Seychelles | 31 | 0.3029 | 0.218 | 0.04 | 1.86 | OLS | 0.73 | 0.94 | 3.68* | 3.18* |
| Sierra Leone | 32 | 0.4138 | 0.332 | 0.013 | 1.76 | OLS | 3.25 | 1.53 | 4.71* | 1.06 |
| Singapore | 33 | 0.3737 | 0.189 | 0.071 | 1.83 | AR1 | 1.22 | 0.02 | 2.86* | 5.38* |
| Somalia | 30 | 0.3401 | 0.136 | 0.019 | 2.13 | AR1 | 4.41* | 0.21 | 3.03* | 1.15 |
| South Africa | 43 | 0.5206 | 0.272 | 0.027 | 1.73 | AR1 | 1.31 | 1.87 | 6.51* | 4.58* |
| South Korea | 39 | 0.1911 | 0.095 | 0.068 | 1.95 | OLS | 2.7 | 0.07 | 2.2* | 5.65* |
| Soviet Union | 30 | 0.0914 | 0.085 | 0.044 | 1.99 | AR1 | 0.22 | 0.04 | 1.46 | 6.05* |
| Spain | 43 | 0.1013 | 0.108 | 0.04 | 1.78 | AR1 | 0.72 | 2.06 | 1.57 | 4.18* |
| Sri Lanka | 43 | 0.3988 | 0.285 | 0.027 | 2.07 | OLS | 1.63 | 0.25 | 5.31* | 4.87* |
| Surinam | 30 | 0.4382 | 0.487 | 0.009 | 1.81 | OLS | 0.18 | 0.47 | 4.77* | 0.7 |
| Swaziland | 30 | 0.3946 | 0.444 | 0.021 | 2.11 | OLS | 0.29 | 0.06 | 4.38* | 1.14 |
| Sweden | 43 | 0.2399 | 0.063 | 0.023 | 2 | AR1 | 4.68* | 0.47 | 1.95 | 4.47* |
| Switzerland | 43 | 0.6455 | 0.254 | 0.02 | 1.7 | AR1 | 1.37 | 0.39 | 7.09* | 2.99* |
| Syria | 32 | 0.5063 | 0.428 | 0.037 | 2.07 | AR1 | 1.37 | 2.73 | 4.6* | 2.48* |
| Taiwan | 40 | 0.2092 | 0.149 | 0.067 | 1.77 | OLS | 0.14 | 1.41 | 3.32* | 9.13* |
| Thailand | 43 | 0.2757 | 0.259 | 0.043 | 2.15 | OLS | 1 | 0.23 | 4.07* | 9.4* |
| Togo | 33 | 0.4894 | 0.314 | 0.025 | 2.1 | OLS | 1.71 | 1.42 | 5.31* | 2.32* |
| Trinidad and Tobago | 42 | 0.5778 | 0.473 | 0.028 | 2.07 | OLS | 0.67 | 0.53 | 7.46* | 3.29* |
| Tunisia | 33 | 0.1977 | 0.165 | 0.044 | 2.12 | OLS | 2.5 | 3.06 | 2.93* | 6.29* |
| Turkey | 43 | -0.021 | -0.01 | 0.058 | 1.92 | OLS | 2.2 | 0.4 | -0.38 | 5.94* |
| Uganda | 43 | 0.1187 | 0.211 | 0.024 | 2.05 | AR1 | 6.85* | 3.46* | 2.13* | 1.29 |
| United Kingdom | 43 | 0.1221 | 0.08 | 0.022 | 1.9 | AR1 | 7.07* | 0.95 | 1.97* | 5.1* |
| United States | 43 | 0.1778 | 0.166 | 0.021 | 1.98 | AR1 | 1.76 | 6.51* | 3.17* | 4.17* |
| Uruguay | 43 | -0.011 | 0.048 | 0.018 | 1.67 | OLS | 3.64* | 1.29 | 0.75 | 1.78 |
| Venezuela | 43 | 0.4588 | 0.231 | 0.036 | 2 | AR1 | 1.36 | 0.11 | 5.74* | 4.8* |
| West Germany | 43 | 0.3964 | 0.16 | 0.031 | 1.94 | AR1 | 2.99 | 0.31 | 2.82* | 3.83* |
| Yugoslavia | 31 | 0.0407 | 0.12 | 0.032 | 1.8 | OLS | 1.3 | 0.72 | 1.49 | 2.54* |

TABLE 2 (Continued)

| Country | Obs | $R^2$ | $b$ | $a$ | $DW$ | Model | $F_1$ | $F_2$ | $t_b$ | $t_a$ |
|---------|-----|-------|-----|-----|------|-------|-------|-------|-------|-------|
| Zaire | 40 | -0.021 | 0.023 | 0.034 | 1.94 | OLS | 2.06 | 1.3 | 0.486 | 2.69* |
| Zambia | 37 | 0.2655 | 0.282 | 0.014 | 2.07 | OLS | 0.88 | 2.65 | 3.69* | 1.35 |
| Zimbabwe | 39 | 0.381 | 0.311 | 0.027 | 1.84 | AR1 | 0.4 | 0.42 | 5.12* | 2.74* |

Note: (1) $t_b$ and $t_a$ are $t$ test statistics for $b$ and $a$ respectively (in equation
(1)). We have assigned an * for the $t$ values significant at 5% level.
The level varies across countries because of the difference in sample
sizes. (2) $F_1$ and $F_2$ are $F$ statistics for testing the null hypothesis of
noncausality between GRGDP and GOP. We have assigned an * for $F$
values significant at 5% level. (3) $DW$ stands for Durbin-Watson
statistic. (4) OLS stands for ordinary least square and AR1 stands for
autoregressive model of order 1. Autoregression refers to the error
process of the regression equation (1).

and Uruguay. There are 10 countries for which $F_2$ is rejected.
These include the following developed countries: Belgium, Denmark
and the USA. The developing countries in this group are Chad,
Guyana, Haiti, Malaysia, Malta, Morocco and Uganda. Of the 124
countries, the two-way causality holds only for Uganda. In a recent
study, Liu, Song and Romilly (1997) find two-way causality between
openness and economic growth, we find no causality in any
direction. However, we use a much longer data period for China.
They use more quarterly data from 1980 while we use annual data
from 1960. Their data comes from the official Chinese data source.
It has been amply demonstrated that official Chinese data (especially
quarterly data) is inherently unreliable. What is somewhat surprising
is that none of the newly industrializing countries show any causal
relationship in either direction (but, it is not surprising according
to Hsieh (1999)).

## IV. Time Series Approach

For standard OLS estimates to be meaningful, we have to have
the underlying dependent and independent variables $I(0)$ or that
they be cointegrated. Thus, as noted earlier, we pursue the time
series approach for 124 countries for which we have done the
causality tests.

It is still possible for the error process in equation (1) to be
autocorrelated. Autocorrelated disturbances will not produce an

unbiased estimate of *b*. We have taken into account of the autocorrelated disturbance in our estimates in Table 2. This is indicated under the column heading of error process. It shows that for most countries the disturbances are autocorrelated. However, autocorrelation of order 1 was sufficient to generate reasonable Durbin-Watson statistic. For most countries, estimate of *b* is positive and significant. The median value of the estimate of *b* is 0.2050. We use the median value of *b* (rather than the mean) because the oil producing countries (e.g. Saudi Arabia) will bias the value upward.

This result is very close to the cross section result obtained by Sinha and Sinha (1996) despite their sample being restricted to a handful Asian countries. However, their time series estimates had an average value of 0.18. But they had very few countries for their time series analysis.

We investigate how different regions show differences in the strengths in the estimate of *b*. For OECD countries, the average value of *b* is 0.2051. This includes 24 countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Luxemburg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States, West Germany). Among them, Turkey shows a negative number. All the countries that rely a great deal on trade (such as Luxemburg) come up with very high numbers. It also shows how important trade has been for geographically isolated countries (such as Australia).

For countries classified under Asia by the World Bank (1992), the average value of *b* is 0.2166. It is widely trumpeted that trade has played a very important role in the newly industrialized countries in Asia. One surprising result is that the value of *b* is below the Asian average for Singapore, South Korea and Taiwan. Has trade not played as big a role as people have thought earlier? This revisionist view is gaining currency (see, for example, Hsieh 1999). Among the emerging Asian countries, Malaysia and Thailand have a value of *b* which is higher than the Asian average, while Indonesia and Thailand have a lower than average value. For Sub-Saharan Africa, the average value is 0.2511. Thus, the average value for sub-Saharan Africa is higher than the average for Asia. This may indicate that at a lower level of economic growth, free trade policies produce bigger dividend. For Latin American countries,

the average is 0.1810. It is well known that the Latin American countries followed an inward looking import substitution policy for a longer time than the newly industrialized countries in Asia. Also, the growth record of the Latin American countries has been far less impressive. For Caribbean countries, the average value of $b$ is 0.2164. Generally speaking, the values for $b$ clearly show the importance of trade for economic growth for developing countries.

What does the result show about Eastern European countries? We have data for four countries for long enough period (Romania, Soviet Union, Czechoslovakia and Yugoslavia). The average value of $b$ is 0.1272. Thus, it is clear that trade in the proper sense of the word (that is, not simply subsidy where market price plays no role at all) hardly played any role in the growth rate of these countries.

When we reclassify the countries according to the World Bank (1992) index of development (developed, less developed and least developed), the average value of $b$ for less developed is 0.24 and for least developed countries the average value of $b$ is 0.24. For the countries in the Middle East, excluding Israel, the value of $b$ is 0.5304. In general, OPEC countries which are located in the Middle East show a marked high value of $b$ is pushed upward because of oil export. Many of these countries ran high trade surplus during the 1970s and parts of 1980's. Obviously for these countries oil boom has indeed generated economic growth (as a stark contrast among the countries of the Middle East, the value of $b$ for Jordan, which has very little oil, is 0.112 much lower than the rest of the countries in the region).

In summary, time series analysis of 124 countries around the world indicates that there is a significant and positive relationship between openness and economic growth. Further, we find the relationship gives a robust value of $b$ around 0.2.

## V. Summary and Conclusions

We have explored the relationship between openness and growth based on evidence from 124 countries. We have used the more natural definition of openness. Previous studies have looked at the relationship between exports and economic growth, by using exports as a proxy for openness. We have performed two types of analyses in this paper. First, we pursue causality tests between openness

and growth. Causality tests have to be preceded by unit root tests to ensure that the variables are either integrated of order zero or that they are cointegrated. Causality tests show that we can reject the null hypothesis that growth of openness does not Granger cause growth of GDP for 11 countries. On the other hand, we can reject the null hypothesis that growth of GDP does not Granger cause growth of openness for 18 countries. Second, we conduct time series analysis for those countries for which causality tests are performed. We find that there is a positive significant relationship between the growth in openness and the growth in GDP for 94 countries. Thus, our analyses add weight to Romer's stylized fact.

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